January 19, 2021

The Honorable Chair and Members
of the Hawai‘i Public Utilities Commission
Kekuanao‘a Building, First Floor
465 South King Street
Honolulu, Hawai‘i 96813

Dear Commissioners:

Subject: Docket No. 2018-0165
Instituting a Proceeding to Investigate Integrated Grid Planning
Hawaiian Electric Companies Updated Workplan

In response to Order No. 37419 *Providing Guidance* issued in the subject proceeding on November 5, 2020, the Companies[1] respectfully submit an update on the Integrated Grid Planning ("IGP") Workplan,[2] revised timelines for review points, and other milestones and deliverables.

The Companies request, to the extent possible, Commission feedback on the Review Point[3] within 30 days to allow the Companies to incorporate any feedback into the final IGP inputs and assumptions. The Companies appreciate the opportunity to update the Commission on the updated workplan and schedule and look forward to continued progress incorporating the process improvements set forth therein.

Sincerely,

/s/ Kevin M. Katsura

Kevin M. Katsura
Director
Regulatory Non-Rate Proceedings

Enclosure

c: Service List

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1 The "Companies" refers to Hawaiian Electric Company, Inc., Maui Electric Company, Limited, and Hawai‘i Electric Light Company, Inc.

2 Filed in Docket No. 2018-0165 on May 27, 2020 and available at https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/dkt_20180165_20200527_IGP_workplan_schedule.pdf

3 See Exhibit A, IGP Review Point, for the draft inputs and assumptions for the Companies 2020 IGP process modeling.

Hawaiian Electric Companies Updated IGP Workplan & Review Point

January 2021

EXECUTIVE SUMMARY

Commission Order 37419, which provided guidance on the Integrated Grid Planning ("IGP") process, highlighted Commission emphasis on several primary points: stakeholder engagement, coordination, transparency, and deadlines. In response, the Companies have prepared this updated workplan, including status updates that should alleviate some of the Commission concerns highlighted in the Order. Additionally, Exhibit A contains the IGP Review Point for the draft inputs and assumptions for Hawaiian Electric's 2020 Integrated Grid Planning process modeling. To facilitate and maintain the schedule illustrated in the updated IGP Workplan, Hawaiian Electric requests Commission feedback on the review point within 30 days so that the Companies can incorporate Commission feedback into the final IGP inputs and assumptions. The Companies envision submitting the final IGP inputs and assumptions by the end of the first quarter of 2021.

For stakeholder engagement, Section 2 of this workplan update summarizes IGP stakeholder engagement to date and articulates the many ways that the Stakeholder Council and working groups' input and feedback has resulted in iterative development and refinement of the IGP deliverables. The intent of the IGP was to engage with stakeholders early in the planning process so that their input and feedback could be utilized during the planning process, rather than only giving stakeholders an opportunity to provide feedback after the planning process was complete. The specific working group deliverables are identified with footnote links to the associated documentation, including meeting notes documenting the stakeholder feedback and providing insight into the level of transparency of the IGP process. These work products were a truly collaborative effort with participating stakeholders. Exhibit C is included to provide the Commission with the IGP Public Meeting and Virtual Open House Feedback.

IGP coordination is a challenge given the multiple parallel or new dockets and initiatives that either have a bearing on IGP or vice versa, but the Companies continue to coordinate across these dockets and initiatives. For example, the May 27, 2020, IGP workplan update noted that the results from the CBRE and DER Policies dockets would be an input to IGP. Section 1 of this updated workplan identifies additional dockets and initiatives whose outcomes will have a bearing on IGP and/or where IGP deliverables provide input to the other dockets and initiatives. However, because progress must be made to complete the first IGP cycle, the Companies have had to make forecasting and planning assumptions for some of the outcomes from these dockets and initiatives. Additionally, there will need to be assumptions made in the integrated needs planning IGP process step, depending on the timing for decisions in the related dockets and outcomes of related initiatives. The next IGP planning cycle would then incorporate the subsequent initiative outcomes and decisions made in other dockets between IGP cycles. Section 1 of this updated workplan also establishes a schedule for the IGP process steps in order to complete this first IGP planning cycle, and it summarizes potential impacts from implementing some of the Commission's guidance from Order 37419.

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OVERVIEW

The Hawaiian Electric Companies[1] ("Companies") are submitting this Integrated Grid Planning ("IGP") Review Point document under Docket No. 2018-0165 to provide the Public Utilities Commission ("Commission") with (1) an updated IGP workplan in response to Commission Order 37419,[2] (2) an update on the status and progress of each working group, including the working group deliverables, and (3) a request for approval of the inputs and forecasts assumptions in Exhibit A1 to be used in the IGP process as well as in related activities.

1 COORDINATION AND SCHEDULE

1.1 IGP WORKPLAN

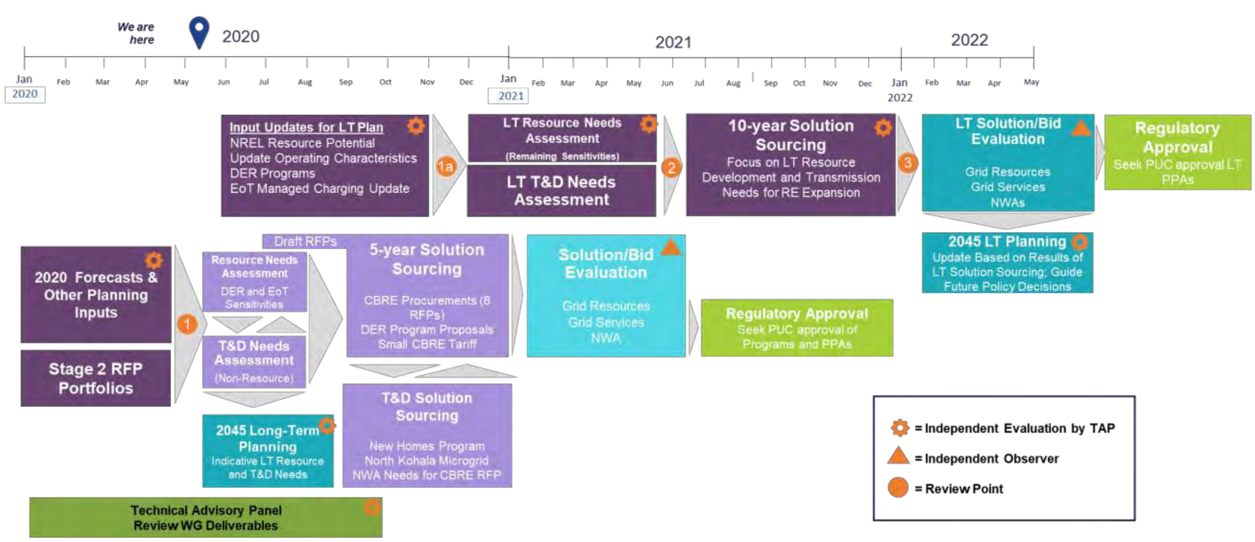
Hawaiian Electric provided an updated IGP Workplan and Schedule to the Commission on May 27, 2020.

That workplan revision was driven by:

- COVID-19 impacts to the Companies;
- The remaining activities for the Competitive Procurement Working Group ("CPWG") and Solution Evaluation Optimization Working Group ("SEOWG");
- The reformation of the Technical Advisory Panel ("TAP"); and
- Recent Commission directives in the CBRE proceeding (Docket No. 2015-0389) and the DER Policies proceeding (Docket No. 2019-0323).

Figure 1 depicts the schedule updates from the May 2020 workplan.

Figure 1 – May 27, 2020 Revised IGP Workplan and Schedule



[1] The "Companies" refers to Hawaiian Electric Company, Inc., Maui Electric Company, Limited, and Hawai'i Electric Light Company, Inc.

[2] See Order No. 37419 Providing Guidance, issued November 5, 2020 in Docket No. 2018-0165.

In March 2020, the forecast and planning inputs, which had been developed with stakeholder input, were considered final, pending final TAP review. As a result of the ongoing COVID-19 pandemic, the March 2020 forecast and planning inputs underwent an update in August 2020, primarily driven by an update to the UHERO economic forecast with consideration for the COVID-19 impacts to the state economy. Exhibit A Review Point includes the Draft IGP Inputs and Assumptions, the documents that were shared with the TAP to assist with their review, and the TAP review document.

Revisiting the forecast and other planning assumptions in light of the COVID-19 economic impact has resulted in some additional schedule delays relative to the May 2020 updated workplan. Hawaiian Electric worked to adapt by conducting working group meetings virtually in order to finalize the working group deliverables. At this time, all working group activity has concluded except the SEOWG, which anticipates at least one or two additional meetings to review the final deliverables with stakeholders.

The Companies anticipated filing the first review point with the Commission in 2020. However, the review of the related methods and results with the TAP has taken longer than originally anticipated. This was largely due to logistical challenges in convening TAP meetings to conduct the review and develop the first TAP review documentation. The TAP recently completed their review of the forecast and planning inputs (see Exhibit A3). Exhibit A1 is a draft of the Inputs and Assumptions that the Companies expect to finalize and file with the Commission in the first quarter of 2021 pending Commission review point feedback. To facilitate and maintain the schedule illustrated in the updated IGP Workplan below, Hawaiian Electric requests Commission feedback on the review point within 30 days so that the Companies can incorporate Commission feedback into the final IGP inputs and assumptions. The Companies envision submitting the final IGP inputs and assumptions by the end of the first quarter of 2021.

While the TAP remains independent with HNEI as chair, improvements in the TAP technical review process and logistics management are necessary to meet the IGP schedule in a timely manner. Hawaiian Electric is working with HNEI to provide additional support and explore other opportunities to expedite the technical review process.

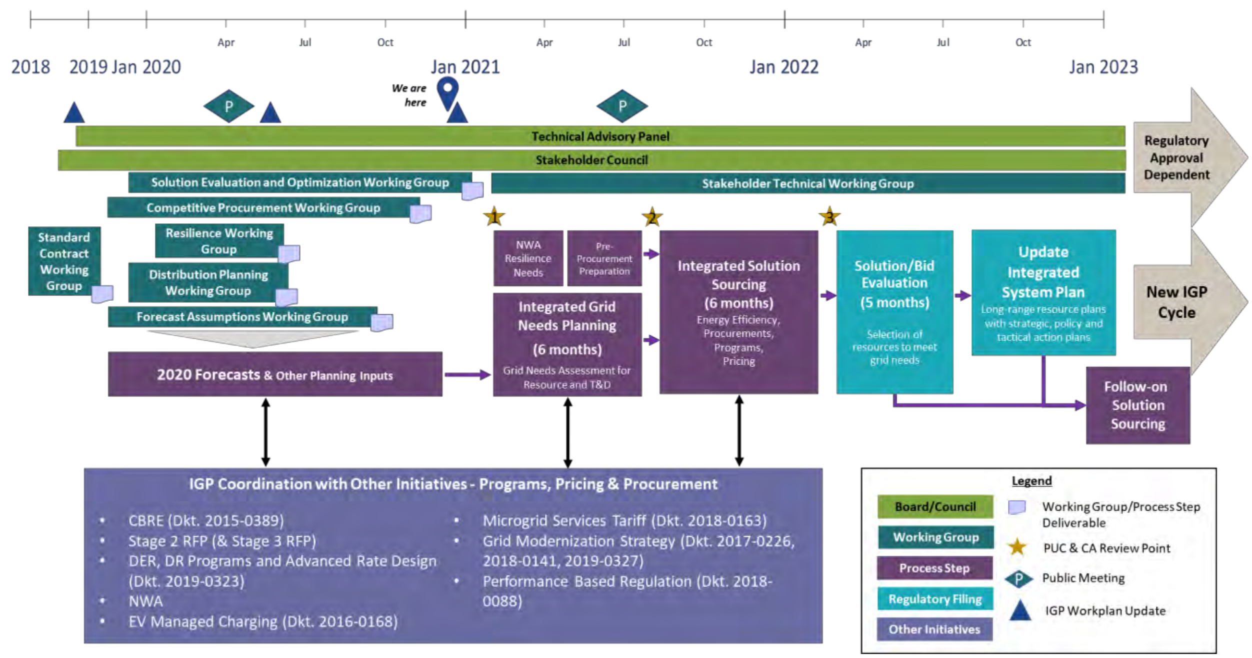
As the Commission noted in its guidance, the Companies have made significant progress through the IGP process to date, resulting in concrete work products that will guide the next phase of the process – integrated grid needs assessment and solution sourcing. The Companies are appreciative of all the time and effort put forth by all stakeholders to help improve the IGP process, inputs, assumptions, and methodologies to truly create a best-in-class integrated planning process. The stakeholder engagement and associated working group deliverables are more fully described in Section 2. The efforts of all involved in the stakeholder process are documented through the following work products:

- Distribution Planning Methodology
- Non-Wires Opportunity Evaluation Methodology
- Draft Inputs and Assumptions Document
- Draft SEOWG Methodology (via Email)
- Resilience Working Group Report
- Revised Competitive Bidding Framework
- Soft Launch RFP, including the Independent Observer's Report
- Standardized Contracts for Grid Services

1.1.1 IGP PROCESS STEPS

Recognizing the Commission's request for "*revised, realistic timelines for the major IGP steps*", Figure 2 is an updated illustration of the expected IGP process steps and a brief description of each step. Meeting this revised schedule partly depends on other regulatory activities and on high-priority initiatives planned for next year due to resource availability and interdependencies with other ongoing initiatives, as discussed below. There is some opportunity for accelerating this timeline if the number of procurement-related filings that Hawaiian Electric makes to the Commission can be reduced, resulting in more streamlined integrated solution sourcing and solution/bid evaluation, as described in Section 2.5 summarizing CPWG activities.

Figure 2 – Updated IGP Status and Workplan



1.1.1.1 IGP Coordination with Other Activities

A number of dockets and initiatives have a bearing on IGP, and similarly IGP has implications for certain dockets and initiatives.[3] The activities, decisions, procurements, and projects associated with these initiatives and dockets are not sequential or time-aligned, and it is not practical to do so at this point. Therefore, while progress in those dockets must be monitored, it is necessary to make assumptions regarding the outcomes or decisions from these activities in order to move forward with IGP activities. However, the eventual outcome from these dockets and initiatives may deviate from these assumptions. As a result, a decision in a regulatory docket or outcome from other IGP-related initiatives may result in adjusting the IGP assumptions. Depending on the timing, docket decisions and initiative outcomes can be reflected in the input assumptions or needs planning process step if those process steps have not yet completed their activity for the current IGP cycle. However, in order to make progress, IGP activities cannot continually stop to go back and revisit process steps each time a decision is reached in a related docket or an initiative outcome is known. Instead, the next iteration of

[3] See Section 1.3 (Interdependencies & Coordination) for IGP coordination details

IGP will need to incorporate the decisions and outcomes from the dockets and initiatives that have occurred since the completion of the prior forecast or needs planning process steps. Because inputs, forecasts, and assumptions have been discussed for the past couple of years, the Companies intend to move forward with the grid needs planning step and start technical analyses in earnest.

1.1.1.2 Forecasts and Other Planning Inputs

The Companies have considered the Commission's guidance suggesting a fundamental change to the IGP process:

> *Forecast should be integrated into the IGP planning process through a series of feedback loops; iteratively inform needs and solutions*

This approach, previously advanced by a few stakeholders, is at odds with the intent of IGP to reflect market-based solutions and would base the IGP plan on predetermined outcomes – the IGP was originally designed to be technology- and business model–neutral. The IGP competitive market-based process has unfortunately been under pressure from the outset as several stakeholders have consistently sought to shape the results of the IGP process to fit their business interests through non-competitive tariffs and programs. That is, some stakeholders are trying to prescriptively shape forecast and sensitivities so that the IGP achieves their desired ends. This is in stark contrast to the spirit and intent of IGP.

The Companies believe that customers would be better served if these interests were addressed in the respective dockets that are focused on the very detailed issues associated with developing new tariffs and programs. The IGP forecast and planning assumption step is not the proper place to conduct an unconstrained number of modeling sensitivity iterations stemming from brainstorming efforts on new tariff and program design ideas. This should be a separate activity in support of the respective dockets. IGP should instead be focused on articulating the forecasts and planning needs that describe the challenges that the tariffs and programs should be designed to address.

Thus, the Companies believe that a baseload forecast with two bookended sensitivities, as recommended by the TAP, is an appropriate starting point for IGP long-term planning. Near-term action plan development under the IGP, is based on market responses to defined needs. This can be accomplished with a base reference load forecast and two sensitivities, as is commonly accepted in the industry. The current approach with an ad hoc set of planning and modeling sensitivities reflecting individual stakeholder interests may not achieve the strategic discussion sought by the Stakeholder Council ("SC") or properly inform a 25-year plan and attendant uncertainties.

The various proposed sensitivities and forecast iterations and resource model runs raised by stakeholders are better done in parallel with this IGP cycle in support of the various dockets described here to inform the development of tariffs and programs. The resulting tariffs and programs will be used in the assumptions for the next cycle of forecasts and IGP planning. In this way, the next IGP cycle can reflect the final outcomes of these dockets while not delaying the current cycle. This is a necessary consideration, as the Companies believe the current IGP procurements and plans should be based not on hypothetical tariff designs and programs but on those the Commission has approved. Also, the related dockets do not have timelines for completion that align with the IGP process. For example, final advanced rate design proposals and final DER program proposals are expected to be submitted on March 1, 2021, and May 3, 2021, respectively.

Energy Efficiency

As discussed and documented in the Forecast Assumptions Working Group ("FAWG"), Energy Efficiency ("EE") was incorporated into the load forecast based on the AEP Hawaii Statewide Market Potential Study. The load forecast adjustment for EE is "*consistent and comparable basis with supply-side resources*" and depends upon Hawaii Energy to deliver these EE savings to Hawaii energy consumers. It is not immediately clear what the Commission intends with its guidance regarding EE, given that EE is the responsibility of Hawaii Energy. However, the Companies remain committed to working with Hawaii Energy and the Commission to support EE programs that optimize the programs' value. This can be done through analytic support similar to that provided for each of the relevant Commission dockets.

In order for the Companies to model EE on a basis comparable to other supply-side resources, the following information would need to be developed by Applied Energy Group ("AEG") as modeling inputs

- Annual developable potential for each modeled EE resource
- Hourly load shape of the EE resource
- EE resource service life and assumed annual degradation of the resource impacts, if any
- Annual cost of the EE resource
- Operational limits on the EE resource that constrain its usage

As such, the Companies fully expect to continue supporting the intent of the Commission's guidance in parallel through the current dockets addressing tariffs and program development as well as supporting Hawaii Energy's program design efforts.

Electrification of Transportation ("EoT") Forecast and Resource Planning

In the context of IGP, the unmanaged electric vehicle charging assumption is incorporated into the baseline forecast. The outcomes from managed charging will then modify this forecast based on specific program provisions. Essentially, managed charging then becomes a programmatic or pricing-based approach to adjust the base forecast. IGP has made assumptions regarding EoT adoption and charging, and will make updates (as described above) based on the outcomes of the EoT-related dockets and resulting EoT programs and tariffs. The Companies are working with E3 (as part of the EoT-related dockets) to develop a managed charging profile to incorporate as a load forecast input layer. The managed charging scenario will consider electric vehicle driver response to pilot time-of-use rates for each island, which were developed using base models currently being used as part of IGP and other proceedings (i.e., CBRE and DER Policy dockets). E3's linear optimization will be used to model drivers who shift their usage to reduce their electricity bill while still retaining enough state of charge to meet their underlying driving profile. The intent is to shift charging to late-night and midnight hours to take advantage of lower time-of-use rates. The managed charging will be load-neutral with respect to the unmanaged charging currently assumed in the IGP forecast on an annual basis.

The inputs for the EoT forecast, including electric vehicle counts and vehicle miles traveled, have been shared with the FAWG and are available on the FAWG web page.[4] Further details on the EoT forecast were provided in response to PUC-HECO-IR-1, filed July 2, 2020, in the IGP docket.

1.1.1.3 Integrated Grid Needs Planning

Realistically, the prior IGP process steps with separate T&D and resource needs assessment is a single integrated grid needs planning process step to perform a grid needs assessment. The IGP is now primarily focusing on integrated grid needs assessment to identify near- and long-term grid needs using the novel planning methods developed with stakeholders over the past couple of years. For example, the Companies have worked with E3 to modify the RESOLVE model that now develops avoided costs of various grid services: energy, ERM (capacity), regulation, inertia, and fast frequency response. This is an improvement over the Power Supply Improvement Plan ("PSIP"),[5] which did not incorporate any directional system security constraints or other services aside from energy and capacity. The SEOWG meeting on October 2, 2020, was an initial preview of the RESOLVE modeling utilizing the Draft Inputs and Assumptions document that was developed in the FAWG and SEOWG discussions.[6] The Companies posted the Input and Assumptions draft document on the FAWG website on September 25, 2020.[7]

The remaining updates to the integrated needs planning inputs that will incorporate data from multiple sources include:

- NREL Resource Potential Study, which was completed on November 6, 2020.[8] The Companies will also evaluate the development of T&D costs to integrate higher amounts of renewable energy resources (i.e., renewable energy zones) as specified by the NREL Resource Potential Study;
- Near-term planned maintenance schedules;
- Capital and operating expenses required to maintain the existing units over the planning horizon for the purposes of optimizing retirements; and
- Updates to the resource portfolio based on Renewable Dispatchable Generation ("RDG"), Community-Based Renewable Energy ("CBRE"), DER procurements, and programs or pricing, to the extent those become available within the next month.

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[4] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200129_wg_fa_meeting_presentation_materials.pdf

[5] See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/power-supply-improvement-plan

[6] See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/solution-evaluation-and-optimization-documents

[7] See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents

[8] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/stakeholder_council/20200818_sc_heco_tech_potential_final_report.pdf

Additions and updates to the draft Inputs and Assumptions documentation[9] and draft Grid Needs Assessment and Solution Evaluation Methodology[10] (deliverables for the FAWG and SEOWG respectively), including those mentioned here, and final resolution of recently received stakeholder comments may be provided to the Commission and stakeholders as part of a stakeholder feedback summary and final drafts of both deliverables.

The Companies also intend to issue a revised SEOWG deliverable with accompanying disposition of stakeholder comments in the near future. The Companies issued a draft SEOWG deliverable via email in June 2020 that explains the proposed process and integration of various analytical tools, methods for solution evaluation of resources to fulfill various grid service needs, and grid service definitions, among others. The Companies are also working with the TAP to vet the grid service definitions, methods, and tools proposed in the SEOWG.

Both RESOLVE and PLEXOS modeling will be conducted based on the planning inputs with scenario-based sensitivities to illustrate a range of resource portfolios that can meet the grid needs required to achieve the 100% RPS goals for 2045. The Companies will work with the SC and TAP and seek their feedback as the Companies progress through the grid needs assessment analysis produced by RESOLVE and PLEXOS. This process is intended to align with the Commission's guidance to:

> *Transparently and fairly model the full range of costs and benefits associated with each resource; work with stakeholders at every step in the process*

At this time, the Companies have substantially developed a "reference case" scenario that can be used to inform immediate-term procurements and other ongoing proceedings. The Companies previewed this reference case at the October 2, 2020, SEOWG meeting, and have provided a substantially similar version to the DER Parties' version for use in Docket No. 2019-0323 to assist in designing new programs, use in Docket No. 2020-0152 to design commercial EV rates, and proposed for use in the upcoming CBRE RFPs. The Companies believe that these updated resource plans should be used to scope and inform any forthcoming competitive procurements, including any contemplated Phase 3 procurement for renewable resources.[11] This is a necessary step, as many components and aspects of the December 2016 PSIP action plan have changed as the action plan was executed over the past four years. Additionally, the Companies will use this "reference case" as a baseline scenario, in addition to the other scenarios and sensitivities that the SEOWG and SC developed consensus around in the past year.

The Companies stress that sensitivities and discussion related to modeling analysis in this step of the process do not become a protracted discussion of technology choices. Rather this step is intended to identify the needs and services required to achieve 100 percent RPS, among

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[9] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200925_draft_IGP_inputs_and_assumptions.pdf

[10] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200602_wg_seo_deliverable_draft_v1.pdf

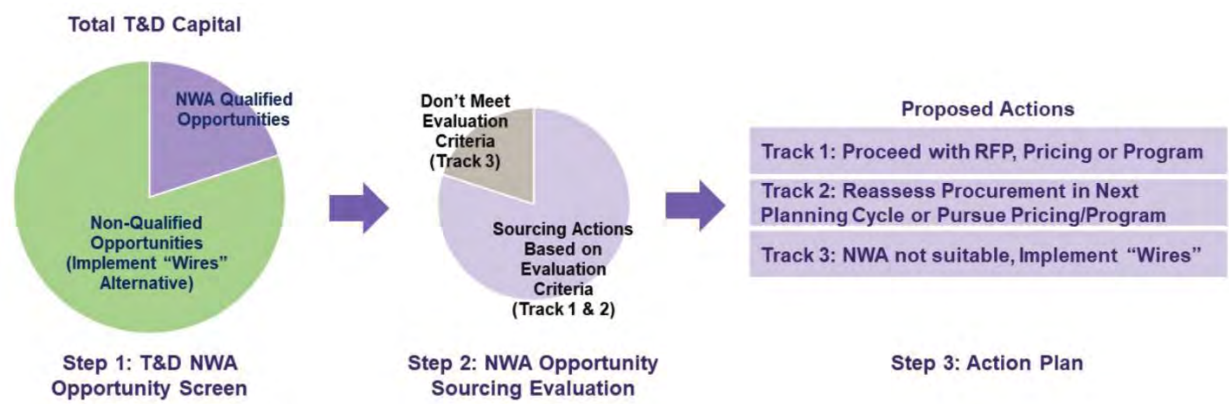
[11] See Docket No. 2017-0122, Order No. 37306, *(1) Denying Hu Honua Bio Energy, LLC's Motion for Reconsideration of Order No. 37205, Issued July 9, 2020, Filed July 20, 2020; and (2) Addressing Related Procedural Motions*, issued on September 9, 2020, at 48.

other policy goals. The solution sourcing will allow the Companies and stakeholders to identify which resources and technologies best meet those needs. That will then translate to a final step in the process whereby the long-term plans are re-optimized and updated with actual market results. As described in Section 1.1.1.7, this then sets the course for investments, policy discussions, and long-term plans to guide other activities until the plan is then updated again during the next IGP cycle.

1.1.1.4 Locational Needs: NWA and Resilience Needs

As part of the CBRE RFP, the Companies have identified distribution grid needs that could qualify for NWA solutions (i.e., Track 1 or 2 opportunities, see Figure 3) and have made those opportunities available in the CBRE RFPs through Appendix O, Grid Needs Assessment.[12] The Companies have also made those opportunities publicly available through the Companies' locational value maps.[13]

Figure 3 – NWA Opportunity Evaluation Process



In response to the Commission's guidance to incorporate resilience into the IGP process, the Companies are building on the RWG's work and report (see Section 2.2) by proposing a resilience framework as described in Exhibit B. This is a topic that would benefit from further SC discussion.

This step in the IGP process will continue these efforts and identify needs that can be sourced through non-wires alternatives ("NWA") at a cost less than it would cost to make a traditional capital investment. Synergistic opportunities where resources can meet locational needs as well as system needs represent potential savings for customers. As explained in the Integrated Solution Sourcing step, finding these "two-for-one" solutions are where the generation, transmission, and distribution realize true integration.

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[12] See Appendix O in Exhibits 5 through 9 in the September 8, 2020 filing of the CBRE Phase 2 Tariff and eFilings, and RFPs at https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs/community-solar/cbre-resources

[13] See https://www.hawaiianelectric.com/clean-energy-hawaii/integration-tools-and-resources/locational-value-maps

1.1.1.5 Pre-Procurement Preparation

This step involves preparing procurement documents for the solution sourcing step with the intent of issuing a draft RFP for stakeholder review near the beginning of the Integrated Solution Sourcing block shown in Figure 2.

1.1.1.6 Integrated Solution Sourcing

IGP integrated solution sourcing provides a holistic approach to evaluating the potential to meet incremental resource, transmission, and distribution requirements through a range of services and resources. It specifically includes services from customer energy resources. The IGP process outlines the sourcing of resources for system needs, which generally involves identification and acquisition of services through three general methods: pricing, programs, and procurements (the 3Ps) described in Table A below:

Table A – Pricing, Programs & Procurements

Mechanism	Description
Pricing	Signaling value and costs through pricing in customer rates. Customers enroll in pricing options rate schedule.
Programs	Enabling customer participation through either energy-efficiency or utility-administered programs. In programs, the customer either purchases an energy efficiency measure in exchange for a rebate or incentive, or enrolls in a utility program and receives an incentive payment, typically in the form of a bill credit.[1]
Procurement	Obtaining energy, capacity, and ancillary services through a competitive procurement process.

The IGP planning process starts with the current state, reflecting existing and approved tariffs and programs as well as existing resources (and contracted resource development) in the forecast. This provides the reference to model the incremental resource and grid services needed. Once incremental resource and grid services needs have been identified, the Companies will initiate sourcing of solutions that meet these needs.

There is a discontinuous dimension to this sourcing, because the regulatory process for determining new tariffs and programs (including Hawaii Energy's energy efficiency programs) is conducted in separate dockets on different timelines that do not align with this initial IGP schedule. The Companies recognize the inherent value of prioritizing customer demand side resources in the development of the resulting solution portfolio. However, due to the timing mismatch it is necessary to incorporate the pending results of the current dockets regarding tariffs and programs for DER, EE, and EoT into the next IGP cycle. It is not appropriate or practical to incorporate a range of hypothetical tariffs and programs into this IGP cycle for the purpose of identifying incremental needs. There is sufficient long-term market opportunity for the value of new tariffs and programs described in the Commission's guidance to consider in the next IGP cycle, especially as customers electrify their means of transportation.

In the meantime, as discussed in this workplan, the Companies will continue to support current Commission tariff and program efforts through analytical modeling outside the current IGP planning process. This separate analytical support will help inform the potential value and shape of these tariffs and programs. The Companies are committed to supporting any discussion regarding how to maximize the value of customer resources and energy efficiency for all customers.

As demonstrated through recent competitive procurement for renewable generation, competitive procurements are the best mechanism to acquire resources at the lowest cost on the market. As such, the Companies have a preference for competitive procurements, whether to acquire DER or grid-scale resources. The current IGP workplan includes an integrated all-resource procurement designed to be ownership- and technology-agnostic to obtain the lowest-cost, best-fit solutions for all customers. Additionally, this procurement will incorporate the identified resource, transmission, and distribution needs. Any near-term needs not met through the procurement will be considered in a follow-on residual needs procurement (as represented by the "Follow-on Solution Sourcing block in Figure 2) and/or program (or addressed by an approved new tariff or program). The scope of this incremental solution sourcing may include immediate NWA or resilience needs that are outside of the regular IGP cycle, for example, where the acquisition of resources do not simultaneously meet locational needs. These follow-on procurements are intended to be streamlined, which is why the Companies will evaluate creating "Form" RFPs for these types of procurements that could be pre-approved by the Commission, as discussed in the CPWG with stakeholders and in revisions to the Competitive Bidding Framework ("CBF").

This approach for this first IGP cycle balances the need to simultaneously conduct an IGP with pressing needs to achieve 2030 goals and specific near-term grid needs while also supporting the ongoing development of the next generation of tariffs and programs to meet Hawai'i's needs. Through this approach, we will have the potential to fully realize the value of independent and customer resources for Hawai'i.

In the CPWG update in Section 2, the Companies describe a number of considerations to streamline the overall competitive procurement and interconnection process, and are currently testing these concepts through various ongoing procurements, which include:

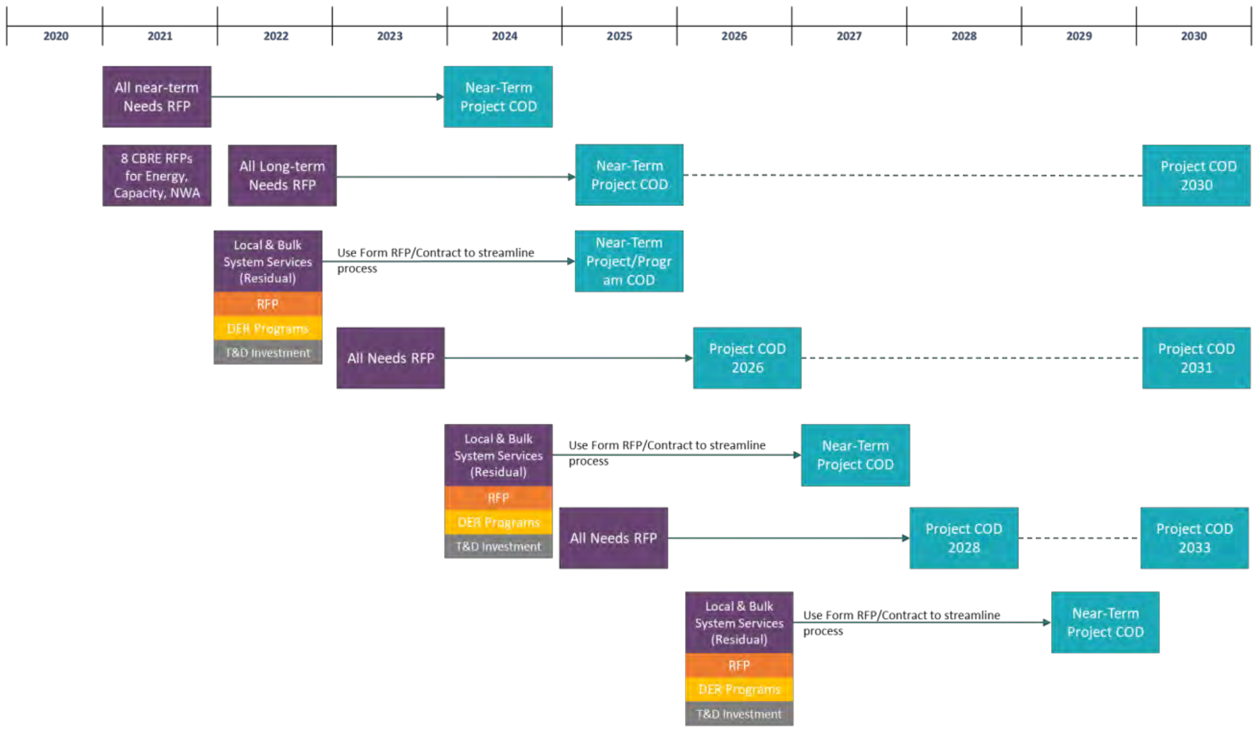
- Specifying certain viable technologies,
- Specifying site selection criteria in greater detail,
- Prescribing components and equipment,
- Using standardized PPAs, and
- Prescribing points of interconnection that have fewer barriers to interconnection, including proactively building transmission facilities in high-potential areas of each island.

1.1.1.7 Updated Integrated System Plan

This step allows for the Companies to develop updated long-range resource plans based on market procurements (as well as developments to pricing and programmatic options). In essence, the Companies and stakeholders will have a near real-time plan that can set forth strategic, policy, and tactical action plans. Through the bid evaluation process, the Companies should be able to re-optimize plans based on final selections made subsequent to the solution sourcing step and identify "residual" grid needs unfulfilled for follow-on solution sourcing.

Figure 4 envisions a cycle of integrated planning and solution sourcing that can create a "living" pathway to the grid we need that will be flexible and adaptable to new technologies as well as to customer needs and that facilitates an energy market in Hawai'i.

Figure 4 – Illustrative IGP Procurement Cycles



1.2 ADDRESSING COMMISSION FEEDBACK ON IGP PROCESS

The Companies remain committed to engaging customers and stakeholders across our various communities of interest. The Companies have been doing this consistently since the 2016 PSIP and are a recognized industry leader in this regard. As such, a significant aspect of the IGP process aligns with the Commission desire for the Companies to incorporate stakeholder feedback into the planning process and is consistent with Commission Order 37419:

> *The Commission has repeatedly emphasized the importance of stakeholder input in the planning process. This means not just presenting findings to stakeholders, but proactively seeking stakeholder feedback, giving stakeholders the time and resources necessary to providing meaningful feedback, and incorporating stakeholder feedback into IGP deliverables.*
>
> *The Commission continues to believe that Hawaiian Electric will benefit by giving these stakeholders meaningful opportunities to develop and improve the IGP process and the plans.*

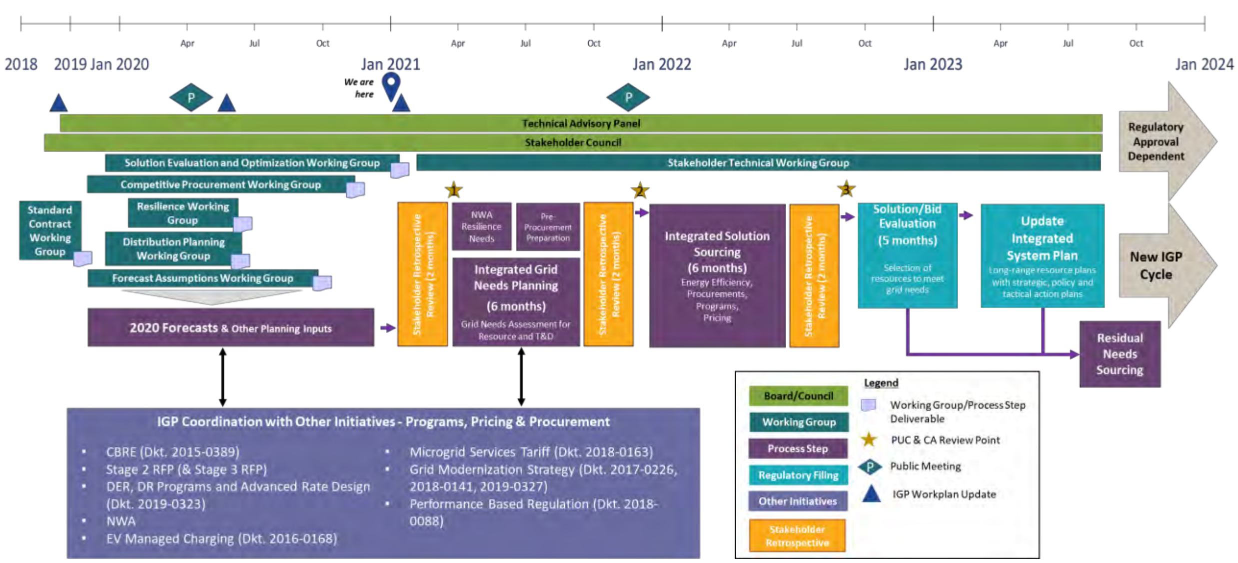
Stakeholder input to each of the working group deliverables is captured in the notes posted to each working group's web page, and the deliverable documents include notations describing how the Companies have incorporated and addressed stakeholder input, as described in the Commission's guidance. Indeed, the hope was that the planning process would become more streamlined because stakeholders had an opportunity to provide input and feedback while work products were being developed, rather than using the more traditional approach of both stakeholders and the Commission reviewing forecasts and plans after they were submitted, which often requires going back to rework the deliverables (e.g., multiple PSIP iterations). It is also hoped that the participation of Commission Staff and the Consumer Advocate in working groups and the SC will also facilitate a more streamlined review of IGP-related regulatory filings.

However, Order 37419 recommends providing the SC with an opportunity to review all of the IGP work products to date:

> *As suggested in the August 18, 2020 Stakeholder Council meeting, one of the first things the re-invigorated Stakeholder Council should consider is a retrospective evaluation of completed IGP deliverables.*

The Companies respectfully maintain that this is unnecessary and redundant and will cause unwarranted delays in the IGP process. The technically oriented SC members have already provided input and feedback during their working group participation on the development and final review of the work products or have had the opportunity to review the publicly accessible documents. Furthermore, the SC is changing its orientation toward more strategic issues, not technical aspects. If the current IGP approach of working with stakeholders during the planning process so that assumptions, inputs, results, and deliverables incorporate stakeholder feedback must also include a "retrospective evaluation" of the work products, it will cause significant delay in the overall IGP planning cycle. As illustrated in Figure 5, these "retrospective evaluations" may add at least two months, and likely more, given meeting logistical challenges, prior to each review point document being filed with the Commission. This would add a total of six or more months to the IGP workplan schedule illustrated in Figure 2. Additionally, if the current level of stakeholder interactions and iterations facilitated by the working groups and SC are insufficient, the process steps depicted will likely take even longer. Additional delays due to retrospective reviews and additional iterations with stakeholders could potentially impact the ability to develop the solutions needed to achieve the 2030 milestone for the RPS portfolio. For example, if new transmission is needed or developers need to develop and deploy technologies, these longer lead-time activities may not be ready by 2030.

Figure 5 – IGP Process Incorporating "Retrospective Evaluation" of Deliverables



To be clear, the Companies are not suggesting that stakeholder feedback is not critical to the IGP process. Rather, the Companies believe that the significant effort put into stakeholder engagement over the past couple of years has significantly improved its work products.

Hawaiian Electric staff is continually working to incorporate input from IGP stakeholders into the deliverables. For example:

- The FAWG provided feedback that a warming trend in forecasted temperatures should be included as a measure of climate change as part of the forecast for the underlying load layer. Subsequent feedback from the FAWG on the Companies' proposed warming trend resulted in a further increase in the assumption.[14]
- Through the feedback from the Distribution Planning Working Group ("DPWG"), the Companies were able to develop a Non-Wires Opportunity Evaluation Methodology, which helped the Commission, the Companies, and stakeholders prioritize and focus NWA efforts. Through these efforts, the Companies have already started using this framework to assess whether NWAs are feasible in seeking approval to commit funds for capital investments greater than $2.5M. Section 2 of that document specifically outlines stakeholder feedback received and how it shaped the methodology. One aspect of the NWA opportunity framework is the consideration of other sourcing mechanisms beyond competitive procurement. In contrast to other jurisdictions surveyed, the Companies added a track to allow NWA opportunities to be solved through programs and tariffs and not just competitive solicitations based on stakeholder feedback. The Companies were unable to acquire a competitive NWA solution through its Soft Launch RFP and has since filed an application for a substation to serve the initial development of the Hoʻopili and East Kapolei area;[15] however, per the NWA opportunity methodology, the Companies will also pursue a programmatic option, as discussed in its application for a new substation.

It is time for the Companies move forward with the current IGP cycle and to utilize the working group deliverables and gain operational experience. The Companies will then be able to apply any lessons learned and update their methodologies, if needed, in time for the next IGP cycle.

1.3 INTERDEPENDENCIES & COORDINATION

Each of the dockets, procurements, programs, and initiatives identified below are interrelated with key interdependencies with the IGP. As described in Section 1.1.1.1 (IGP Coordination with Other Activities), many interrelated activities and decisions occur concurrently; therefore, the IGP process must involve assumptions regarding outcomes from these dockets, procurements, programs, and initiatives. Similarly, these dockets, procurements, programs, and initiatives must make some assumptions regarding grid needs. As decisions are made, the assumptions in the related activities are updated, but in some instances IGP will need to proceed with an earlier assumption because it is too late to go back and start the forecasting, scenario planning, and modeling efforts all over again. In that instance, those decisions and outcomes will need to be incorporated into the subsequent IGP cycle when forecasts and assumptions are reassessed. The anticipated 2-year IGP cycles should allow changes to be

[14] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/dkt_20180165_20200702_HECO_response_to_PUC_IRs_1-2.pdf, at 3.

[15] See Docket No 2020-0182 Kulanihakoi (fka Hoʻopili) Substation application filed November 4, 2020

incorporated sooner than in past long-term planning cycles and provide for the plans to be refreshed more frequently and provide more flexibility.

1.3.1 RENEWABLE ENERGY PROCUREMENT

- Stage 2 Renewable and Grid Services RFPs, Docket No. 2017-0352

The Companies' May 27, 2020, *Update to IGP Schedule, Workplan, and Interdependencies with Other Dockets* filing was developed in part to adjust for the Stage 2 Variable Renewable Dispatchable Generation and Energy Storage RFP such that the results could be considered in the IGP. The proposals have now been received and are being evaluated. The Companies will incorporate changes to final selections, but as the projects progress toward approved PPA applications , the latest changes might not be fully captured. The Companies also do not intend to wait for final decisions on pending approvals of PPAs to freeze assumptions for use in any base case.

- Community-Based Renewable Energy ("CBRE") Program, Docket No. 2015-0389

Phase 2 of the CBRE Program commenced with the issuance of Decision and Order No. 37070 on April 9, 2020. This order expanded the target capacity to 235 MW and emphasized the need for smaller projects and greater customer access. Moreover, related specifically to IGP issues, the Companies will "use evaluation criteria to promote NWA to encourage and facilitate CBRE projects in locations that help defer or obviate conventional investments in transmission and distribution infrastructure…. [and] that can provide community resilience benefits…."[16] The outcomes from the CBRE docket and related CBRE project completions and customer subscriptions will be factored into the energy supply portfolio in the IGP. Currently, the Companies have assumed the full allocation of CBRE program capacity to be in-service by 2025 as a planned resource providing certain grid services under an RDG-type contract. The Companies have also proposed to use the solution-bid evaluation methods proposed in the SEOWG that appropriately value grid services that resources can provide. As part of the solution evaluation, the Companies will use its latest IGP reference case as part of the process, which incorporates the RESOLVE model in the Initial Evaluation using a levelized benefit methodology,[17] with PLEXOS in the Detailed Evaluation to validate selected optimized portfolios.

1.3.2 GRID MODERNIZATION STRATEGY ("GMS")

The IGP was first proposed as part of the GMS. The implementation of GMS and the efforts around IGP have subsequently proceeded within separate dockets:

- Grid Modernization Strategy (GMS), Docket No. 2017-0226

The GMS (as well as the Power Supply Improvement Plan - PSIP) were precursors to IGP. The Commission approved the GMS on February 7, 2018,[18] and the GMS forms the basis for some of the IGP assumptions regarding technical capabilities for future distribution grid management capabilities for monitoring, control, and automation.

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[16] Docket No. 2015-0389, Decision and Order No. 37070, issued on April 9, 2020, at 26.

[17] See, the Companies' Supplemental Response to PUC-IR-128 filed in Docket No. 2015-0389 on December 4, 2020.

[18] Docket No. 2017-0226, Decision and Order No. 35268, issued on February 7, 2018.

- Grid Modernization Implementation Phase 1, Docket No. 2018-0141

As described in the Grid Modernization Strategy Phase 1 Semi-Annual Progress Report and supplement,[19] the Companies intend to adjust the proportional deployment approach for advanced meters and the field area network (FAN) and are making progress in the implementation of the Meter Data Management System (MDMS) with a go live date in April 2021. The advanced meters will provide additional data and insight for customer load profiles, outage notifications and power quality issues related to voltage, which will provide additional data and insight for the IGP in identifying and prioritizing grid needs.

- Grid Modernization Phase 2 ADMS, Docket No. 2019-0327

Order No. 36921 suspended the GMS Phase 2 Advanced Distribution Management System (ADMS) application docket until a distribution field device application has been submitted.[20] The ADMS is the core component providing technical control capabilities for distribution grid management, including sensing, control, and automation. It will take two years for the initial release of the ADMS to be implemented after Commission approval. The Companies anticipate filing the Phase 2 Field Device application in the first quarter of 2021. The ADMS, in conjunction with the field devices and advanced meter data and notifications, will provide operational insight for distribution system situational awareness, including outage conditions and voltage issues. That same data will be utilized for analytics for planning purposes in order for IGP to identify and prioritize grid needs.

1.3.3 CUSTOMER ENERGY RESOURCES

- Distributed Energy Resource Policies, Docket No. 2019-0323

Order No. 37066, issued April 9, 2020, established procedural details for the procedural track for both DER Programs and for Advanced Rate Designs. The new docket continues work done in previous dockets on DER Programs (Docket No. 2014-0192) and Grid Services (Docket No. 2015-0412). The Companies note that the adopted procedural schedule will make it difficult to incorporate decisions and input from working group discussions within this IGP cycle. However, the Companies will update the CGS+ projections and will actively work to articulate grid needs in a timely fashion to facilitate alignment of any new program with grid needs. The Companies have provided the latest IGP reference case RESOLVE models to the DER Parties under non-disclosure agreement to assist the Parties in designing and proposing new long-term DER programs. This will ensure that any developed programs are based on the Companies' latest long-term resource plans and assumptions.

Advanced Rate Designs

Rate design can have some impact on resource requirements, for example, to the extent that customers respond to TOU rate designs by adjusting their energy requirements both in amount of energy usage and in time of energy use. The incremental impact of the rate design

[19] See Docket No. 2018-0141, Hawaiian Electric Companies' Semi-Annual Progress Report, filed on June 30, 2020; Hawaiian Electric Companies' Supplement to June 30, 2020 Semi-Annual Status Report (Proportional Opt-Out Meter Deployment) filed on September 30, 2020.

[20] Docket No. 2019-0327, Order No. 36921 Suspending the Docket, issued on December 30, 2019.

depends on the magnitude of the customer response and the system resources already available or planned.

In this sense, rate design can be characterized as incentives for customer response rather than as system resources. Rate design does not provide a guaranteed kilowatt ("kW") or kilowatt-hour ("kWh") resource or even a response that the Companies can dispatch or control. It is the customer's actions (or non-actions) that determine the related contribution from rate design. The cumulative customer response to TOU rate design can affect system load shape throughout the day: such a condition is more likely when most or all customers face TOU rates and much less likely during the proposed rollout of TOU rates to a small portion of advanced meter placements, which in turn are a fraction of the total meters on the system.

To meaningfully integrate rate designs with long-term planning, certain types of information need to be estimated, such as the number of participants in each TOU rate for each rate schedule; implementation timing, including ramp-up over time; and guidance on what the anticipated impact to those customers' load profiles will be. For opt-out participation, the Companies would need to know which customers are affected with reasonably sufficient detail to build sales, peak, and hourly forecasts (e.g., by rate, over time, load shape impact, etc.), and the potential pool of customers that are likely to opt out. This data can then be used to generate inputs that would be used in the assessment of grid needs.

- Microgrid Services Tariff, Docket No. 2018-0163

Order No. 36514, filed on September 16, 2019, detailed a procedural investigation to establish a microgrid services tariff. Representatives from the Companies and the Consumer Advocate led a working group process that filed a Working Group report on February 14, 2020. Utilizing the Working Group's deliverable, the Companies filed a draft microgrid services tariff along with proposed changes to existing DER tariffs on March 30, 2020. The Companies' filing provides a draft to clarify interconnection of customer microgrids and to enable the interconnection of hybrid microgrids. On December 10, 2020, the Commission provided guidance to the Companies and docket intervenors to continue the Working Group process to finalize the tariff and related documents. This effort is currently in progress.

The current draft tariff does not incorporate a resilience grid service; however, any need for resilience services will be identified in the IGP process through the incorporation of resilience planning considerations informed by the Resilience Working Group ("RWG"). As such, any need for resilience grid services will be included in the resilience planning linked to the IGP solution identification process (see Exhibit B).

- Electrification of Transportation

In accordance with Commission Order No. 36448, issued on July 31, 2019, in Docket No. 2018-0135, the Companies submitted their EoT Workplan consistent with Commission guidance that the "Companies ... identify and evaluate opportunities to support electrification of transportation through 'make-ready' infrastructure as a short-term priority." In that workplan, the Companies identified three major filings to be submitted in the 2020 time frame that would support the initiatives identified in the EoT Roadmap. Those filings were identified as:

1) an electric bus make-ready program,[21]
2) a commercial EV rate design,[22] and
3) a make-ready program for fleets, workplaces, multi-unit dwellings, and commercial settings, commonly referred to as the “commercial make-ready” filing.[23]

In addition, the Commission requested that the Companies develop an “innovative pilot projects program framework (‘Framework’) for use in establishing new technologies, programs, and business models related to the Companies’ EoT efforts.”[24] Consistent with the guidance set forth therein, the Companies filed a Framework Recommendation that included biennial workplans to define innovative pilots that allow the Companies, with stakeholder input, to effectively prioritize EoT pilots while considering the EoT Strategic Roadmap, market availability of technologies, long-term customer benefits, impacts on key performance metrics, and market needs in the Companies’ service territory. Subsequent to this filing, the Commission transferred the EoT Innovation Pilot Framework to the PBR docket (2018-0088) ruling that this docket “will better position the EoT Innovation Pilot Framework for resolution as part of the comprehensive changes to Hawaiian Electric's regulatory structure.”[25] The PBR docket Phase 2 Decision and Order was filed December 23, 2020 (“PBR Phase 2 D&O”), and includes a new streamlined approval process for innovative pilot projects, presumably including EOT projects. The Companies are presently reviewing the PBR Phase 2 D&O.

- Procurement of Additional Grid Services in 2021

As discussed at the December 18, 2020, Status Conference and described in Docket No. 2017-0352, the Companies intend to issue a Grid Services RFP for O‘ahu seeking grid services in connection with the expiration of the AES coal plant PPA. The Companies are currently targeting issuing an RFP in Q1 2021 to enable those services in 2022 and 2023. To the extent feasible, the Companies will incorporate any procurement targets into the planning analyses.

1.3.4 REGULATORY FRAMEWORK

- Performance-Based Regulation (PBR), Docket No. 2018-0088

In its guidance, the Commission implied a lack of coordination between IGP and PBR. First, the Companies will ensure that there is tight coordination between IGP activities and the PBR framework going forward. However, the timing of the PBR docket and when the Companies completed testing RESOLVE for use in IGP were significantly different. The PBR docket, ongoing since 2018, needed resource plans for use in the docket, such as for Ulupono’s RIST model. However, when the Companies presented their initial results of RESOLVE modeling using IGP proposed methods in October 2020, that analysis had only recently been completed. The resource plans used in PBR Phase 1 and Phase 2 were modified from PSIP 2016 plans that contained the best information available at the time. Those plans were not necessarily

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[21] See Docket No. 2020-0098 filed on July 10, 2020

[22] See Docket No. 2020-0152 filed on September 30, 2020

[23] See Docket No. 2020-0202 filed on December 4, 2020

[24] See Docket No. 2018-0135 Framework and Commission Letter dated June 19, 2020 in Docket No. 2018-0135 at 2.

[25] See Docket No. 2018-0135, Order No. 37373 *Transferring The Electrification Of Transportation Innovative Pilot Framework Into Docket No. 2018-0088*, issued on October 16, 2020, at 2.

optimized, unlike the Companies' latest initial IGP plans, which have been optimized through RESOLVE.

2 STATUS OF WORKING GROUPS AND STAKEHOLDER FEEDBACK

As the Companies' December 2018 IGP Workplan[26] described, seven working groups would be assembled in 2019 to address key areas of development that would shape the inputs, assumptions, and methods to integrate resource, transmission, distribution planning to produce a stakeholder driven long-term resource plan that meets the needs of customers and state policy objectives. The seven working groups each had a clear set of objectives and deliverables as outlined in the Workplan and working groups. Those objectives and deliverables were re-affirmed at the November 7, 2019 SC meeting[27] in response to the Commission's guidance provided on November 4, 2019 through Order No. 36725 in Docket No. 2018-0165 ("November Commission Guidance").

The IGP stakeholder engagement plan has been a significant undertaking for the Companies as well as stakeholders with a proactive engagement approach to attain:

- Constructive and long-term working relationships with stakeholders,
- Stronger communication and transparency between parties, regulators, and the utility,
- Building of common ground on key issues and common vocabulary,
- More efficient and streamlined regulatory proceedings related to grid planning
- Stakeholder feedback to incorporate into the development of planning inputs, assumptions, methodologies, and processes, and
- Transparency, predictability, and buy-in from different interested parties.

A summary of the activities and deliverables from each working group is summarized below. In line with Commission Order 37419, each working group has performed multiple reviews and iterations with stakeholders on the working group output and deliverables and have ensured that stakeholders' feedback is clearly incorporated into every decision-making step. Often this included working group review of redlined versions of the deliverables to verify that the Companies were interpreting and incorporating the stakeholder feedback appropriately.

2.1 STANDARDIZED CONTRACT WORKING GROUP ("SCWG")

The SCWG provided a forum for open exchange of knowledge and ideas surrounding the procurement of services through a contracting mechanism between the Companies as the market operator and third-party providers of grid and other ancillary services. The focus was around contract options including:

- Structure – standard language combined with specific service language
- Mechanisms – components and features
- Terms – details of mechanisms

[26] Integrated Grid Planning Workplan filed in Docket No. 2018-0165 on December 14, 2018 ("Workplan")

[27] See, https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/stakeholder_council/20191107_sc_meeting_presentation_materials.pdf

The SCWG met four times (see Figure 6) and both the SCWG presentations and meeting notes capturing stakeholder input and feedback are available online.[28]

Figure 6 – SCWG Meetings

Year	2018			2019		
Month	Oct	Nov	Dec	Jan	Feb	Mar
Standardized Contracts Working Group (SCWG)			♦	♦	♦	♦

The SCWG began with the Grid Services Purchase Agreement ("GSPA") and the Companies' Model Renewable Dispatchable Generation Power Purchase Agreement ("PPA") and Model Firm PPA and worked with stakeholders to:

- Determine and document the optimal approach to contracting for energy, capacity, and ancillary services from a variety of sources,
- Determine if a unified contracting approach can apply to all competitive procurements, or if multiple contract forms are required for different counter-parties, and
- Propose a streamlined procurement process that maintains confidentiality of bids to encourage a brisk, competitive, and innovative proposal process.

Stakeholders provided an opportunity to review the draft GSPA and provide feedback and the final version incorporated with input from the Working Groups and SC. This feedback was posted on the SCWG web site[29] and stakeholder feedback was incorporated into the final GSPA.[30]

SCWG closed upon filing of GSPA on March 29, 2019[31] and subsequent contract-related discussions have taken place in CPWG meetings (see Section 2.5).

2.2 RESILIENCE WORKING GROUP ("RWG")

The RWG included 28 different organizations and 63 different individuals during the stakeholder engagement process. The presentations and meeting notes capturing stakeholder feedback from each of the meetings are publicly available on the RWG web page. [32]

Figure 7 – RWG Meetings

Year	2019							2020					
Month	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Resilience Working Group (RWG)		♦	♦	♦	♦	♦	♦						♦

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[28] See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/standardized-contract-documents

[29] See GSPA Stakeholder Comments: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/standardized_contracts/20190312_wg_sc_stakeholder_comments.pdf

[30] See RFP No. 103119-02 August 22, 2019 Docket No. 2017-0352 Appendix L – Grid Service Purchase Agreement https://www.hawaiianelectric.com/documents/products_and_services/demand_response/20190822_gspa.pdf

[31] See Revised GSPA: https://www.hawaiianelectric.com/documents/products_and_services/demand_response/20190329_revised_GSPA.pdf

[32] See RWG web page: https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/resilience-documents

The RWG was focused on supporting the development of resilience planning criteria including to:

- Identify and prioritize resilience threat scenarios and potential grid impacts,
- Identify key customer and infrastructure sector capabilities and needs following a severe event and loss of power,
- Identify gaps and priorities in grid and customer capabilities following a severe event and loss of power,
- Provide recommendations and inputs for IGP to address resilience needs, and
- Recommend additional grid and customer actions to close gaps in capabilities following severe events.

The RWG adopted the Commission's definition of resilience as "*the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions.*"[33] Resilience objectives consistent with the Commission's definition include:

- Reduce the likelihood of an outage during a severe event,
- Reduce the magnitude of an outage during and after a severe event,
- Reduce restoration and recovery time following a severe event,
- Return Tier 1 and Tier 2 customers' power within appropriate times,
- Return all customers within appropriate times, and
- Limit environmental impacts of a severe event.

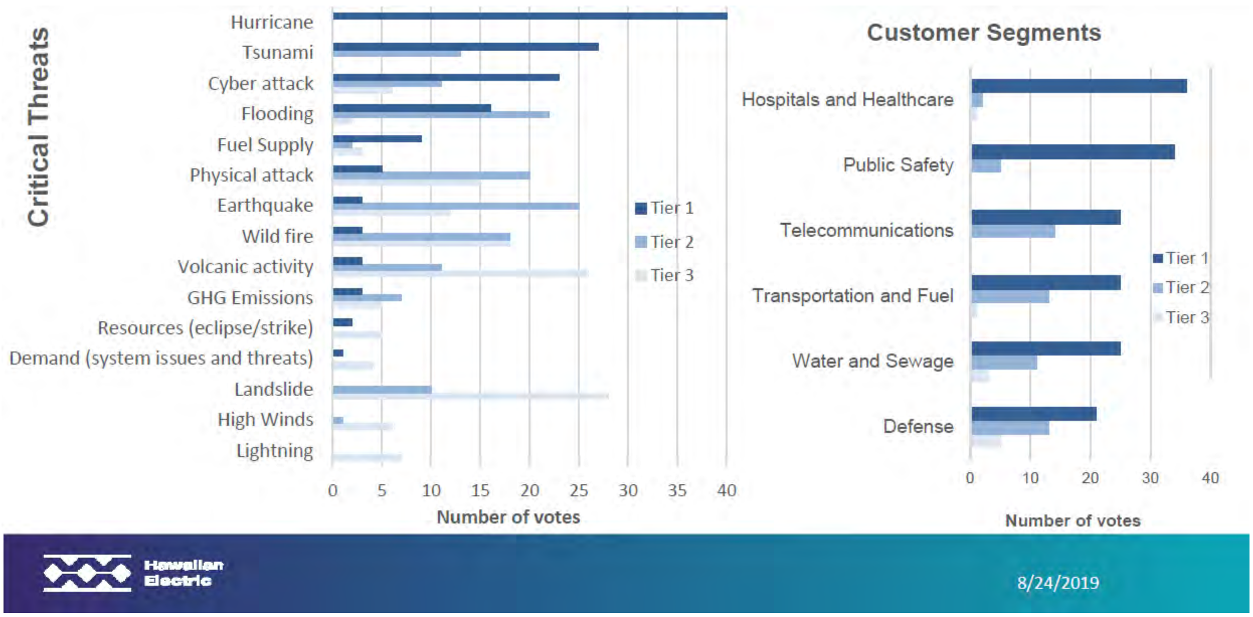
To help launch the RWG, the IGP SC suggested some potential RWG members as the RWG was being organized. Throughout the RWG meetings, questions were posed to the stakeholders to gain consensus and immediate feedback on certain assumptions and conclusions. For example, the July 22, 2019 RWG meeting posed the following questions to stakeholders:

1. Question #1: What threats should be considered?
2. Question #2: What criteria should be used to prioritize customer segments with regard to grid resilience needs?
3. Question #3: What kinds of mitigating actions should be taken to address grid resilience needs? By whom?

Responses from these questions are summarized in Figure 8 below as resented at the August RWG Meeting.

[33] See Docket 2018-088 Commission letter and Staff Proposal dated February 7, 2019 at Appendix A page 5 and Assessing the Existing Regulatory Framework in Hawaii Concept Paper to Support Docket Activities dated September 18, 2018

Figure 8 – Summary of July 22, 2019 RWG Breakout Sessions



The subsequent RWG meetings continued to solicit additional stakeholder member input culminating in the draft RWG report. For example, discussions included:

- Identify key customer/sector capabilities and needs following a severe event and extended loss of power,
- Prioritize key customer sectors for recovery,
- Provide stakeholder inputs to RWG report on key customer sector grid resilience needs,
- Preliminary understanding of power system strengths and vulnerabilities to severe threats, and
- Consensus on capabilities of critical infrastructure and customer segments under severe event scenarios

The RWG published a draft *Resilience Working Group Report for Integrated Grid Planning* on December 9, 2019 and solicited stakeholder feedback until January 10, 2020 and stakeholder feedback was incorporated into the final working group report.[34]

The RWG intentionally focused on identifying and prioritizing potential threats and categories of critical customers/facilities. This foundational input combined with the Jupiter Intelligence predictive weather forecasts will be used to assess specific asset threat risks and related risk mitigation requirements that will lead to identification of potential utility, third party and customer solutions integrated with IGP. The Companies are continuing to adopt and adapt industry leading practices as described in the integrated resilience planning approach (under development) described in Exhibit B that will be shared with the SC and Stakeholder Technical working group for feedback.

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[34] Resilience Working Group Report (PDF): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/resilience/20200429_rwg_report.pdf

2.3 FORECAST ASSUMPTIONS WORKING GROUP ("FAWG")

The FAWG supported development of forecast assumptions and sensitivities as part of the pre-IGP planning cycle activity and provides strategic inputs and feedback on assumptions and methodologies used for load forecast development and results. The FAWG structure and level of engagement was one of the most proactive in the industry to-date combining industry experts for best practice validation and resident Hawaii experts representing their respective contributions on economic outlook, energy efficiency potentials and program roadmaps, and transportation electrification. This was in addition to engaging a broad set of stakeholders in the FAWG and with the SC.

Figure 9 – FAWG Meetings

Year	2019											
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Forecast Assumptions Working Group (FAWG)			◆		◆		◆	◆				

Year	2020											
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Forecast Assumptions Working Group (FAWG)	◆		◆					◆				

The FAWG engaged 18 different organizations and 26 different individuals and various docket intervenors during the stakeholder engagement process. The FAWG met with stakeholders eight times (including a two-day meeting in May 2019) before finalizing the forecast. The forecast assumptions[35] informed by FAWG stakeholder input was presented to the FAWG on January 29, 2020 and included the Applied Energy Group (AEP) Energy Efficiency Potential Study,[36] Distributed Energy Resource forecasts,[37] Electrification of Transportation Forecast,[38] and a Behind the Meter (BTM) Solar Photovoltaic (PV) and Battery Energy Storage System (BESS) forecast.[39] The load forecast with these layers was presented to the FAWG on

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[35] FAWG draft IGP Inputs and Assumptions: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200925_draft_IGP_inputs_and_assumptions.pdf

[36] AEG Hawaii Statewide Market Potential Study (PDF): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200129_wg_fa_hawaii_market_potential_study_draft_results.pdf

[37] IGP DER Forecast - Oahu (EXCEL): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/HE_DER_forecast_IGP.xlsx; IGP DER Forecast - Hawaii (EXCEL): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/HL_DER_forecast_IGP.xlsx; and IGP DER Forecast - Maui (EXCEL): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/ME_DER_forecast_IGP.xlsx

[38] IGP EoT Forecast (EXCEL): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/EoT_forecast_IGP.xlsx

[39] IGP BTM PV_BESS Cost Forecast (EXCEL) - https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/BTM_PV_and_paired_BESS_cost_forecast_IGP.xlsx

March 9, 2020.[40] Additionally, resource related inputs were shared with the FAWG including the Fuel Forecast[41] and Resource Cost forecast.[42] The FAWG reconvened on August 31, 2020 to review updates to the forecast based on near-term economic impacts forecasted by UHERO[43] as a result of the COVID-19 pandemic and effect on the forecasted sales and peak forecast.[44]

The Companies summarized and submitted much of the forecast and planning input information to the Commission on July 2, 2020 in response to the Commission's June 8, 2020 information request.[45] The TAP recently completed their review of the forecast and planning inputs and the Companies are including the draft *IGP Inputs and Assumptions* in the attached Exhibit A Review Point. Additionally, Ulupono and the Commission have provided feedback on the forecast assumptions and the Companies will incorporate that feedback with the final version.

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[40] March 9, 2020 forecast presentation (https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200309_wg_fa_meeting_presentation_materials.pdf) and Forecasts by layer: Hawai'i Island (EXCEL) https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/hawaii_island_IGP_forecast_by_layer.xlsx; Maui, Moloka'i, and Lana'i (EXCEL): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/MECO_IGP_forecast_by_layer.xlsx;

and O'ahu (EXCEL): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/oahu_IGP_forecast_by_layer.xlsx

[41] IGP 2020 Fuels Forecast (EXCEL) https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200420_wg_seo_igp_2020_fuels_forecast.xlsx

[42] Resource Cost Summary (Updated September 7, 2020) (EXCEL) https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200717_wg_seo_resource_cost_forecast.xlsx

[43] UHERO Presentation (PDF) - https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200831_wg_fa_meeting_presentation_materials_UHERO.pdf

[44] August 31, 2020 Forecast Assumptions Presentation: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200831_wg_fa_meeting_presentation_materials_HECO.pdf; and notes including stakeholder feedback and questions: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200831_wg_fa_meeting_summary_notes.pdf

Hawai'i Sales and Peak Forecast (EXCEL) https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/hawaii_sales_and_peak_FAWG.xlsx; Oahu Sales and Peak Forecast (EXCEL) - https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/oahu_sales_and_peak_FAWG.xlsx; Maui, Moloka'i, Lana'i Sales and Peak Forecast (EXCEL) - https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/maui_sales_and_peak_FAWG.xlsx

[45] See Docket No. 2018-0165.

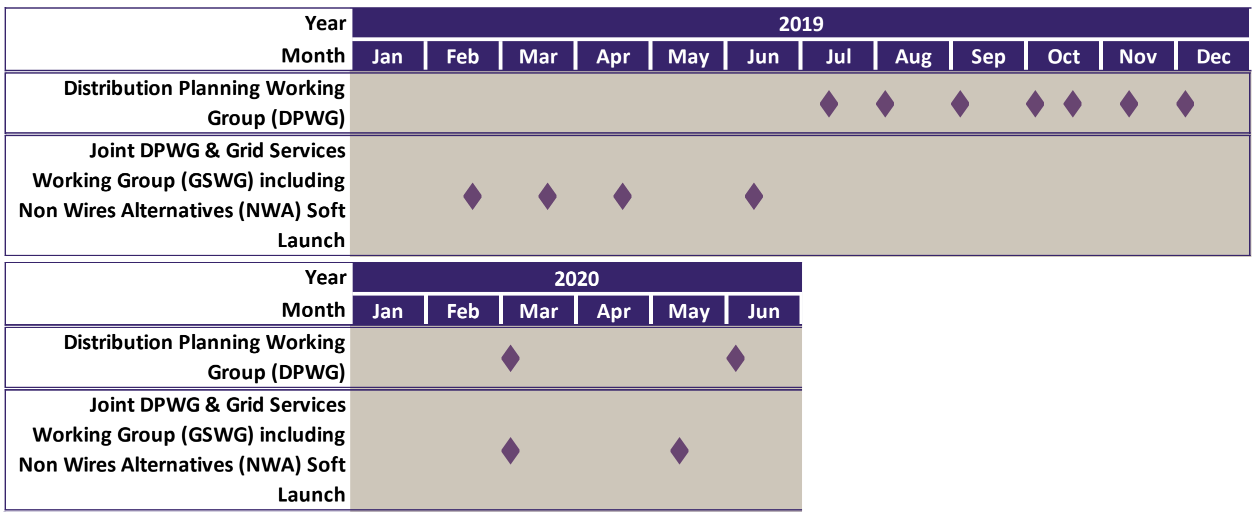
2.4 DISTRIBUTION PLANNING WORKING GROUP ("DPWG")

Including Grid Services Working Group ("GSWG") & Non-Wires Alternative ("NWA") Soft Launch

The DPWG, GSWG (partial) and the NWA Soft Launch activities merged into a single working group of stakeholders. The DPWG subsumed the local distribution grid services work and the bulk system grid services were merged as part of the SEOWG. Therefore, the DPWG summary below includes the GSWG distribution grid services and NWA activities and progress to date.

The DPWG has engaged with 40 different organizations and 73 different individuals during the stakeholder engagement process. The DPWG and GSWG (for distribution grid services) stakeholder meetings were combined in part to support the NWA Soft-Launch discussions. The presentations and meeting notes capturing stakeholder feedback from each of the meetings are publicly available on the DPWG web page.[46]

Figure 10 – Combined DPWG, GSWG and NWA Soft Launch Meetings



As outlined in the DPWG *NWA Opportunity Evaluation Methodology* document, the Companies conducted a survey and industry analysis of NWAs which found that the use of NWAs for distribution grid needs is at an early stage of utilization. The industry is still learning and refining approaches to improve upon the early mixed success to-date.[47] However, commonalities are emerging from these early states' and utilities' learnings that provide valuable insights for Hawai'i's success.

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[46] See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/distribution-planning-and-grid-services-documents

[47] In 2020, SCE had 4 projects proposed for NWA opportunity out of 321 capital projects. This is consistent with prior years and experience for PG&E, SDG&E and in New York. http://www3.sce.com/sscc/law/dis/dbattach5e.nsf/0/5BA7A7A7BE7E52CD882585C800063F1B/$FILE/R1408013-SCE%202020%20GNA%20and%20DDOR%20Reports%20(Public).pdf

Stakeholder feedback has been incorporated into the topics covered in the DPWG. For instance, stakeholders requested additional information about hosting capacity enhancements and the DPWG met for multiple hours on this topic. Stakeholder feedback has included:

- Not to limit DERs only to the distribution level and evaluation for more DER opportunities at the transmission level.
- The need for a tool to identify DER program opportunities that would also remain DER agnostic.

The DPWG solicited specific feedback on how the DPWG deliverables can/should be integrated into the IGP process:

- What should be documented in the Distribution Grid Needs Documentation (e.g., summarize attributes for every feeder and substation transformer)?
- For the circuits or substations with an identified grid need (i.e., overload), are Resource Type, Peak Need, Delivery Timeframe, Duration, and Delivery Days (similar to Soft Launch) sufficient for information to be provided?
- Is a 30-day review period sufficient to provide stakeholder feedback on deliverables?
- Are there any sensitivities or scenarios that should be considered in the Distribution Planning Process?
- If so, what should the process be to choose one scenario for Grid Needs identification?

The GSWG benchmarked and surveyed states with NWA experience or regulatory rules including California,[48,49] New York,[50] Texas,[51] Rhode Island, New Hampshire, and Maine. Interviews were also conducted with the California utilities to gain understanding and appreciation for the activities and effort for implementation of the CPUC rules.

An additional reference reviewed by stakeholders was the Rocky Mountain Institute (RMI) publication *The Non-Wires Solutions Implementation Playbook*[52] with key takeaways listed in the DPWG *Non-Wires Opportunity Evaluation Methodology* document. The deliverable also includes notes on how stakeholder consensus was reached for the grid services definitions and the scope of potential projects suitable for NWA opportunities.

DPWG and GSWG stakeholder feedback was incorporated into the NWA Soft Launch RFP including:

- Expanded RFP to test the market for two distinct types of opportunities:
    - Ho'opili: long duration, high MW need for new development
    - East Kapolei: moderate duration, moderate MW need for load growth

[48] See https://www.cpuc.ca.gov/General.aspx?id=10710

[49] See http://www.caiso.com/Pages/default.aspx

[50] See https://jointutilitiesofny.org/

[51] See http://www.ercot.com/

[52] See The Non-Wires Solutions Implementation Playbook - A Practical Guide for Regulators, Utilities, and Developers, 2018: https://rmi.org/insight/non-wires-solutions-playbook/

- Utilized an Independent Observer to oversee RFP process[53]
    - o The Companies used an IO for the Soft Launch RFP
    - o Clarifying revisions to CBF on-going in the CPWG
- Allowed solutions to be bid in multiple procurements for "value stacking"
- Realized technical requirements for 5-minute reconnection time
- The Companies also considered extending 5-year term. Ultimately, the Companies did not extend the term because the industry standard is for 5-7 year contracts, and with load growth uncertainty, it is difficult to commit for more than 5+ years. Note that the load growth uncertainty could result in potentially higher costs for customers if transformer or additional NWA is need during contract term.

The Draft Soft Launch RFP was posted September 3, 2019 with comment period through October 21, 2019 and comments received were incorporated into the final RFP.[54] For example, one change, agreed to through stakeholder conversation was to reduce the minimum bid from 100 kW and a 4-hour duration to 50 kW for 2 hours.

Results from the DPWG effort have been captured in the *Distribution Planning Methodology* document which was informed by the input from stakeholders.[55] Additionally, the criteria and rationale for NWA has been documented in the *NWA Opportunity Evaluation Methodology.*[56]

In its report, the IO provided nine recommendations[57] for future NWA procurements. The Companies will incorporate those recommendations to the greatest extent possible as it heads into the next set of procurements in this first IGP cycle. For example, the Companies try to avoid bid submittal dates over the end of year holiday periods. The Companies will look at refinement of screening criteria for deferral opportunities by seeking out shorter duration needs (unlike the up to 17-hour duration identified for the Soft Launch RFP). The IO noted that the RFP documents were quite comprehensive, but the IO recommended that the documents be simplified. The Companies will strive to create "Form RFPs" for these types of opportunities to simplify and streamline the process. Additionally, the Companies intend to incorporate the IO's recommendation to have NWA resources realize the value of other services that it could provide. As described above as part of the Integrated Grid Needs Assessment and Integrated

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[53] See Docket No. 2020-0182, Application of Hawaiian Electric Company, Inc.; Verification; Exhibits 1-15; Book 2 of 2; Exhibit 11 Sedway Consulting, Inc. Independent Observer Report For Hawaiian Electric's 2019 Request For Proposals For Non-Wires Alternatives To Provide Reliability (Back-Tie) Services For The East Kapolei Area: https://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A20K05B40558B00342

[54] See, https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/20191108_igp_soft_launch_rfp_with_appx_a-j.pdf

[55] Distribution Planning Methodology (PDF) - https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/distribution_planning/20200602_dpwg_distribution_planning_methodology.pdf

[56] Non-Wires Opportunity Evaluation Methodology (PDF) - https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/distribution_planning/20200602_dpwg_non_wires_opportunity_evaluation_methodology.pdf

[57] See Independent Observer Report for Hawaiian Electric's 2019 Request for Proposals for Non-Wires Alternatives to Provide Reliability (Back-Tie_ Services for the East Kapolei Area. Available at, https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/soft_launch/20200519_igp_soft_launch_rfp_io_report.pdf

Solution Sourcing steps, the Companies will seek “two-for-one” opportunities for locational needs. The Companies will “test” this concept out through the upcoming CBRE RFPs in 2021.

2.5 COMPETITIVE PROCUREMENT WORKING GROUP (“CPWG”)

The stated objective of the CPWG was to develop a fair, efficient, streamlined procurement process to facilitate the competitive solicitation of system resources in alignment with Companies’ grid plans as identified through the IGP process. The CPWG helped to define the terms to articulate the Grid Needs and Grid Needs Assessment as inputs into the CPWG solution process. The CPWG further sought to:

- Provide strategic input and feedback on competitive procurement process development, activities and results, and aspects for improvement,
- Review current procurement practices in Hawai‘i and other jurisdictions,
- Develop competitive procurement best practices for application in Hawai‘i,
- Develop an improved process and accelerated timeframe for procurements that align with broader IGP objectives,
- Foster collegial, balanced discussions to achieve shared understanding of the competitive procurement process, and to build common ground through iterative discussions and feedback, and
- Identify proposed changes to the Commission’s Framework for Competitive Bidding to reduce barriers to market participation and enable integration with the IGP.

The CPWG has engaged with more than 25 different organizations and nearly 50 different individuals during the stakeholder engagement process. The presentations and meeting notes capturing stakeholder feedback from each of the meetings are publicly available on the CPWG web page.[58]

Figure 11 – CPWG Meetings

Year	2019											
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Competitive Procurement Working Group (CPWG)			♦	♦				♦		♦	♦	♦
Year	2020											
Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Competitive Procurement Working Group (CPWG)	♦	♦	♦	♦	♦						♦	

The deliverables of the CPWG included:

- A detailed description of each of the competitive procurement process steps in the IGP sourcing approach,
- Recommendations for potential updates/modifications to the CBF to cover the range of applicable IGP procurements, and
- Documented proposal for a streamlined, improved competitive procurement process.

58 See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/competitive-procurement-documents

The CPWG meetings through the fall of 2019 focused on the proposed IGP solution sourcing process which initially included a two-step solicitation process. These meetings heavily discussed the anticipated effects of the proposed new process when compared to the current process used in the most recent solicitations. Initial discussion included identification of recommendations for potential updates/modifications to the CBF to cover the range of applicable IGP procurements. The CPWG conducted an assessment comparison of current procurement practices in Hawai‘i and other jurisdictions to identify best practices for Hawai‘i with presentations from several other utilities.

There were multiple joint sessions with the SEOWG starting in the 4th quarter of 2019 due to overlapping subject matter, particularly the development of grid needs and solution evaluation processes as these are key inputs and outputs of the competitive procurement process. These meetings:

- Reviewed latest revisions to the IGP Solution Sourcing Process Diagram and sought additional comments, particularly with respect to how the proposed sourcing process was “truly integrated” between distribution level and system level resource development. The grid service needs methodology and the solution evaluation methodology were developed by the SEOWG Group in close coordination with the CPWG and will continue to be refined with stakeholder feedback.
- Reconfigured proposed Commission Review Points to better align with process step deliverables.

Starting in 2020, as the competitive solicitation/RFP process solidified, the CPWG shifted to focus on changes to the CBF that will support the IGP process.

The CPWG spent a good deal of time discussing the greater IGP solution sourcing process. Feedback from the working group informed further refinement of the process. For example, feedback included recommendations for evaluating the time duration of the solicitation process and how to evaluate and incorporate different types of projects including those with longer development timeframes. The IGP solution sourcing process initially included a two-step solicitation process. Stakeholder feedback included support of a more streamlined, single step process (i.e., stakeholders did not see the need for RFI and preferred a single RFP solicitation). Stakeholders provided presentations on procurement examples and lessons learned from specific use cases. Additional streamlining is anticipated from the establishment of the defined link between the Grid Needs Assessment and the procurements. A step-by-step description focusing on the procurement process boxes described in the IGP Solution Sourcing Diagram (a subsection of the larger IGP process steps highlighted above) was provided to the Working Group ahead of Meeting #13. This description included the major tasks envisioned for each step and estimated durations. The process estimated eleven months from the transition from the Grid Needs Assessment acceptance to selection of an award group in the RFP. Although the duration of the RFP from its issue through the evaluation remains approximately the same, by identifying the components that make up the initial “Draft RFP” step that has an estimated duration of three months, it is believed that further opportunities for overall streamlining may be available as the process is refined.

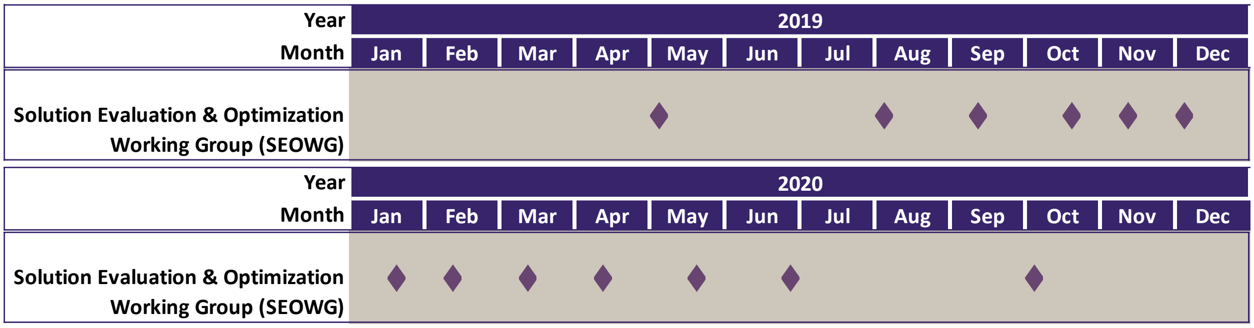
After completion of the development of procurement timelines, the CPWG turned its attention to the CBF. The review and proposed modification of the CBF has been the primary focus of the WG effort in 2020 and the CPWG developed a revised CBF to clarify roles and responsibilities in procurements. The revised CBF document will be submitted to the Commission in early 2021.

Stakeholders also discussed other areas for potential improvement and streamlining, such as interconnection and procurement scoping, but those details were determined to be more appropriately addressed through the particular procurements rather than through the CBF. For example, the current RFP for Lāna‘i specifies location, technology, and sizing of the resource, and the proposed CBRE RFPs for Low and Moderate Income (“LMI”) customers proposed that the Companies would separately take responsibility for the construction of interconnection facilities owned by the Companies, removing that cost uncertainty from the RFP responses. These new processes for the CBRE Lāna‘i and LMI RFPs are a direct result of suggestions made by various stakeholders of the CPWG. Going forward, based on discussions and feedback from the CPWG, procurements will benefit from more detailed interconnection information as well as the Companies selecting sites and technology in advance of procurement will help streamline the procurement process. This more centralized approach to interconnection where the Companies provides insight into interconnection requirements and cost would be more efficient than requiring developers to develop the interconnection information. Additionally, selecting sites and technology in advance and working with stakeholders such as the Commission, Consumer Advocate, the Hawaii State Energy Office, landowners, and others to complete community outreach for locations prior to running RFPs or selecting developers will significantly aid in the interconnection process. Having set locations and technology can remove steps in the evaluation process as seen with the Lāna‘i RFP, overall shortening the process. Even if such steps do not shorten the evaluation process, for example, if the RFP selected multiple locations to compete against each other, they should still shorten the overall interconnection process as it is expected that (1) there is a chance to create more community support for projects if outreach is done well in advance of the RFP, and (2) locations can be selected in areas where interconnection equipment already exists or can be installed relatively easily or done in advance of the procurement. Of course, such steps will require time prior to the procurement to identify sites, interconnection requirements and complete community outreach, but the Companies (and many stakeholders who have reached out to the Companies) believe that such efforts will speed the overall process in the end.

2.6 SOLUTION EVALUATION AND OPTIMIZATION WORKING GROUP (“SEOWG”)

The purpose of the SEOWG is to identify Grid Needs and review and make recommendations regarding the transparent evaluation and optimization method used to fairly assess proposed solutions from the solution sourcing procurement process. The SEOWG is taking the T&D Needs and developing process for the system level solution sourcing steps. The SEOWG has engaged with 13 different organizations and 29 different individuals during the stakeholder engagement process.

Figure 12 – SEOWG Stakeholder Meetings



The SEOWG is identifying and defining the additional capacity, ancillary and T&D NWA services (collectively "Grid Services") in support of IGP Solution Sourcing for the first IGP cycle. The SEOWG is also developing a transparent evaluation methodology and process for assessing the technical and economic "best fit" of proposed solutions from the "3Ps" – pricing, programs, and procurement - on a comparative (apples-to-apples) basis. This will require the ability to assess combinations of proposed solutions to address an identified need if solutions meeting partial requirements are allowed.

The SEOWG stakeholders and participants provided an abundance of feedback on the topics described including:

- Concern over large-scale procurements crowding out smaller projects or solutions provided by DER aggregators or DER programs.
- Confirmation that the Companies will develop and issue resource RFPs that are technology agnostic.
- Interest in transmission hosting capacity evaluation and how the locations for NTAs will be identified and analyzed.
- Input on system needs evaluation.
- Refinement of proposed Commission Review Points to better align with process step deliverables.
- A request that the IGP solution sourcing process include illustration of sequencing in future years to show how each IGP process step linked and supported the Bi-Annual competitive solicitation process and the annual forecasting/distribution planning process.
- Interest in how scenario/sensitivity analysis could be used to evaluate potential incremental benefit from expanding/better utilizing existing DER on the system versus system level resource additions and an agreement to develop several sensitivity scenarios that might support this evaluation.
- Suggested scenario/sensitivity tests for consideration with some clarification discussion.
- Input on the RESOVLE and PLEXOS models and on the grid services definitions for consideration.
- Clarification on the proposed sensitivities for study, including the motivation behind each proposal.
- Input and feedback on the updated sensitivities, including those that were merged, and the proposed modeling approach to capture the sensitivities with the available tools.

Reflecting the Companies' efforts to incorporate stakeholder feedback, Renewable Energy Action Coalition of Hawaii, Inc. ("REACH") submitted a Motion to Withdraw from the IGP Docket No. 2018-0165 (the "Docket") in part stating:[59]

> *REACH's participation in the Docket has been primarily through the Solution Evaluation and Optimization Working Group (SEOWG). REACH appreciates the Commission allowing REACH to participate in this Docket. Upon reviewing the presentations made by the Hawaiian Electric Companies in the meetings of the SEOWG, REACH believes that most of the issues that motivated REACH's participation in the Docket have been adequately addressed in the planning process discussions that preceded the Hawaiian Electric Companies' RESOLVE modeling of resource plans.*

The Companies issued its most recent draft SEOWG deliverable and is currently working through collected stakeholder comments. The Companies intend to issue another iteration or a final draft of the deliverable in early 2021 to stakeholders. The Companies are also working with the TAP to vet through certain key issues.

3 ONGOING STAKEHOLDER AND PUBLIC ENGAGEMENT

Hawaiian Electric will Continue its Multi-Level Engagement with Stakeholders

The Companies will continue to proactively seek stakeholder feedback, giving stakeholders time and resources to provide meaningful feedback, and incorporating feedback into deliverables as appropriate. This will occur through periodic public engagement as noted on the revised IGP process timeline and two focused venues: the SC and a new Stakeholder Technical Working Group.

3.1 PUBLIC ENGAGEMENT

Prior to the COVID-19 pandemic limiting the ability to interface with customers directly, the Companies conducted several workshops coordinated by the IGP process that not only discussed IGP but also Grid Modernization and renewable energy initiatives (Community Based Renewable Energy, Grid Scale Renewable Resources, Resilience and Rooftop Solar). A total 160 customers attended the public meetings:

- March 10, 2020, Hawaii Pacific University
- March 12, 2020, Hawaiian Electric (Maui Auditorium)
- March 5, 2020, Hilo High School

The panel discussions from those public meetings as well as the presentation materials are posted on the IGP Broad Public Engagement web page.[60] Additionally, for customers that were unable to attend the public meetings, a virtual open house was made available online which provided customers with information and solicited their input on the IGP but also Grid Modernization and renewable energy initiatives.[61] The virtual open house had 1,260 unique

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[59] See Docket No. 2018-0165, Renewable Energy Action Coalition of Hawaii, Inc.'s Motion to Withdraw filed on December 1, 2020: https://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A20L02A85652G00412

[60] IGP Broad Public Engagement: https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/broad-public-engagement

[61] IGP Virtual Open House: https://igp.hawaiianelectric.com/

visitors. A summary of Public Meeting and Virtual Open House Feedback is included as Exhibit C.

Two of the most prominent themes from the public meetings and panelists included a discussion related to community impacts and land use (i.e., agricultural lands) in the development of renewable projects. The Companies intend to discuss these very important issues with the SC to find solutions to address these customer suggestions, comments, and concerns. This is an important issue that, if solved in the right way, would yield significant benefits not only to the IGP process and but also in attaining the RPS goals. Customers that attended the sessions also expressed an interest in electric vehicles and community solar, which are prominent components of our long-range plans and which also have specific on-going initiatives within the Companies and through regulatory proceedings.

The Companies will continue to engage the public as the IGP process progresses to ensure that the Companies plans are not developed in a "vacuum".

3.2 STAKEHOLDER COUNCIL ("SC")[62]

The SC has elected to refine its orientation toward a more strategic advisory role that enables meaningful engagement on key considerations to achieve Hawaii's public policy goals. The working structure of the SC will also evolve to support this new orientation. The SC will utilize ad hoc small group discussions on SC selected topics to initially explore issues and frame for broader discussion with the full SC. The Companies will continue to support and engage with the SC in this refined advisory role. The SC is a non-technical strategic advisory group to support the Companies' efforts and IGP process to achieve Hawaii's goals. As such it is not a decision-making body or steering committee. In this context, the SC explicitly identified review of technical work products as outside its scope and interest. Therefore, several of the Commission suggestions regarding SC providing input on technical planning processes and programmatic designs should be redirected to the new Stakeholder Technical Working Group that is being formed for this purpose.

3.3 STAKEHOLDER TECHNICAL WORKING GROUP ("SWG")

A new SWG will be formed to address input and feedback on technical issues and increase transparency in the subsequent steps of the IGP process as the Commission also recognizes. This is particularly the case on the ongoing technical issues as they arise in the development of specific deliverables through the remainder of the IGP process. This includes the Commission's items noted above for redirection. For example, this technical working group could be used to solicit feedback on NWA opportunities, other acquisition of grid services, modeling sensitivity results, etc. The Companies, however, do not believe the SWG will need to conduct a retrospective of the prior working group deliverables as they have already been reviewed by stakeholders (including most of the anticipated SWG participants), have been publicly accessible, and would create an unnecessary delay in the development of the IGP. It is essential that all participants in working groups proactively share feedback during the discussions and on work products in a timely manner given the prominent role that stakeholders hold in this process.

[62] See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/stakeholder-council

Additionally, as originally envisioned by the Commission,[63] participants in this new stakeholder technical working group should be ”prepared to address these issues in depth and to meaningfully participate in the discussion and resolution” of issues raised. Participants should also be prepared to “present detailed information” to support their recommendations. Thus, potential participants “should demonstrate engineering, economic, and policy expertise commensurate with the highly complex and technical nature of these interrelated issues. This is necessary so that the issues can be addressed in both a comprehensive and timely fashion.”

This new working group will supersede the earlier IGP process development oriented working groups to focus on aspects that arise from the actual planning and sourcing activities that will begin in Q1. The SWG will launch after the final SEOWG meeting in the first quarter of 2021. The SWG will meet as needed to support the IGP process and seek timely input and feedback consistent with the Commission’s guidance. This SWG is not a replacement for the TAP’s independent technical review.

[63] Docket No. 2018-0165, Order No. 35569, Instituting a Proceeding to Investigate Integrated Grid Planning, at 29-30

EXHIBIT A: REVIEW POINT

Exhibit A contains the following documents:

- Exhibit A1 - Draft IGP Inputs and Assumptions
- Exhibit A2 - August 14, 2020 TAP Meeting Materials to review forecasts and assumptions with the TAP.
- Exhibit A3 - Technical Advisory Panel Review of IGP Forecasts

The Draft IGP Inputs and Assumptions document (see Exhibit A1) is a compilation of the inputs and assumptions used in the RESOLVE modeling, including the forecasts for sales, candidate resources and fuel as discussed in the FAWG. The Companies are currently incorporating stakeholder feedback received on the Draft IGP Inputs and Assumptions document and will issue a finalized Inputs and Assumptions document in Q1 2021 incorporating commission review point feedback. To facilitate and maintain the schedule depicted in Figure 2, Hawaiian Electric requests Commission feedback within 30 days so that the Companies can incorporate Commission feedback into the final IGP inputs and assumptions. The Companies envision submitting the final IGP inputs and assumptions by the end of the first quarter of 2021.

The TAP Review of the IGP forecasts (see Exhibit A3) describes the TAP's feedback and assessment of the forecasts that were developed as part of the FAWG. The Companies met with the full TAP on June 8, 2020, June 12, 2020, and August 14, 2020 to discuss the TAP's role and the IGP forecasts and assumptions. The Companies also met with HNEI to discuss the forecasts and assumptions on July 9, 2020, July 21, 2020, July 24, 2020, August 6, 2020, and August 27, 2020. The Companies received constructive feedback and intend on incorporating the TAP's recommendation, which include:

- HECO should consider testing the sensitivity of models and resulting portfolios by running bookend scenarios that utilize the cumulative potential high and low load forecasts for each layer.
- HECO should ensure that subsequent modeling tasks include sensitivities for time-of-use flexibility and/or variation in the daily load profiles of DER and EV loads, rather than using a static load profile across modeling tasks.
- HECO should consider using a wider range of future energy efficiency and EV adoption rates due to the high uncertainty, especially beyond year 10. The TAP noted that proposed retirement of thermal units might be impacted by this uncertainty.

The Companies intend to address the TAP's recommendations through sensitivity analyses that will modify the level of energy efficiency and DER assumed in the market forecast. By adjusting the assumed energy efficiency and DER layers, high and low bookends can be created to test in RESOLVE.

A.1. DRAFT IGP INPUTS AND ASSUMPTIONS

Hawaiian Electric

2020 Integrated Grid Planning Inputs and Assumptions

Draft September 2020

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1. INTRODUCTION

This document describes the key inputs and assumptions for Hawaiian Electric's 2020 Integrated Grid Planning process modeling and provides an overview of how the inputs and assumptions are used by the RESOLVE and PLEXOS models to develop a reference portfolio.

2. OVERVIEW OF THE RESOLVE AND PLEXOS MODELS

Hawaiian Electric proposes to use the RESOLVE model to produce a reference optimized resource plan that is then verified in PLEXOS through an hourly production simulation to capture total system costs as part of the Grid Needs Assessment.

2.1. RESOLVE CAPACITY EXPANSION MODEL

RESOLVE is a mixed-integer linear optimization model that is explicitly tailored to the study of electricity systems with high renewable and clean energy policy goals. The optimization performed in RESOLVE balances the fixed costs of new investments with variable costs of system operations, identifying a least-cost portfolio of resources to meet planning needs across a long-term horizon.

RESOLVE can solve for:

- Optimal investments in renewable resources, energy storage, thermal generating units as well as retention of existing thermal resources.

Subject to the following constraints:

- An annual renewable energy constraint that reflects the State of Hawai'i's Renewable Portfolio Standards policy;
- An Energy Reserve Margin constraint to maintain adequacy of supply for reliability;
- Constraints on operational reserves for regulating reserve, fast frequency response, and minimum system inertia;
- Operational restrictions and performance characteristics for generators and resources;
- Hourly load requirements; and
- Constraints on the ability to develop specific new resources (timing and amount).

RESOLVE uses statistical sampling to downscale annual data to 30 representative days per year. These representative days are weighted based on historical data to capture operational costs under most conditions. In addition to the day sampling, resources with similar operating characteristics are aggregated to facilitate efficient solving for the optimized portfolio.

The representative days developed for the RESOLVE modeling, including their day weights and distributions, are provided below.

O'ahu

Table 1: O'ahu Day Weights

Model Day	Weight	Historical Day
1	26.327	11/16/2016
2	20.132	8/8/2016
3	19.134	6/12/2016
4	18.757	5/30/2015
5	18.040	2/25/2016
6	17.242	3/4/2017
7	16.360	9/7/2015
8	16.312	1/31/2016
9	15.927	12/1/2016
10	15.806	4/27/2015
11	15.737	7/6/2017
12	15.243	7/31/2016
13	14.913	12/3/2018
14	14.668	1/26/2017
15	13.738	3/28/2016
16	13.407	10/11/2018
17	12.282	10/26/2018
18	12.222	5/9/2017
19	10.192	2/25/2018
20	9.801	6/8/2018
21	9.394	8/17/2017
22	8.126	4/6/2018
23	7.679	9/4/2016
24	6.049	4/26/2015
25	5.941	9/10/2018
26	5.291	10/21/2017

27	2.654	11/23/2018
28	1.453	8/11/2018
29	1.175	12/10/2017
30	1.000	11/13/2016

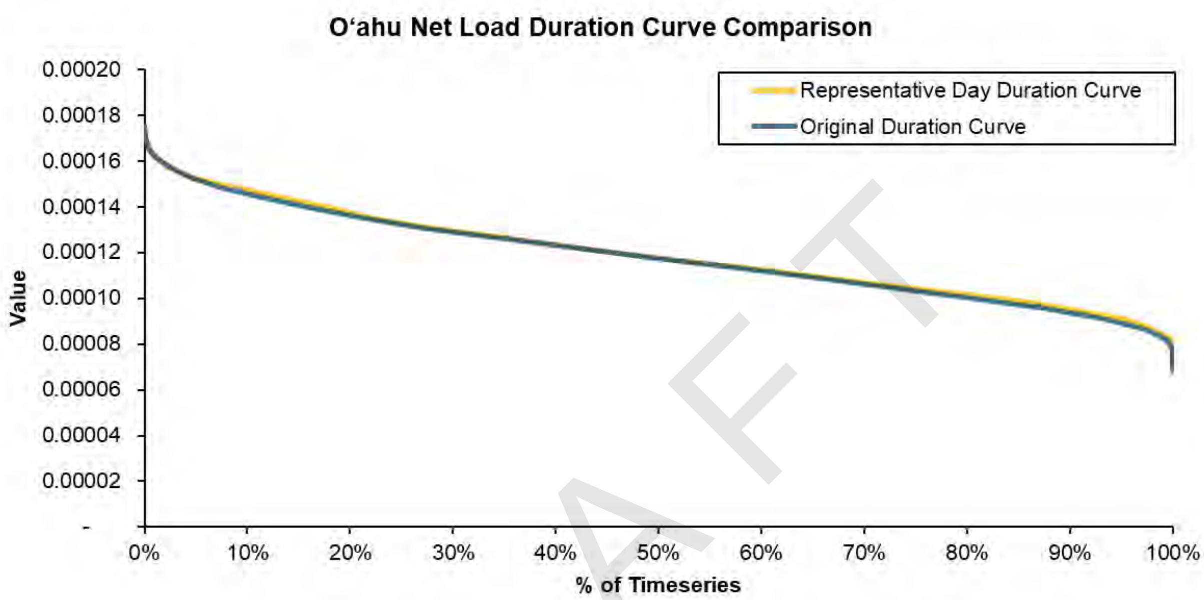


Figure 1: O'ahu Net Load Duration Curve Comparison

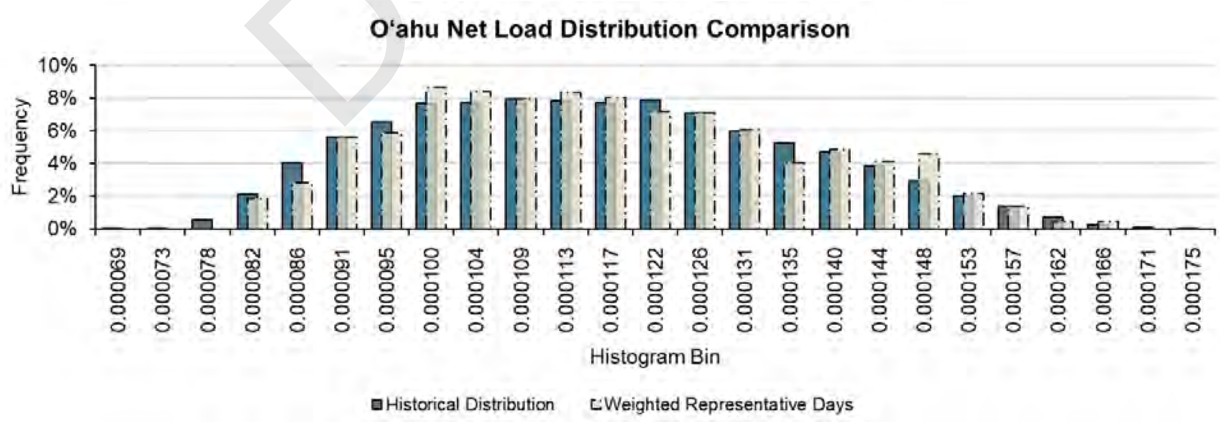


Figure 2: O'ahu Net Load Distribution Comparison

Hawai'i Island

Table 2: Hawai'i Island Day Weights

Model Day	Weight	Historical Day
1	29.984	8/3/2017
2	26.625	4/5/2016
3	26.040	2/3/2017
4	25.358	6/9/2016
5	21.690	1/24/2017
6	21.568	5/8/2015
7	19.093	10/10/2016
8	18.935	3/11/2015
9	16.383	11/26/2015
10	16.315	12/5/2017
11	15.444	7/8/2017
12	15.337	9/10/2017
13	14.647	9/3/2018
14	13.647	7/6/2017
15	11.958	12/17/2016
16	11.891	10/22/2017
17	11.049	3/3/2018
18	9.294	1/3/2016
19	8.416	5/7/2017
20	8.101	11/3/2016
21	5.500	11/11/2017
22	4.626	6/25/2017
23	3.359	4/21/2018
24	2.703	12/21/2018
25	1.893	7/20/2016
26	1.144	2/14/2016
27	1.001	2/16/2017
28	1.000	3/19/2015

29	1.000	8/20/2017
30	1.000	5/11/2018

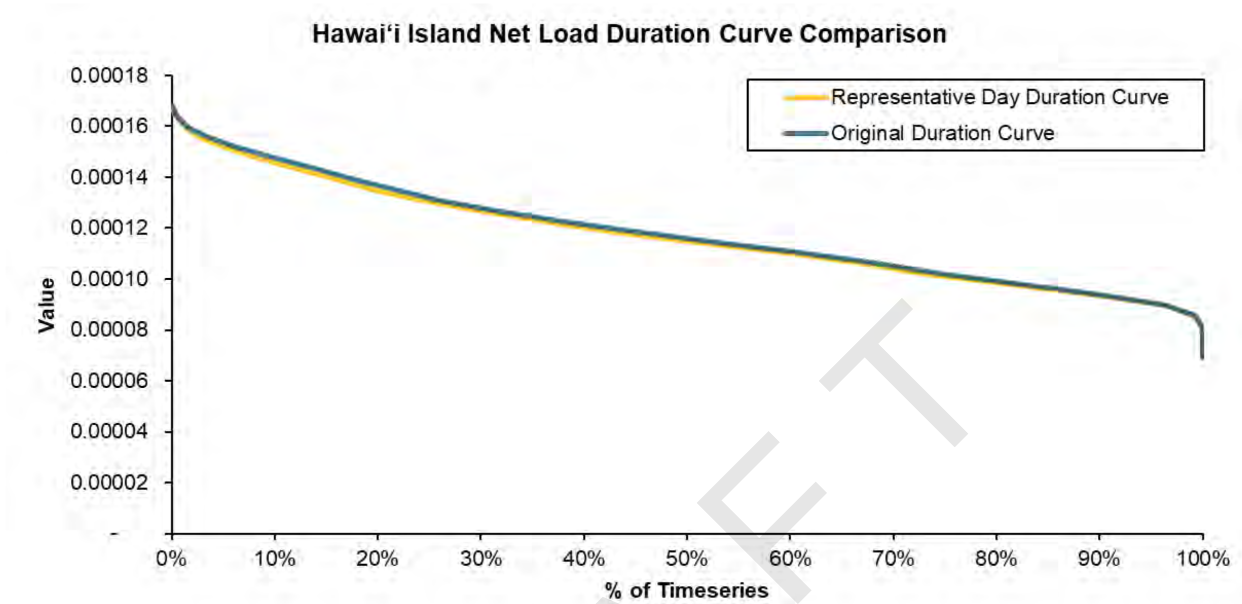


Figure 3: Hawai'i Island Net Load Duration Curve Comparison

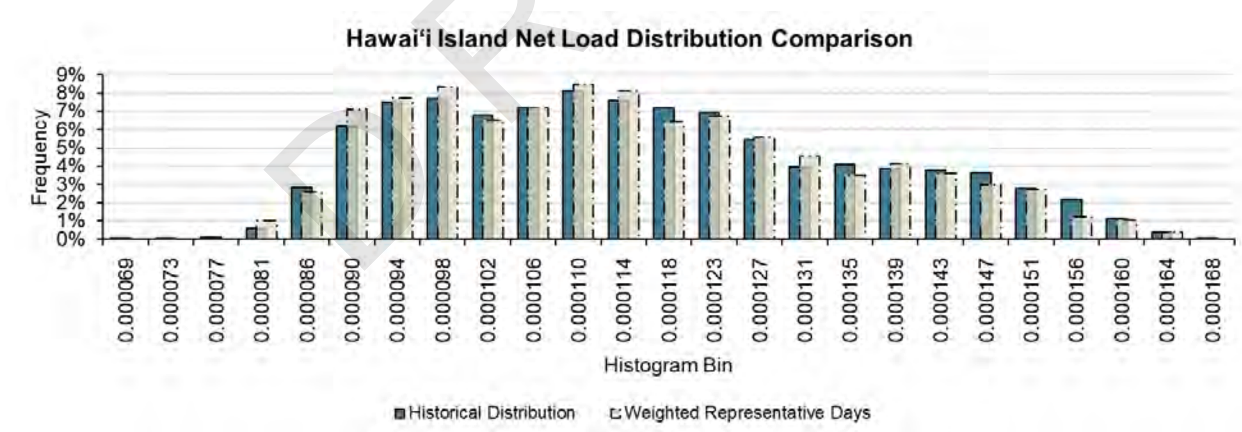


Figure 4: Hawai'i Island Net Load Distribution Comparison

Maui

Table 3: Maui Day Weights

Model Day	Weight	Historical Day
1	20.599	2/6/2018
2	20.506	5/16/2016
3	18.987	8/18/2018
4	18.818	4/18/2017
5	18.208	1/31/2016
6	18.081	6/15/2017
7	17.924	7/22/2016
8	17.295	9/11/2016
9	16.926	11/24/2017
10	16.855	3/25/2015
11	14.129	3/29/2015
12	14.038	10/20/2016
13	12.776	1/17/2017
14	12.689	9/28/2018
15	12.282	12/26/2016
16	12.214	12/22/2018
17	11.996	8/6/2015
18	11.903	6/12/2016
19	11.167	4/10/2016
20	11.166	10/17/2015
21	10.124	11/8/2016
22	8.674	7/26/2018
23	6.810	5/31/2015
24	6.586	2/14/2016
25	6.479	12/23/2015
26	5.780	10/3/2016
27	4.386	7/8/2017
28	3.667	5/4/2018

29	2.934	11/21/2015
30	1.000	2/19/2016

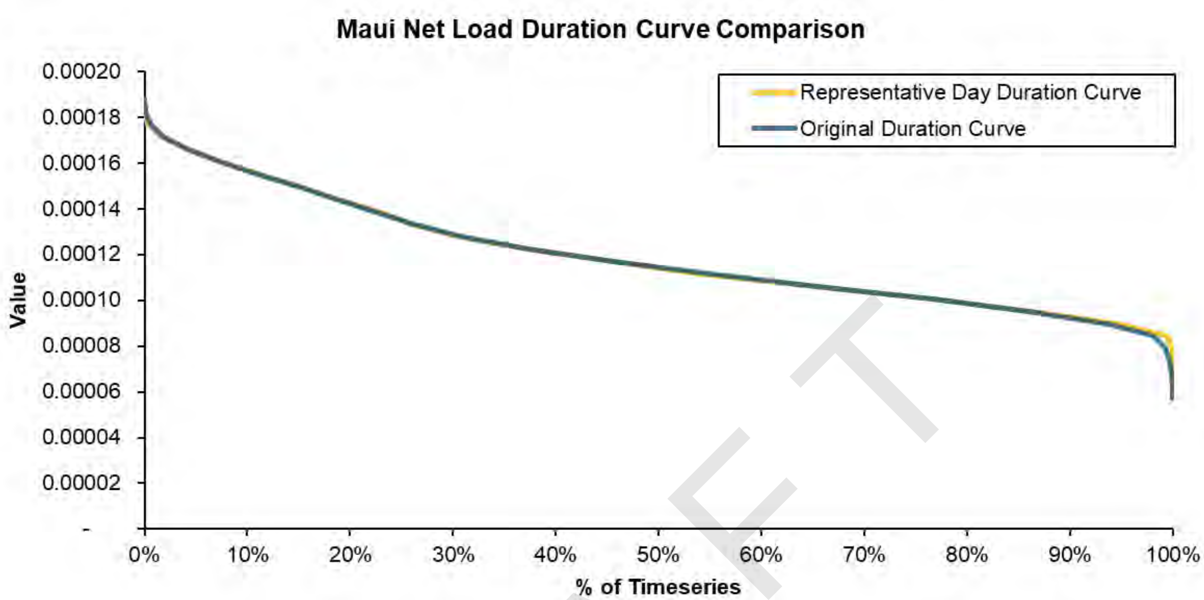


Figure 5: Maui Net Load Duration Curve Comparison

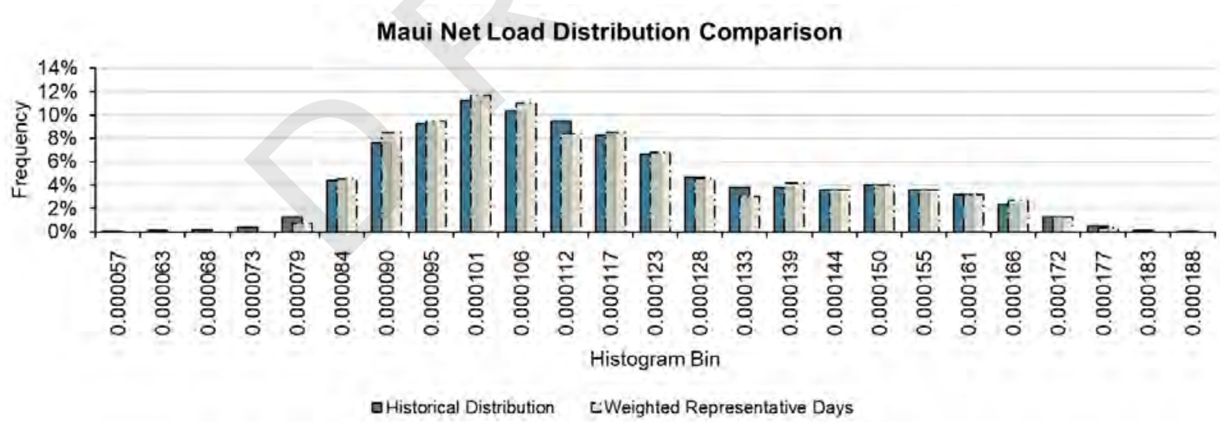


Figure 6: Maui Net Load Distribution Comparison

Moloka'i

Table 4: Moloka'i Day Weights

Model Day	Weight	Historical Day
1	26.64	7/23/2017
2	23.83	8/23/2017
3	21.21	9/1/2018
4	19.75	1/21/2017
5	16.96	3/22/2017
6	16.42	2/27/2017
7	15.78	11/2/2018
8	15.74	5/4/2018
9	15.63	6/9/2018
10	15.53	12/25/2017
11	15.45	12/22/2018
12	15.43	10/31/2018
13	15.24	5/20/2017
14	15.07	4/16/2018
15	14.03	3/25/2017
16	13.35	6/8/2018
17	13.20	11/22/2017
18	12.09	10/14/2018
19	11.80	4/7/2017
20	11.76	2/18/2018
21	11.23	1/17/2017
22	8.77	9/28/2018
23	6.16	8/18/2018
24	3.47	10/30/2018
25	3.35	7/14/2018
26	3.12	4/22/2017
27	1.00	6/15/2017
28	1.00	7/13/2017

29	1.00	8/2/2017
30	1.00	11/11/2017

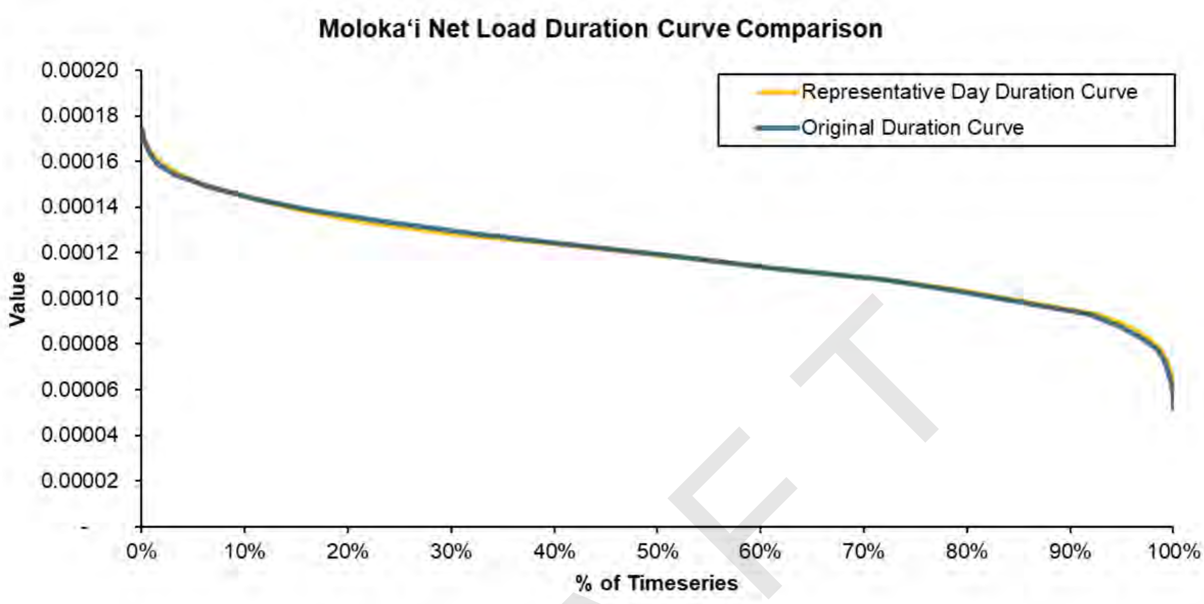


Figure 7: Moloka'i Net Load Duration Curve Comparison

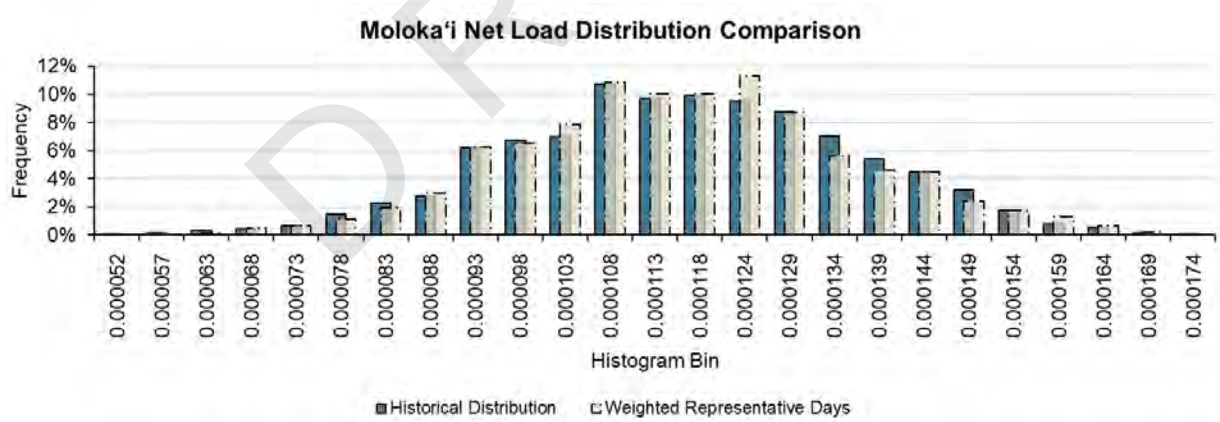


Figure 8: Moloka'i Net Load Distribution Comparison

Lāna'i

Table 5: Lāna'i Day Weights

Model Day	Weight	Historical Day
1	26.803	1/17/2017
2	26.214	7/18/2017
3	23.755	10/13/2017
4	19.847	8/11/2017
5	19.206	9/3/2018
6	18.965	6/15/2017
7	18.125	5/11/2017
8	17.128	2/18/2018
9	16.906	3/9/2018
10	16.280	12/22/2018
11	15.442	4/15/2018
12	14.708	12/6/2017
13	14.559	4/18/2018
14	14.104	11/12/2018
15	13.095	3/3/2018
16	11.876	5/10/2018
17	11.036	6/24/2017
18	10.873	2/14/2018
19	10.795	9/22/2018
20	10.155	8/30/2017
21	8.079	11/15/2018
22	7.818	11/11/2017
23	6.247	10/8/2018
24	4.198	1/20/2018
25	3.787	7/14/2018
26	1.000	5/6/2017
27	1.000	7/13/2017
28	1.000	3/21/2018

29	1.000	8/18/2018
30	1.000	10/6/2018

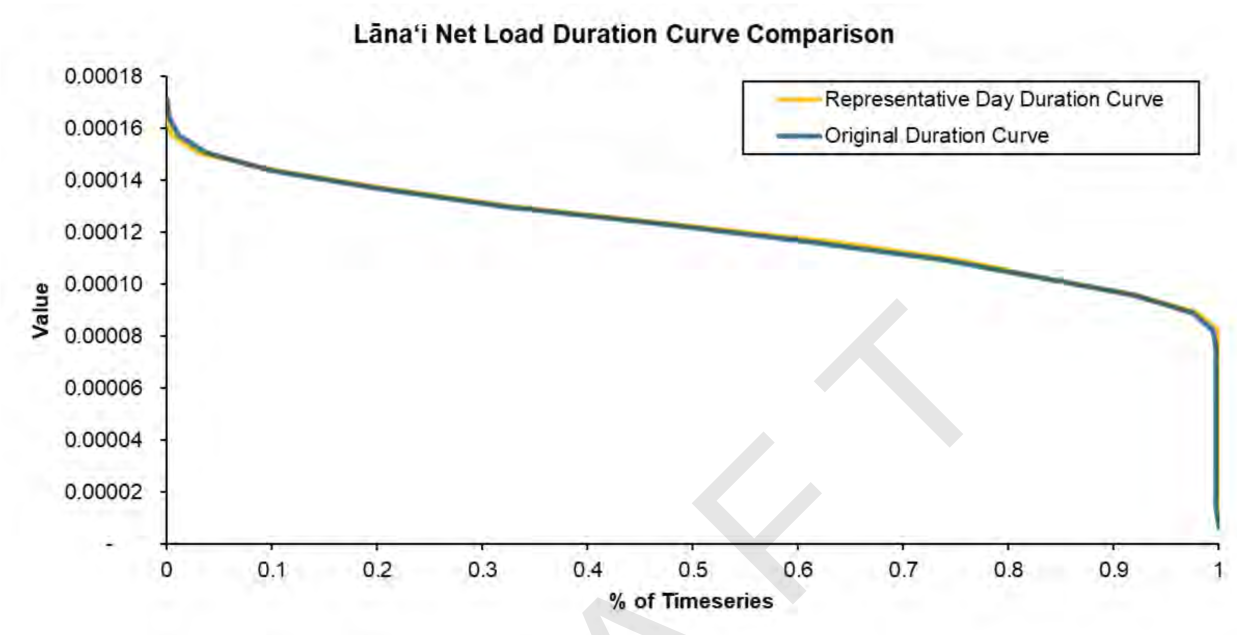


Figure 9: Lāna'i Net Load Duration Curve Comparison

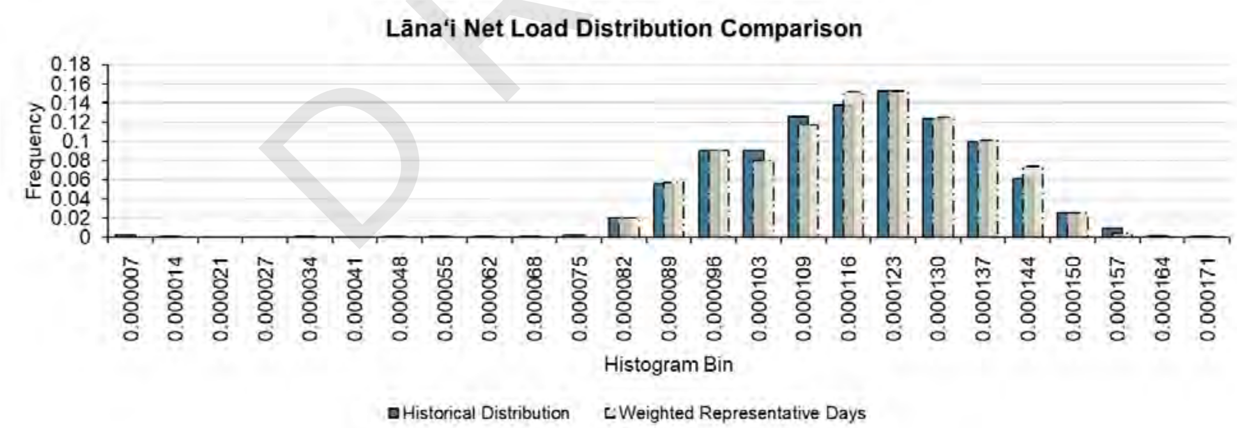


Figure 10: Lāna'i Net Load Distribution Comparison

2.2. PLEXOS PRODUCTION SIMULATION MODEL

PLEXOS is a production simulation model that analyzes the chronological, hour-by-hour operation of a utility's generation system. PLEXOS dispatches (mathematically allocates) the forecasted hourly net megawatt (MW) load among the dispatchable generating units in operation. Unit commitment (starting and stopping of units) and dispatch levels of generation are generally based on fuel cost and unit efficiency.

The net load – that is, the load remaining after partly being served by non-dispatchable energy – is allocated to the dispatchable resources such that overall fuel expense of the system is minimized (i.e., economically dispatched) within the constraints of the system. The model calculates the fuel consumed using the generating unit dispatch described above. The total fuel consumed is the summation of hourly fuel consumption from all the generating units.

The PLEXOS modeling software provides the flexibility to model a wide range of current and future technologies, such as energy storage, demand response, variable generation renewable resources, firm renewable resources and fast starting resources.

The key inputs to the PLEXOS production simulation model, as applied to the Hawaiian Electric system, are as follows:

- Hourly load to be served by all units (dispatchable and non-dispatchable);
- Operating characteristics of each Hawaiian Electric and IPP generating unit;
- Operating constraints such as system inertia, fast frequency response, and regulating reserve requirements;
- Contractual terms for IPP generating units;
- Planned maintenance schedules for the generating units;
- Estimated forced outage rates for Hawaiian Electric and thermal IPP generating units;
- Prices for fuels used by the dispatchable generating units; and
- Hourly MW profiles for non-dispatchable, variable renewable generation sources.

3. FORECAST ASSUMPTIONS

The modeling process for the Grid Needs Assessment relies on a set of forecast assumptions to define what the future system could look like. Many of these assumptions have been developed by the Forecast Assumptions Working Group (FAWG) and the Solution Evaluation & Optimization Working Group (SEOWG).

3.1. LOAD FORECAST

The load forecast is a key assumption for the planning models that provides the energy requirements and peak demands that must be served by Hawaiian Electric through the planning horizon. The forecasts were developed for each of the five islands and began with the development of the energy forecast ("sales forecast") by rate class (residential, small, medium and large commercial and street lighting) and by layer (underlying load forecast and adjusting layers – energy efficiency, distributed energy resources, and electrification of transportation).

The underlying load forecast is driven primarily by the economy, weather, electricity price, and known adjustments to large customer loads and is informed by historical data, structural changes[1], and historical and future disruptions. The impacts of energy efficiency (EE), distributed energy resources (DER), primarily photovoltaic systems with and without storage (i.e., batteries), and electrification of transportation (light duty electric vehicles (EV) and electric buses (eBus)) (collectively, EoT) were layered onto the underlying sales outlook to develop the sales forecast at the customer level.

Multiple methods and models were analyzed to develop the underlying forecast as presented in the July 17, 2019 FAWG meeting.[2] The forecasts and assumptions presented in the FAWG meetings held from March 2019 through March 2020 and described in the response to PUC-HECO-IR-1[3] were developed prior to the unprecedented global and local events of the COVID-19 pandemic and therefore do not include impacts of the virus on the forecasts. The Company updated its forecasts to account for the impacts of COVID-19 as presented in the August 31, 2020 FAWG meeting.[4]

The residential and commercial sectors are forecasted separately as each sector's electricity usage has been found to be related to a different set of drivers. Historical recorded sales used in econometric models are adjusted to remove sales impact of DER, EE and EoT, which are treated as separate layers. Input data sources for developing the underlying sales forecast include economic drivers, weather variables, electricity price and historical data from the Company's own assumptions, as shown in the table below.

Table 6: Input Data Sources for Underlying Forecast

University of Hawaii Economic Research Organization	Real personal income Resident population

[1] Structural changes include the addition of new resort loads or new air conditioning loads that have a persistent impact on the forecast.

[2] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20190717_wg_fa_meeting_presentation_materials.pdf, slides 10–12.

[3] See https://dms.puc.hawaii.gov/dms/DocumentViewer?pid=A1001001A20G06A84950E00012

[4] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200831_wg_fa_meeting_presentation_materials_HECO.pdf, slides 6, 9, 11, 13 and 16 for Oʻahu, Maui, Molokaʻi, Lānaʻi and Hawaiʻi islands respectively.

	Non-farm jobs Visitor arrivals
NOAA – Honolulu, Kahului, Hilo and Kona Airports	Cooling degree days Dewpoint Temperature Rainfall
Itron, Inc.	Commercial energy intensity trend for Pacific Region for non-heating/cooling end uses.
Hawaiian Electric	Recorded kWh sales Recorded customer counts Large load adjustments Real electricity price

3.1.1. DISTRIBUTED ENERGY RESOURCE FORECASTS

The DER layer includes impacts of behind the meter PV and battery energy storage systems as well as known projects for other technologies (e.g., wind). This forecast adjustment estimated new additions of DER capacity in each month by island, rate class and program, and projected the resulting monthly sales impact from these additions. Future DER capacity modeling considered two time horizons:

- Near term (2020 through 2022) reflects the current pace of incoming applications and executed agreements, existing program (NEM, NEM+, SIA, CGS, GSP, CSS and ISE)[5] subscription level and caps, feedback from the Companies' program administrators and installers, customer input and any studies or upgrades being done to address short-term hurdles (e.g. circuit study, equipment upgrades) that affect the installation pace; and

- Longer term are model based as the detailed application information is not available. To extend the DER forecast from the short-term through the full planning period an economic choice model using simple payback considers a set of assumptions such as the installed cost of PV and battery, installation incentives, electricity price, program structure that affect the economic benefit to the customer which is the primary driver of their decision to adopt the system. The addressable market, or the number of utility customers that have the potential to install a DER behind the meter is also considered.

Another important assumption to consider was the structure of programs. There is an array of program choices today, some of which are subject to capacity caps. Assumptions were made as to the structure of future programs for the long term after obtaining input and

[5] Existing programs include Net Energy Metering, Net Energy Metering Plus, Standard Interconnection Agreement, Customer Grid Supply, Customer Grid Supply Plus, Customer Self Supply, and Interim Smart Export.

perspectives from program administrators/designers, industry and policy/consultancies. The future new tariff is assumed to have compensation for export[6] that is aligned with system needs and allows for controllability during system emergencies. The export compensation and exact tariff structure was not available at the time the forecasts were developed however, insight from the DER panel members on the Panel of Experts meeting held on March 22, 2019 as well as already interconnected systems, applications and permit data show that customers are choosing to use battery storage to shift their generation to offset their own load rather than exporting to the grid during the daytime. Since storage is expected to continue to decline in cost, it seemed likely that compensation for daytime export will continue to be relatively low compared to retail rates and therefore the assumption was made that most future systems under the future tariff will be paired with storage.

There isn't enough information to include grid services revenues yet however, knowing that there will likely be a program in the future supports the assumption that PV systems paired with storage are the preferred future. Standard Interconnection Agreements were assumed to be utilized by large commercial customers with loads exceeding potential on-site PV generation. As work progresses on advanced rate design, forecast assumptions may be revisited as information becomes available.[7]

Monthly DER capacity factors for each island were used to convert installed capacity to customer energy reductions. The monthly capacity factors recognize the variations in solar irradiance throughout the year rather than using a single average annual capacity factor to more accurately reflect monthly variations in the energy production of DER systems. A degradation factor of 0.5% a year[8] was applied to the sales impacts to recognize that the DER system's performance degrades over time.

For incentives, the following was assumed for Federal and State investment tax credits.

Table 7: Incentive Rate Schedule

Class	2019	2020	2021	2022+
Residential	30%	26%	22%	0%
Commercial	30%	26%	22%	10%

[6] See, Order No. 37066 issued on April 9, 2020 in Docket No. 2019-0323, Instituting a Proceeding to Investigate Distributed Energy Resource Policies pertaining to the Hawaiian Electric Companies.

[7] In the November Commission Guidance, the Commission stated, "[t]he Companies' IGP forecasting team should also coordinate with the Companies' staff working on developing the Advanced Rate Design Strategy in the DER docket." at pp. 9-10.

[8] Median degradation rate from NREL "Photovoltaic Degradation Rates – An Analytical Review", D.C. Jordan and S.R. Kurz, 2012, http://www.nrel.gov/docs/fy12osti/51664.pdf

The addressable market for residential customers included single family and multi-family homes with a maximum of four units that were owner occupied and with a high enough energy consumption to utilize at least a 3 kW PV system.

Table 8: Addressable Market for Residential Customers

Island	Percent of Schedule R Customers
Oʻahu	37%
Hawaiʻi Island	40%
Maui	43%
Lānaʻi	24%
Molokaʻi	30%

For commercial customers, public and private building ownership was considered. Structures greater than six stories were excluded. Similar to residential customers, small and medium commercial consumption needed to be above a set threshold.

Table 9: Addressable Market for Commercial Customers

Island	Percent of Schedule G Customers	Percent of Schedule J Customers	Percent of Schedule P Customers
Oʻahu	37%	53%	78%
Hawaiʻi	35%	68%	44%
Maui	41%	63%	68%

Table 10: Cumulative Distributed PV Capacity (kW)

Year	Oʻahu	Hawaiʻi Island	Maui	Molokaʻi	Lānaʻi	Consolidated
MW	A	B	C	D	E	F =A + B + C + D +E
2025	655,712	135,631	145,757	3,112	1,006	941,218
2030	757,845	156,486	168,105	3,440	1,187	1,087,064
2040	936,374	197,218	207,486	4,088	1,545	1,346,711
2045	1,011,101	220,219	223,980	4,400	1,739	1,461,440
2050	1,073,105	241,791	238,385	4,668	1,912	1,559,861

Table 11: Cumulative Distributed BESS Capacity (kWh)

Year	O'ahu	Hawai'i Island	Maui	Moloka'i	Lāna'i	Consolidated
MW	A	B	C	D	E	F =A + B + C + D +E
2025	133,409	69,805	82,955	796	362	287,326
2030	276,352	94,799	118,891	1,480	605	492,127
2040	553,654	145,443	184,317	2,824	1,082	887,319
2045	671,661	176,872	214,197	3,460	1,325	1,067,515
2050	768,058	206,292	240,143	4,000	1,550	1,220,042

3.1.2. ENERGY EFFICIENCY

The energy efficiency layer is based on projections from the Statewide Market Potential Study prepared by Applied Energy Group (AEG) and sponsored by the Hawaii Public Utilities Commission.[9] The preliminary results from the study were presented to the FAWG on January 29, 2020.[10] The market potential study considered customer segmentation, technologies and measures, building codes and appliance standards as well as the progress towards achieving the Energy Efficiency Portfolio Standards. The study included technical, economic and achievable energy efficiency potentials.

An achievable Business As Usual (BAU) energy efficiency potential forecast by island and sector covering the years 2020 through 2045 was provided to the Company in February 2020 to use for the Company's forecasts. The BAU potential forecast represented savings from realistic customer adoption of energy efficiency measures through future interventions that were similar in nature to existing interventions. In addition to the BAU forecast, a codes and standards (C&S) forecast was also provided.

The forecasts provided to the Company reclassified certain market segments to different customer classes to align with how the Company forecasts sales. Since a thirty-year forecast was needed, the Company extended the forecast out to 2050 using trends in AEG's forecast. AEG's forecast for Lāna'i and Moloka'i was adjusted to be consistent with Hawaii Energy's historical island allocation. A five year average net-to-gross ratio from Hawaii Energy's program years 2014 through 2018 for each island was applied to the

[9] See https://622c4de9-1fe4-418c-ac8a-695cbe1a8f60.filesusr.com/ugd/0c9650_647db07744d248fab7a9f563cf5b416d.pdf

[10] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200129_wg_fa_hawaii_market_potential_study_draft_results.pdf

forecasts in order to exclude free riders[11] from the energy savings estimates as impacts from free riders were assumed to be embedded in the underlying forecasts described above. The impacts from AEG were derived at an annualized level and included free riders which reflected savings for all measures as if they were all installed in January and provided savings for the whole year. The annualized impacts were ramped throughout the year to arrive at energy efficiency impacts by month for each forecasted year. For simplicity, the installations were assumed to be evenly distributed throughout the year.

3.1.3. ELECTRIFICATION OF TRANSPORTATION

The electrification of transportation layer consists of impacts from the charging of light duty electric vehicles and electric buses.

<u>Light Duty Electric Vehicles</u>
The light duty electric vehicle forecast was based on an adoption model developed by Integral Analytics, Inc. as described in Appendix E of the EoT Roadmap[12] to arrive at EV saturations of total light duty vehicles (LDV) by year for each island. Historical data for LDV registrations were provided by the Department of Business, Economic Development, and Tourism (DBEDT) and reported at the county level. In order to get to the island level for Maui County, an allocation factor supplied by DBEDT and based on vehicle registration for the three islands was used. The total LDV forecast for each county was estimated using a regression model driven by population and jobs based on UHERO's October 2019 economic forecast. The development of the EV forecast utilized the EV saturation by island and applied the saturation to the LDV forecast for each island to arrive at the number of light duty EVs.

To estimate the sales impact from EV charging for each island, the annual kWh used per vehicle was calculated based on the following equation:

$$Annual\ kWh\ per\ vehicle\ = \frac{\left(Annual\ VMT * (kWh\ per\ mile)\right) * 10^6}{Total\ LDV\ Forecast}$$

where

- *Annual VMT* is the annual vehicle miles travelled
- *kWh per mile* is a weighted average of fuel economies of electric vehicles registered

[11] A free rider is someone who would install an energy efficient measure without program incentives.

[12] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/electrification_of_transportation/201803_eot_roadmap.pdf

Annual VMT is forecasted by applying the baseline economic growth rate developed by the Federal Highway Administration for light duty vehicles to DBEDT's reported vehicle miles travelled for each county.[13] For Lānaʻi and Molokaʻi, vehicle miles travelled were developed based on information from DBEDT and on-island sources.

Historical *kWh per mile* was obtained using the weighted average fuel economy of registered electric vehicles by island. For Lānaʻi and Molokaʻi, the fuel economy from a predominant electric vehicle represented each island's average. Fuel economy and vehicle registration by type data were obtained from the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy and Electric Power Research Institute (EPRI), respectively[14]. *Annual kWh per vehicle* was forecasted by applying a reference growth rate developed using the U.S. Energy Information Administration's (EIA) Annual Energy Outlook to the historical weighted average fuel economies.[15] The reference fuel economy growth rate was developed based on the expectation that battery technology will improve and larger vehicles will be produced.

Car registration data at the ownership level was not available to determine whether a car was a personally or commercially owned vehicle. Therefore, the Company used a ratio between residential and commercial PV installations in historical years to allocate the number of EVs between residential and commercial customers for each island. EVs were a relatively new technology and the number of PV installations were found to be correlated to EV adoption. Within the commercial EVs, a percentage based on PV capacity installed by commercial rate Schedules G, J, and P was applied to the total commercial EV count to arrive at the number of EVs at the commercial rate schedule level. The sales impact by rate schedule was calculated by multiplying the number of EVs by sales impact per vehicle for each island.

<u>Electric Buses</u>

The electric bus forecast was based on information provided by the Company's Electrification of Transportation team following discussions with several bus operators throughout Honolulu, Hawaiʻi and Maui counties. Route information and schedules for weekdays, weekends and holidays were used to estimate the miles traveled for each bus operator. Since specific information on the buses were not available for most operators, the Company used the average bus efficiency (kWh per mile) for two different Proterra models. For each island, the total sales impact for each bus operator was applied to the rate schedule on which each bus operator was serviced.

[13] See https://www.fhwa.dot.gov/policyinformation/tables/vmt/vmt_forecast_sum.pdf
[14] See www.fueleconomy.gov
[15] See https://www.eia.gov/outlooks/aeo/data/browser/#/?id=113-AEO2019&cases=ref2019&sourcekey=0

Once all the layers are developed for each island, they are added together to arrive at the sales forecast at the customer level by island as shown in the following tables.

Table 12: O'ahu Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2025	9,456	(1,141)	(1,887)	92	6,521
2030	10,133	(1,293)	(2,307)	221	6,753
2040	11,110	(1,551)	(2,917)	789	7,432
2045	11,499	(1,643)	(3,142)	1,366	8,079
2050	11,905	(1,714)	(3,332)	1,964	8,822

Table 13: Hawai'i Island Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2025	1,471	(223)	(268)	10	990
2030	1,535	(252)	(345)	39	977
2040	1,634	(307)	(461)	172	1,038
2045	1,670	(337)	(501)	288	1,120
2050	1,708	(364)	(535)	435	1,244

Table 14: Maui Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2025	1,474	(251)	(300)	14	937
2030	1,572	(285)	(371)	56	973
2040	1,726	(341)	(473)	255	1,166

2045	1,787	(362)	(505)	357	1,277
2050	1,852	(379)	(529)	443	1,388

Table 15: Molokaʻi Sales Forecast

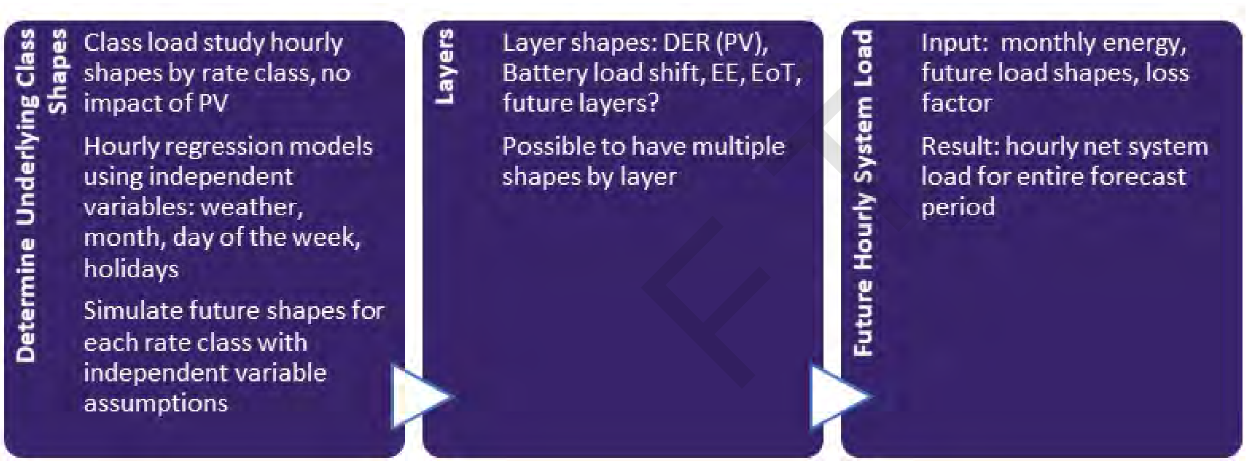
Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2025	36.0	(5.6)	(3.1)	0.1	27.4
2030	36.4	(6.1)	(3.6)	0.3	27.0
2040	37.8	(7.0)	(4.2)	1.1	27.7
2045	38.3	(7.4)	(4.5)	2.1	28.5
2050	38.9	(7.7)	(4.7)	3.2	29.7

Table 16: Lānaʻi Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2025	40.8	(1.6)	(1.6)	0.1	37.7
2030	42.2	(1.9)	(2.0)	0.2	38.5
2040	44.1	(2.4)	(2.8)	0.7	39.7
2045	44.7	(2.6)	(3.0)	1.3	40.4
2050	45.6	(2.9)	(3.3)	1.9	41.3

3.2. PEAK FORECASTS

Once the sales forecast is developed by layer (underlying, DER, EE and EoT) for each island, it is converted from a monthly sales forecast into a load forecast at the system level for each hour over the entire forecast horizon. The method to do the conversion from sales to an hourly load forecast is shown in the figure below. Hourly shapes from class load studies ("CLS") for each rate class or the total system load excluding the impact from PV are used to derive the underlying system load forecast shape. Hourly regression models are evaluated to look for relationships with explanatory variables (weather, month, day of the week, holidays) in order to accommodate change in the underlying shapes over time for each rate class or total system load. The hourly regression models are used to simulate shapes for the underlying forecast based on the forecast assumptions over the entire horizon. The forecasted energy for the underlying and each adjusting layer (DER PV, battery load shift, energy efficiency and EoT) is placed under its respective future load shape then converted from the customer level to system level using a loss factor as presented in the July 17, 2019[16] and March 9, 2020[17] FAWG meetings .



The result is an hourly net system load for the entire forecast period.

Once all the forecasted layers are developed by hour for each island, they are combined to arrive at an aggregated hourly load forecast. The annual peak forecast is the highest value in each year. The peaks presented in the August 31, 2020 FAWG meeting include the impacts of COVID-19.[18]

Table 17: O‘ahu Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D

[16] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20190717_wg_fa_meeting_presentation_materials.pdf
[17] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200309_wg_fa_meeting_presentation_materials.pdf
[18] See https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200831_wg_fa_meeting_presentation_materials_HECO.pdf and https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200831_wg_fa_meeting_presentation_materials_HECO.pdf. See slides 7, 10, 12, 14 and 17 for O‘ahu, Maui, Moloka‘i, Lāna‘i and Hawai‘i islands respectively.

2025	1574	(14)	(340)	31	1251
2030	1637	(30)	(403)	68	1272
2040	1791	(58)	(488)	245	1489
2045	1868	(68)	(528)	432	1703
2050	1947	(78)	(556)	621	1935

Table 18: Hawai‘i Island Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2025	228.2	(4.9)	(44.7)	3.0	181.6
2030	236.8	(8.5)	(55.5)	11.9	184.7
2040	241.2	(12.4)	(76.3)	63.0	215.5
2045	247.2	(3.5)	(85.3)	103.7	262.1
2050	253.3	(3.7)	(90.5)	156.7	315.8

Table 19: Maui Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2025	247.0	(5.4)	(47.6)	3.8	197.8
2030	261.5	(8.8)	(58.5)	18.4	212.6
2040	287.0	(14.1)	(74.5)	85.8	284.2
2045	297.0	(16.8)	(80.9)	121.1	320.4
2050	304.1	(22.6)	(87.4)	160.2	354.3

Table 20: Moloka‘i Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast

MW	A	B	C	D	E =A + B + C + D
2025	6.0	(0.1)	(0.2)	0.1	5.8
2030	6.0	(0.1)	(0.3)	0.1	5.7
2040	6.3	(0.4)	(0.3)	0.3	5.9
2045	6.4	(0.4)	(0.4)	0.5	6.1
2050	6.5	(0.5)	(0.4)	0.9	6.5

Table 21: Lāna‘i Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2025	6.8	–	(0.1)	–	6.7
2030	7.1	–	(0.2)	–	6.9
2040	7.5	(0.1)	(0.3)	0.2	7.3
2045	7.6	(0.1)	(0.4)	0.4	7.5
2050	7.8	(0.1)	(0.4)	0.5	7.8

3.3. FUEL PRICE FORECASTS

The cost of producing electricity is dependent upon, in part, the cost of fuels utilized to generate power. Hawaiian Electric uses the following fuel types:

- Low Sulfur Fuel Oil (LSFO): A residual fuel oil similar to No. 6 fuel oil that contains less than 5,000 parts per million of sulfur; about 0.5% sulfur content
- No. 2 Diesel Oil
- Ultra-Low Sulfur Diesel (ULSD)
- Naphtha
- High Sulfur Fuel Oil (HSFO): Also called Industrial Fuel Oil (IFO), HSFO contains less than 2% sulfur

The fuel price forecast was developed using a correlation between historical, actual fuel prices and the Brent North Sea Crude Oil Benchmark (Brent) from 1983-2019. The R^2 value for petroleum fuels was greater than 0.93. Hawaiian Electric's 2020 forecast was based on the Brent forecast provided by Facts Global Energy (FGE) with near-term prices reflecting the current oil situation.

Table 22: Oʻahu Fuel Price Forecast

Year $/MMBTU	LSFO	Diesel	ULSD – CIP	ULSD – SGS	Biodiesel
2020	7.38	10.11	10.52	11.31	26.84
2021	9.40	12.20	12.67	13.47	28.66
2022	11.45	14.33	14.84	15.66	30.50
2023	11.35	14.27	14.79	15.62	30.77
2024	10.38	13.32	13.82	14.66	30.38
2025	10.72	13.71	14.22	15.08	30.97
2026	11.84	14.89	15.43	16.30	32.14
2027	13.06	16.18	16.76	17.64	33.40
2028	13.43	16.60	17.19	18.08	34.03
2029	14.39	17.63	18.24	19.15	35.11
2030	13.68	16.94	17.54	18.46	34.94
2031	12.39	15.67	16.24	17.18	34.36
2032	13.39	16.73	17.33	18.28	35.48
2033	14.02	17.43	18.05	19.01	36.33
2034	14.18	17.64	18.27	19.24	36.84
2035	13.31	16.79	17.41	18.40	36.58
2036	13.41	16.95	17.57	18.58	37.06
2037	13.87	17.46	18.10	19.12	37.81
2038	14.37	18.02	18.67	19.71	38.59
2039	15.05	18.77	19.44	20.50	39.52
2040	15.81	19.60	20.29	21.36	40.51
2041	16.45	20.30	21.01	22.09	41.41
2042	17.15	21.06	21.80	22.90	42.37
2043	17.87	21.85	22.61	23.72	43.35
2044	18.60	22.66	23.44	24.57	44.34
2045	19.36	23.48	24.28	25.43	45.36

2046	20.13	24.33	25.15	26.32	46.40
2047	20.92	25.19	26.04	27.22	47.46
2048	21.73	26.08	26.95	28.15	48.54
2049	22.56	26.98	27.88	29.10	49.64
2050	23.42	27.91	28.83	30.07	50.77

Table 23: Hawai‘i Island Fuel Price Forecast

Year $/MMBTU	IFO	Diesel	ULSD	Naphtha	Biodiesel
2020	6.27	10.72	11.21	12.41	26.84
2021	8.02	12.97	13.52	14.56	28.66
2022	9.80	15.27	15.87	16.74	30.50
2023	9.72	15.21	15.82	16.72	30.77
2024	8.87	14.18	14.76	15.79	30.38
2025	9.16	14.60	15.19	16.22	30.97
2026	10.13	15.86	16.50	17.44	32.14
2027	11.19	17.26	17.93	18.79	33.40
2028	11.51	17.71	18.39	19.25	34.03
2029	12.34	18.81	19.52	20.32	35.11
2030	11.72	18.07	18.77	19.67	34.94
2031	10.59	16.69	17.36	18.42	34.36
2032	11.46	17.84	18.54	19.53	35.48
2033	12.01	18.59	19.31	20.28	36.33
2034	12.15	18.81	19.54	20.53	36.84
2035	11.38	17.89	18.61	19.71	36.58
2036	11.47	18.06	18.78	19.91	37.06
2037	11.87	18.61	19.35	20.47	37.81
2038	12.30	19.21	19.97	21.08	38.59
2039	12.89	20.01	20.80	21.88	39.52
2040	13.55	20.90	21.71	22.76	40.51
2041	14.09	21.65	22.48	23.51	41.41

2042	14.70	22.48	23.33	24.33	42.37
2043	15.32	23.32	24.20	25.17	43.35
2044	15.96	24.19	25.09	26.03	44.34
2045	16.61	25.08	26.01	26.91	45.36
2046	17.28	25.98	26.94	27.81	46.40
2047	17.96	26.91	27.90	28.74	47.46
2048	18.66	27.87	28.88	29.68	48.54
2049	19.38	28.84	29.88	30.65	49.64
2050	20.12	29.84	30.90	31.63	50.77

Table 24: Maui County Fuel Price Forecast

Year	Maui				Moloka'i	Lāna'i
$/MMBTU	IFO	Diesel	ULSD	Biodiesel	ULSD	ULSD
2020	5.93	10.23	10.56	26.84	11.39	14.53
2021	7.66	12.56	12.95	28.66	13.75	16.91
2022	9.41	14.94	15.38	30.50	16.15	19.32
2023	9.33	14.86	15.30	30.77	16.09	19.31
2024	8.49	13.77	14.19	30.38	15.01	18.31
2025	8.77	14.19	14.62	30.97	15.45	18.79
2026	9.72	15.50	15.96	32.14	16.78	20.15
2027	10.77	16.93	17.43	33.40	18.24	21.64
2028	11.08	17.38	17.89	34.03	18.71	22.16
2029	11.90	18.52	19.05	35.11	19.87	23.35
2030	11.28	17.73	18.24	34.94	19.09	22.65
2031	10.16	16.28	16.76	34.36	17.66	21.30
2032	11.01	17.45	17.97	35.48	18.86	22.53
2033	11.55	18.22	18.75	36.33	19.64	23.37
2034	11.68	18.43	18.97	36.84	19.88	23.66
2035	10.92	17.46	17.98	36.58	18.93	22.78
2036	11.01	17.62	18.14	37.06	19.10	23.02

2037	11.39	18.17	18.71	37.81	19.68	23.65
2038	11.81	18.78	19.33	38.59	20.31	24.34
2039	12.39	19.60	20.17	39.52	21.16	25.23
2040	13.04	20.50	21.10	40.51	22.09	26.22
2041	13.57	21.26	21.88	41.41	22.88	27.06
2042	14.17	22.10	22.74	42.37	23.74	27.98
2043	14.78	22.96	23.62	43.35	24.63	28.92
2044	15.40	23.85	24.53	44.34	25.54	29.88
2045	16.04	24.75	25.45	45.36	26.47	30.87
2046	16.70	25.67	26.40	46.40	27.42	31.88
2047	17.37	26.62	27.37	47.46	28.39	32.91
2048	18.06	27.59	28.36	48.54	29.39	33.97
2049	18.76	28.58	29.38	49.64	30.41	35.05
2050	19.48	29.60	30.42	50.77	31.46	36.15

3.4. RESOURCE COST FORECASTS

Resource cost assumptions were based on a combination of publicly available datasets as well as the Company's own assumptions, as shown in Table 25.

Table 25: Resource Cost Data Sources

U.S. Department of Energy (DOE)	• Distributed wind
National Renewable Energy Laboratory (NREL)	• Geothermal • Biomass • Offshore wind
US Energy Information Administration (EIA)	• Waste-to-energy
IHS Markit	• Grid-scale PV • Distributed PV • Onshore wind • Grid-scale storage • Distributed storage
Hawaiian Electric	• ICE • Pumped storage hydro

General Electric	• LM2500 and LM6000 CT and Combined Cycle
Siemens	• Synchronous Condenser

Resource cost assumptions began with a base technology capital cost that was adjusted for:

1. Future technology trends through the planning period;
2. Location-specific capital and O&M cost adjustments for Hawai'i; and
3. Applicable Federal & State tax incentives.

Figure 11 is a summary of the resource forecasts in nominal dollars. The resource cost forecasts from 2020-2050 can be found in Appendix A: Resource Cost Forecasts (2020 – 2050).

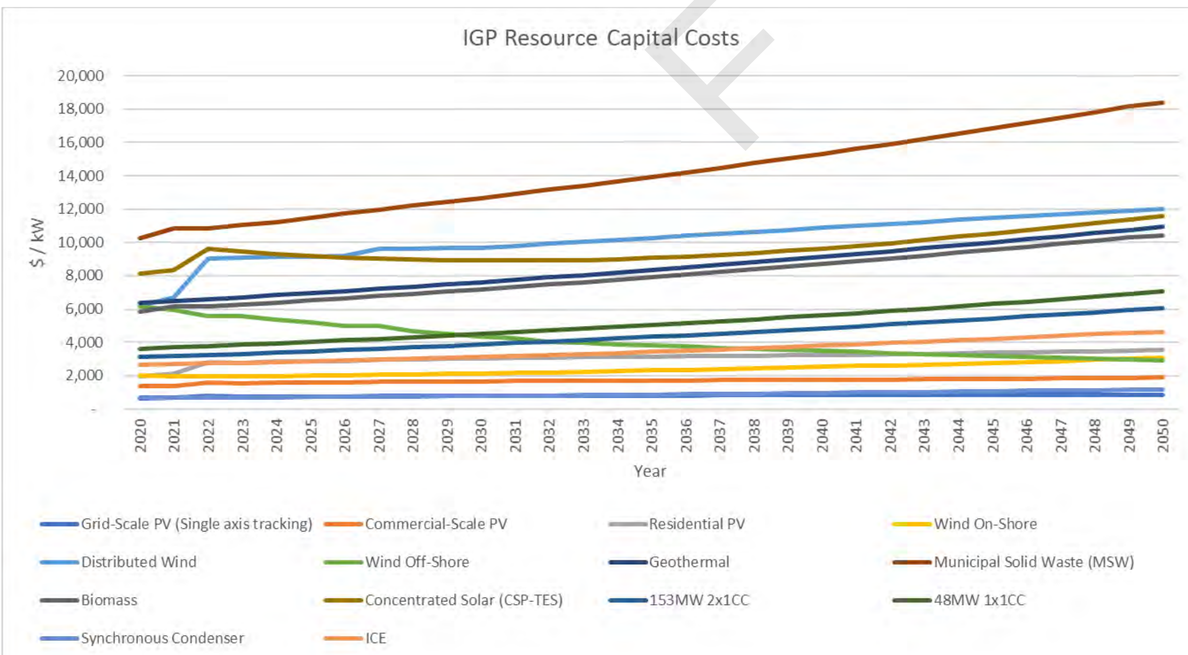


Figure 11: Capital Costs for IGP Candidate Resources

A comparison of the levelized cost of energy for select resources to the recently procured solar paired with storage PPAs[19] is shown below in Figure 12.

[19] See https://www.hawaiianelectric.com/new-renewable-projects-submitted-to-regulators-will-produce-lower-cost-electricity-advance-clean-energy

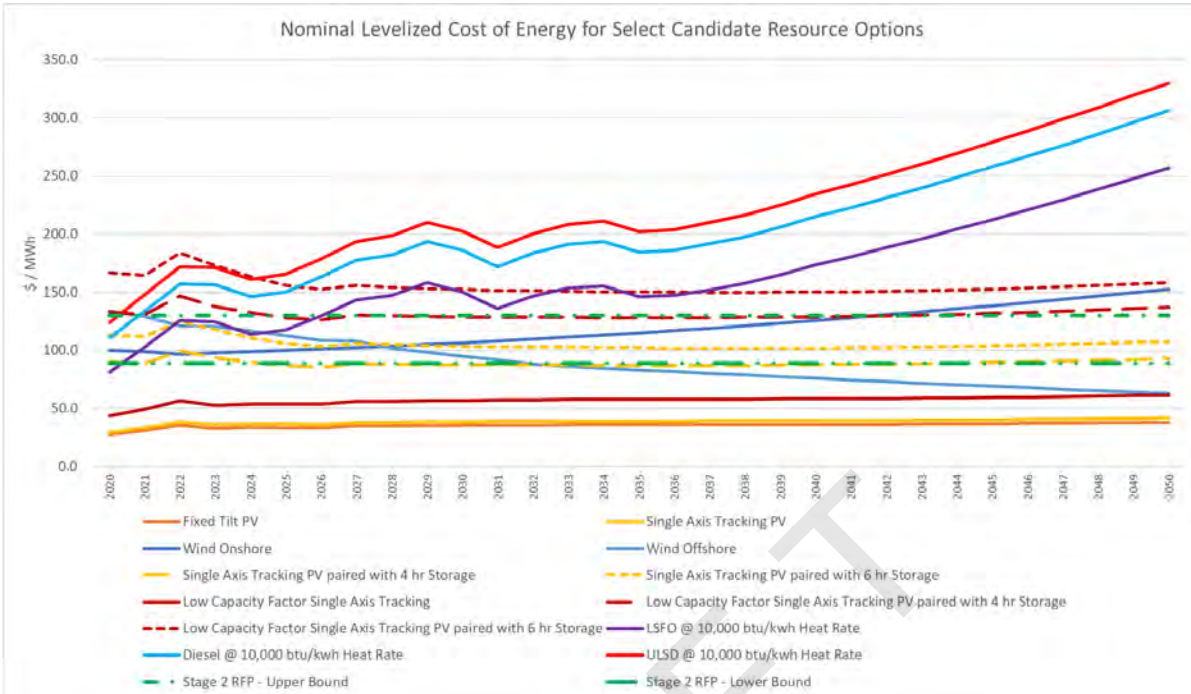


Figure 12: Levelized Cost of Energy for Select IGP Candidate Resources

<u>Photovoltaics (PV)</u>

For PV, three different classes were forecasted: Commercial PV, Residential PV and Grid-Scale PV. Each class used a similar process to develop the cost forecast.

Data Source

The source data for capital and fixed operations and maintenance (O&M) costs was provided by the IHS Markit U.S. Benchmark Capital Cost for PV Technology.[20] The capital costs were in nominal dollars $/kW$_{dc}$. The fixed O&M costs were in nominal $/kW-year. The capital costs were adjusted to remove embedded interconnection and land cost components from the estimate. The future trend for the capital cost was derived from the IHS Markit projections. The future cost for O&M was derived by applying a future escalation factor.

Location Adjustment

A location adjustment factor was applied to convert both capital costs ($/kW) and O&M costs ($/kW-year) to Hawai‘i costs. A 62% location adjustment factor for capital[21] was provided by the U.S. Energy Information Administration (EIA)[22] and an 18.5% location

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20 https://ihsmarkit.com

21 A location cost variation percentage from the EIA Capital Cost Estimates for Utility Scale Electricity Generating Plants.

22 See https://www.eia.gov/analysis/studies/powerplants/capitalcost/pdf/capcost_assumption.pdf

adjustment factor for fixed O&M costs was provided by the RSMeans City Cost Index.[23]

DC to AC Conversion

Capital costs for PV were converted from $\$/kW_{dc}$ to $\$/kW_{ac}$. For commercial and residential PV, a DC to AC conversion factor of 1.15 was used. For grid-scale PV, a conversion factor of 1.3 was used. These conversion factors were based on assumptions provided by IHS Markit.

Investment Tax Credit Adjustment

The Federal[24] and State ITC[25] schedules assumed for PV are summarized in Table 26 below.

Table 26: Federal and State ITC Schedule for PV

Year	2020	2021	2022	2023	2024	2025	2026	2027	Future
Federal ITC for Grid-Scale and Commercial-Scale PV	26%	22%	10%	10%	10%	10%	10%	10%	10%
Federal ITC for Residential PV	26%	22%	0%	0%	0%	0%	0%	0%	0%
State ITC for Grid-Scale, Commercial and Residential PV	35%	25%	25%	25%	20%	20%	20%	15%	15%

Onshore Wind

Data Source

The source data for capital and fixed O&M costs for on-shore wind was provided by the IHS Markit US Benchmark Capital Cost for On-Shore Wind Technology. The capital costs were in nominal dollars $/kW. The fixed O&M costs were in nominal $/kW-year. The future trend for the capital costs was derived from the IHS Markit projections. The future cost for O&M was derived by applying a future escalation factor.

Location Adjustment

The capital costs were converted to Hawai'i costs using a 35% factor from EIA for wind technology. The O&M costs were converted to Hawai'i costs using an 18.5% RSMeans factor. Location-specific interconnection costs were not included in the estimate.

[23] RSMeans Building Construction Cost Data (BCCD) is a reference book for estimating construction costs in the U.S. and Canada.

[24] See https://programs.dsireusa.org/system/program/detail/658 and https://programs.dsireusa.org/system/program/detail/1235

[25] See https://tax.hawaii.gov/geninfo/renewable

Offshore Wind

Data Source

The source data for the offshore wind estimate was developed in collaboration with stakeholders. The underlying costs for both capital and O&M were based on the NREL report "Cost of Floating Offshore Wind Energy Using New England Aqua Ventus Concrete Semisubmersible Technology".[26] Cost trends provided in the study for capital and O&M were used as initial data points for capital and O&M costs from 2020-2032. Capital and O&M costs for years 2033-2050 were not available in the study so the cost forecast for the remaining years was estimated based on NREL's Annual Technology Baseline (ATB) for the off-shore wind technology.[27] The percent change in capital and O&M cost from NREL was used to approximate the cost trend for 2033-2050 for offshore wind.

Location Adjustment

The capital costs were converted to Hawai'i costs using a 35% EIA factor for wind technology. The O&M costs were converted to Hawai'i using an 18.5% RSMeans factor. The location-specific interconnection costs were not included in the estimate, however, 1 kilometer of interconnection on dry land was included in the cost estimate as provided in the offshore wind study.

Distributed Wind

Data Source

The capital and fixed O&M source data for distributed wind was provided by the Department of Energy's 2017 Distributed Wind Market Report.[28] The average installed small wind costs were used from the report. These costs were converted from 2017 dollars to 2019 dollars using a GDPIPD[29] (Gross Domestic Product Implicit Price Deflator) factor. The future cost trend was estimated using the future cost projections from the NREL ATB for land-based wind.

Location Adjustment

The U.S. benchmark cost was converted to Hawai'i costs for capital and O&M cost estimates. A 35% EIA factor for wind technology was applied for the capital cost conversion to Hawai'i. An 18.5% RSMeans factor was used to convert fixed O&M costs to Hawai'i costs. Location-specific interconnection costs were not included in the estimate.

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26 https://www.nrel.gov/docs/fy20osti/75618.pdf

27 Annual Technology Baseline (ATB), https://atb.nrel.gov/

28 2017 Distributed Wind Market Report, Department of Energy, https://www.energy.gov/

29 Gross Domestic Product, https://www.bea.gov/data/gdp/gross-domestic-product

Investment Tax Credit Adjustment

The following Federal[30] and State investment tax credit[31] schedule was assumed for distributed wind in Table 27 below.

Table 27: Federal and State ITC for Distributed Wind

Year	2020	2021	2022	2023	2024	2025	2026	2027	Future
Federal ITC	26%	22%	0%	0%	0%	0%	0%	0%	0%
State ITC	20%	20%	20%	20%	20%	20%	20%	15%	15%

Biomass

Data Source

The source data for biomass capital, fixed O&M, and variable O&M costs as well as biomass fuel sources were provided by the NREL ATB for dedicated biomass technology. The capital costs, O&M costs and fuel costs were given in real dollars. The real 2019 costs were converted to nominal 2019 dollars using the GDPIPD factor. The future cost trend was converted from real dollars to nominal by applying an escalation factor.

Location Adjustment

Nominal capital, O&M and fuel costs for biomass were converted to Hawai'i costs. The capital costs were converted using a 46% EIA factor. The O&M and fuel costs were converted to Hawaii using an 18.5% RSMeans factor. Location-specific interconnection costs were not included in the estimate.

Pumped Storage Hydro

Data Source

Costs for pumped storage hydro were sourced from Hawaiian Electric's 2016 Power Supply Improvement Plan. The 2016 capital and O&M cost estimates were escalated to 2019 dollars using the GDPIPD factor.

Combustion Turbine with Synchronous Condenser Function

Data Source

30 https://programs.dsireusa.org/system/program/detail/1235

31 https://tax.hawaii.gov/geninfo/renewable/

The source data for high level capital costs for a combustion turbine that can function as a synchronous condenser were provided by General Electric and were based on the LM2500 and LM6000 technology. The O&M costs were estimated from NREL ATB. The O&M costs were given in real dollars and converted to nominal 2019 dollars using the GDPIPD factor. The future capital cost trend was based on the NREL ATB. Hawaiian Electric estimates for additional plant infrastructure, outside engineering, and construction costs were added to the equipment cost estimates provided by General Electric to further supplement the forecasted capital cost.

Location Adjustment

A 45% EIA factor for CT technology was used to convert the capital costs to Hawai'i costs and an 18.5% RSMeans factor was used to convert the fixed O&M and variable O&M costs to Hawai'i costs. Location-specific interconnection costs were not included in the estimate.

Concentrated Solar Power (CSP)

Data Source

The source data for concentrated solar power (CSP) capital, fixed O&M and variable O&M costs was provided by the NREL ATB. Capital costs, O&M costs and fuel costs were given in real dollars and converted to nominal 2019 dollars using the GDPIPD factor. The future cost trend was converted from real dollars to nominal by applying an escalation factor.

Location Adjustment

A 62% EIA factor for PV was used as an approximation to convert capital costs to Hawai'i costs. The federal and state investment tax credit schedule was assumed to be the same as grid scale PV. Fixed and variable O&M costs were converted to Hawai'i costs using an 18.5% RSMeans factor. Location-specific interconnection costs were not included in the estimate.

Geothermal

Data Source

The source data for the geothermal capital, fixed and variable O&M were provided by the NREL ATB for geothermal geo-hydro binary technology. The capital costs, O&M costs and fuel costs in ATB were given in real dollars and converted to nominal 2019 dollars using the GDPIPD factor. The future cost trend was converted from real dollars to nominal by applying an escalation factor.

Location Adjustment

A 20% EIA factor for geothermal technology was used to convert capital costs to Hawai'i costs. Fixed O&M and variable O&M costs used an 18.5% RSMeans factor. Location-specific interconnection costs were not included in the estimate.

Investment Tax Credit Adjustment

The following federal tax credit schedule[32] was assumed for geothermal technology.

Table 28: Federal and State ITC for Geothermal

Year	2020	2021	2022	2023	2024	2025	2026	2027	Future
Federal ITC	10%	10%	10%	10%	10%	10%	10%	10%	10%
State ITC	0%	0%	0%	0%	0%	0%	0%	0%	0%

Internal Combustion Engine (ICE)

Data Source

The source data to estimate internal combustion engine (ICE) technology was informed by actual costs for the Schofield Generating Station project constructed on O'ahu. The cost estimates were escalated from 2017 dollars using the GDPIPD factor. The future cost trend was estimated using the cost trend for gas CT technology discussed above due to limited information on a future ICE capital cost trend.

Municipal Solid Waste (MSW)

Data Source

The MSW source data was based on the U.S. Energy Information Administration Cost and Performance Characteristics of New Generating Technologies Annual Energy Outlook for 2019.[33] The costs were adjusted from 2018 dollars to 2019 dollars using GDPIPD. The future cost projections were estimated using future cost trend from biomass technology discussed above due to limited information on future MSW capital cost trend.

Location Adjustment

A 20% EIA factor for biomass technology was used as an approximation to convert capital costs. Fixed O&M and variable O&M costs were converted to Hawai'i costs using an 18.5% RSMeans factor.

Battery Energy Storage

32 https://programs.dsireusa.org/system/program/detail/658

33 See https://www.eia.gov/, Cost and Performance Characteristics of New Generating Technologies, Annual Energy Outlook 2019

The battery energy storage system (BESS) costs were estimated for grid-scale, commercial-scale and residential storage. Capital costs for various storage durations were based on balance of system costs plus the storage duration multiplied by the storage module component price provided by IHS.

Data Source
The source data for grid-scale, commercial and residential storage was provided in the IHS Markit US Benchmark Capital Cost for BESS. Capital costs were given in nominal dollars, $/kW for the balance of system costs and $/kWh for the storage module costs. Embedded interconnection cost was removed from the estimate.

Location Adjustment
The capital costs for balance of system and modules were converted to Hawai‘i costs using a 32% EIA factor. Fixed O&M and variable O&M costs were converted to Hawai‘i costs using an 18.5% RSMeans factor.

<u>Synchronous Condenser</u>

Data Source
The cost estimate for synchronous condensers was based on estimates from Siemens. The future capital cost trend was estimated using the NREL ATB for combustion turbines.

Location Adjustment
A 45% EIA factor for combustion turbines was used as an approximation to convert capital costs.

4. RESOURCE POTENTIAL AND RENEWABLE ENERGY ZONES

The first year available for each of the candidate resources that can be selected in RESOLVE reflects typical development timelines to bring the resource online. The first year available varies by resource and is summarized in the table below. Planned resources will be built according to their commercial operations date before 2025.

Table 29: First Year Available for Candidate Resources

Resource Type	First Year Available
Grid-Scale PV	2025
Onshore Wind	2025
Battery Energy Storage	2025
Synchronous Condenser	2025

Offshore Wind	2028–2030
ICE	2028–2030
Combustion Turbine	2028–2030
Combined Cycle	2028–2030
Biomass	2028–2030
Geothermal	2028–2030

4.1 NREL SOLAR AND WIND RESOURCE POTENTIAL STUDY UPDATE

NREL will use their Renewable Energy Potential Model (reV) to assess the potential for solar and wind energy deployment. The solar and wind resource data sets will be sourced from the National Solar Radiation Database and the Hawaii WIND toolkit. The NSRDB has a temporal interval of 30-minutes and nominal spatial resolution of 4 km. The WIND toolkit has an hourly temporal interval with a nominal spatial resolution of 2 km. The model will consider land exclusions such as slope, man-made structures, protected areas, and land cover. System configurations can also be considered in the model such as axis tracking, losses, tilt, panel type, inverter efficiency, and DC/AC ratio.

The NREL Resource Potential Study will also include PV rooftop potential analysis, which will rely upon Light Detection and Ranging (LiDAR) data. The model will consider LiDAR point clouds, buildings, solar resource from the NSRDB, parcels, and tree canopy. The system configurations can also be considered such as, fixed roof, losses, tilt, azimuth, panel type, module efficiency, inverter efficiency, and DC/AC ratio.

[Results to be added once the study is finalized]

5. THERMAL GENERATING UNIT PORTFOLIOS

Hawaiian Electric's thermal generating unit capacity is provided by a mix of utility-owned generation and independent power producers (IPPs). Key inputs to characterize the operation of the utility-owned generation include the minimum and maximum capacity, heat rate coefficients, planned maintenance outages, forced outage rates, and maintenance outage rates.

Minimum and Maximum Capacity
The minimum and maximum capacity of a generating unit define its dispatchable range.

Heat Rate Coefficients

The heat rate coefficients define the heat input function $y = cx^2 + bx + a$ where y is the amount of fuel consumed to produce at the megawatt level x for one hour.

Maintenance Outages
Maintenance outages can be defined as discrete occurrences with a start date and duration or can be defined as a percentage of the year that the unit will be out of service on maintenance. Maintenance outages can remove an entire unit from service or reduce the generating unit's capacity that is available for service.

[Planned maintenance schedules will be updated to the latest assumption prior to commencing the PLEXOS modeling]

Forced Outages
Forced outages are unexpected and unplanned generating unit outages and are defined as a percentage of the year that the unit may experience an outage based on historical data.

O'ahu

Table 30: O'ahu Minimum and Maximum Capacity for Thermal Resources

Unit	Operating Minimum (Net MW)	Normal Top Load (Net MW)	Fuel Type
Kahe 1	23.2	82.6	LSFO
Kahe 2	23.3	82.4	LSFO
Kahe 3	23.1	86.1	LSFO
Kahe 4	23.1	85.4	LSFO
Kahe 5	50.4	134.9	LSFO
Kahe 6	40.0	134.7	LSFO
Waiau 3	23.5	47.1	LSFO
Waiau 4	23.5	46.5	LSFO
Waiau 5	23.4	54.4	LSFO
Waiau 6	23.5	53.7	LSFO
Waiau 7	23.1	82.9	LSFO
Waiau 8	23.1	86.3	LSFO
Waiau 9	5.9	52.9	Diesel
Waiau 10	5.9	49.9	Diesel
Campbell Industrial Park	41.2	129.0	Diesel

H-Power	35.0	68.5	Refuse
AES	63.0	180.0	Coal
Kalaeloa Energy Partners	65.0	208.0	LSFO
Airport DSG	4.0	8.0	Biodiesel
Schofield 1	4.0	8.1	ULSD / Biodiesel
Schofield 2	4.0	8.1	ULSD / Biodiesel
Schofield 3	4.0	8.1	ULSD / Biodiesel
Schofield 4	4.0	8.1	ULSD / Biodiesel
Schofield 5	4.0	8.1	ULSD / Biodiesel
Schofield 6	4.0	8.1	ULSD / Biodiesel

Table 31: O‘ahu Heat Rate Coefficients for Thermal Resources

Unit	A Coefficient (MMBTU/hr)	B Coefficient (MMBTU/hr-MW)	C Coefficient (MMBTU/hr-MW^2)
Kahe 1	72.1042	9.1921	0.0022
Kahe 2	72.0121	8.3600	0.0118
Kahe 3	73.2636	8.1711	0.0167
Kahe 4	116.5162	6.5015	0.0264
Kahe 5	113.3406	7.9454	0.0106
Kahe 6	59.8050	9.4934	0.0031
Waiau 3	60.8508	8.5429	0.0309
Waiau 4	25.8219	10.3352	0.0272
Waiau 5	37.8539	10.2088	0.0019
Waiau 6	33.4800	10.0324	0.0143
Waiau 7	101.1916	7.4411	0.0174
Waiau 8	78.0588	8.2162	0.0117
Waiau 9	206.3054	7.0804	0.0249
Waiau 10	190.6694	8.0059	0.0184
Campbell Industrial Park	271.1301	8.6971	0.0050
H-Power	1	1	1
AES	258.7479	14.9713	0.0051

Kalaeloa Energy Partners	299.0258	4.4067	0.0093
Airport DSG	0.0000	10.2090	0.0000
Schofield 1	8.5503	6.8097	0.0602
Schofield 2	8.4677	6.7967	0.0614
Schofield 3	8.5584	6.7376	0.0684
Schofield 4	8.5071	6.6227	0.0814
Schofield 5	8.4171	6.8237	0.0550
Schofield 6	7.6438	7.0152	0.0513

Table 32: Oʻahu Forced Outage Rates for Thermal Resources (1 of 4)

Year	Waiau 3	Waiau 4	Waiau 5	Waiau 6	Waiau 7	Waiau 8	Waiau 9	Waiau 10
%								
2021	7	7	4.5	4.5	4.5	4.5	4	4
2022	7	7	4.5	4.5	4.5	4.5	4	4
2023	7	7	4.5	4.5	4.5	4.5	4	4
2024	7	7	4.5	4.5	4.5	4.5	4	4
2025	9	9	5	5	4.5	4.5	4	4
2026	9	9	5	5	4.5	4.5	4	4
2027	9	9	5	5	4.5	4.5	4	4
2028	9	9	5	5	4.5	4.5	4	4
2029	9	9	5	5	4.5	4.5	4	4
2030	9	9	6	6	5.5	5.5	4	4
2031	9	9	6	6	5.5	5.5	4	4
2032	9	9	6	6	5.5	5.5	4	4
2033	9	9	6	6	5.5	5.5	4	4
2034	9	9	6	6	5.5	5.5	4	4
2035	9	9	6	6	5.5	5.5	4	4
2036	9	9	6	6	5.5	5.5	4	4
2037	9	9	6	6	5.5	5.5	4	4
2038	9	9	6	6	5.5	5.5	4	4
2039	9	9	6	6	5.5	5.5	4	4

2040	9	9	6	6	5.5	5.5	4	4
2041	9	9	6	6	5.5	5.5	4	4
2042	9	9	6	6	5.5	5.5	4	4
2043	9	9	6	6	5.5	5.5	4	4
2044	9	9	6	6	5.5	5.5	4	4
2045	9	9	6	6	5.5	5.5	4	4
2046	9	9	6	6	5.5	5.5	4	4
2047	9	9	6	6	5.5	5.5	4	4
2048	9	9	6	6	5.5	5.5	4	4
2049	9	9	6	6	5.5	5.5	4	4
2050	9	9	6	6	5.5	5.5	4	4

Table 33: O‘ahu Forced Outage Rates for Thermal Resources (2 of 4)

Year %	Kahe 1	Kahe 2	Kahe 3	Kahe 4	Kahe 5	Kahe 6	CIP CT-1
2021	4.5	4.5	4.5	4.5	5	5	3
2022	4.5	4.5	4.5	4.5	5	5	3
2023	4.5	4.5	4.5	4.5	5	5	3
2024	4.5	4.5	4.5	4.5	5	5	3
2025	4.5	4.5	4.5	4.5	5	5	3
2026	4.5	4.5	4.5	4.5	5	5	3
2027	4.5	4.5	4.5	4.5	5	5	3
2028	4.5	4.5	4.5	4.5	5	5	3
2029	4.5	4.5	4.5	4.5	5	5	3
2030	5.5	5.5	5	5	5	5	3
2031	5.5	5.5	5	5	5	5	3
2032	5.5	5.5	5	5	5	5	3
2033	5.5	5.5	5	5	5	5	3
2034	5.5	5.5	5	5	5	5	3
2035	5.5	5.5	5	5	5	5	3
2036	5.5	5.5	5	5	5	5	3

2037	5.5	5.5	5	5	5	5	3
2038	5.5	5.5	5	5	5	5	3
2039	5.5	5.5	5	5	5	5	3
2040	5.5	5.5	5	5	5	5	3
2041	5.5	5.5	5	5	5	5	3
2042	5.5	5.5	5	5	5	5	3
2043	5.5	5.5	5	5	5	5	3
2044	5.5	5.5	5	5	5	5	3
2045	5.5	5.5	5	5	5	5	3
2046	5.5	5.5	5	5	5	5	3
2047	5.5	5.5	5	5	5	5	3
2048	5.5	5.5	5	5	5	5	3
2049	5.5	5.5	5	5	5	5	3
2050	5.5	5.5	5	5	5	5	3

Table 34: Oʻahu Forced Outage Rates for Thermal Resources (3 of 4)

Year %	Airport DSG	Schofield 1	Schofield 2	Schofield 3	Schofield 4	Schofield 5	Schofield 6
2021	5	2	2	2	2	2	2
2022	5	2	2	2	2	2	2
2023	5	2	2	2	2	2	2
2024	5	2	2	2	2	2	2
2025	5	2	2	2	2	2	2
2026	5	2	2	2	2	2	2
2027	5	2	2	2	2	2	2
2028	5	2	2	2	2	2	2
2029	5	2	2	2	2	2	2
2030	5	2	2	2	2	2	2
2031	5	2	2	2	2	2	2
2032	5	2	2	2	2	2	2
2033	5	2	2	2	2	2	2

2034	5	2	2	2	2	2	2
2035	5	2	2	2	2	2	2
2036	5	2	2	2	2	2	2
2037	5	2	2	2	2	2	2
2038	5	2	2	2	2	2	2
2039	5	2	2	2	2	2	2
2040	5	2	2	2	2	2	2
2041	5	2	2	2	2	2	2
2042	5	2	2	2	2	2	2
2043	5	2	2	2	2	2	2
2044	5	2	2	2	2	2	2
2045	5	2	2	2	2	2	2
2046	5	2	2	2	2	2	2
2047	5	2	2	2	2	2	2
2048	5	2	2	2	2	2	2
2049	5	2	2	2	2	2	2
2050	5	2	2	2	2	2	2

Table 35: O'ahu Forced Outage Rates for Thermal Resources (4 of 4)

Year	H-POWER	Kalaeloa	AES
%			
2021	3	1.5	1.5
2022	3	1.5	1.5
2023	3	1.5	
2024	3	1.5	
2025	3	1.5	
2026	3	1.5	
2027	3	1.5	
2028	3	1.5	
2029	3	1.5	
2030	3	1.5	

2031	3	1.5	
2032	3	1.5	
2033	3	1.5	
2034	3	1.5	
2035	3	1.5	
2036	3	1.5	
2037	3	1.5	
2038	3	1.5	
2039	3	1.5	
2040	3	1.5	
2041	3	1.5	
2042	3	1.5	
2043	3	1.5	
2044	3	1.5	
2045	3	1.5	
2046	3	1.5	
2047	3	1.5	
2048	3	1.5	
2049	3	1.5	
2050	3	1.5	

Table 36: O‘ahu Maintenance Outage Rates for Thermal Resources (1 of 3)

Year %	Waiau 3	Waiau 4	Waiau 5	Waiau 6	Waiau 7	Waiau 8	Waiau 9	Waiau 10
2021	1.92	1.92	5.75	5.75	7.67	7.67	3.84	15.34
2022	13.42	1.92	21.10	13.42	3.84	3.84	3.84	3.84
2023	1.92	13.42	3.84	3.84	13.42	13.42	3.84	3.84
2024	3.84	3.84	5.75	5.75	7.67	7.67	3.84	3.84
2025	13.42	1.92	13.42	13.42	1.92	1.92	3.84	3.84
2026	0.00	13.42	0.00	0.00	17.26	13.42	26.85	3.84

2027	3.84	3.84	5.75	5.75	5.75	5.75	3.84	26.85
2028	13.42	1.92	13.42	21.10	3.84	3.84	3.84	3.84
2029	1.92	13.42	1.92	1.92	13.42	21.10	3.84	3.84
2030	1.92	1.92	3.84	3.84	5.75	5.75	3.84	3.84
2031	13.42	1.92	21.10	13.42	1.92	1.92	3.84	3.84
2032	1.92	13.42	1.92	1.92	13.42	13.42	15.34	3.84
2033	1.92	1.92	5.75	5.75	5.75	5.75	3.84	15.34
2034	13.42	1.92	13.42	13.42	5.75	5.75	3.84	3.84
2035	0.00	13.42	0.00	0.00	17.26	13.42	3.84	3.84
2036	1.92	1.92	5.75	5.75	5.75	5.75	3.84	3.84
2037	13.42	0.00	13.42	21.10	1.92	1.92	3.84	3.84
2038	0.00	13.42	1.92	1.92	13.42	21.10	26.85	3.84
2039	1.92	1.92	5.75	5.75	3.84	3.84	3.84	26.85
2040	13.42	1.92	13.42	13.42	3.84	3.84	3.84	3.84
2041	1.92	13.42	5.75	5.75	13.42	13.42	3.84	3.84
2042	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2043	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2044	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2045	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2046	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2047	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2048	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2049	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75
2050	1.92	1.92	5.75	5.75	5.75	5.75	5.75	5.75

Table 37: O'ahu Maintenance Outage Rates for Thermal Resources (2 of 3)

Year	Kahe 1	Kahe 2	Kahe 3	Kahe 4	Kahe 5	Kahe 6	CIP CT-1
%							
2021	21.10	5.75	5.75	5.75	5.75	5.75	3.84
2022	3.84	17.26	3.84	13.42	13.42	3.84	3.84
2023	3.84	5.75	13.42	5.75	3.84	13.42	3.84

2024	13.42	7.67	7.67	7.67	5.75	5.75	15.34
2025	1.92	13.42	3.84	13.42	19.18	1.92	3.84
2026	0.00	0.00	17.26	0.00	0.00	23.01	3.84
2027	13.42	7.67	7.67	7.67	5.75	5.75	3.84
2028	1.92	13.42	1.92	21.10	13.42	3.84	3.84
2029	3.84	3.84	13.42	3.84	1.92	13.42	3.84
2030	21.10	5.75	5.75	5.75	5.75	5.75	19.18
2031	3.84	17.26	1.92	13.42	13.42	1.92	3.84
2032	3.84	3.84	21.10	3.84	3.84	13.42	3.84
2033	13.42	7.67	7.67	7.67	7.67	7.67	3.84
2034	5.75	13.42	5.75	13.42	13.42	3.84	3.84
2035	0.00	0.00	13.42	1.92	1.92	23.01	3.84
2036	13.42	7.67	7.67	7.67	7.67	5.75	15.34
2037	1.92	13.42	1.92	21.10	13.42	1.92	3.84
2038	3.84	3.84	13.42	1.92	1.92	13.42	3.84
2039	21.10	5.75	5.75	5.75	5.75	5.75	3.84
2040	5.75	17.26	5.75	13.42	13.42	3.84	3.84
2041	3.84	3.84	13.42	3.84	3.84	13.42	3.84
2042	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2043	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2044	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2045	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2046	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2047	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2048	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2049	7.67	7.67	7.67	7.67	7.67	7.67	5.75
2050	7.67	7.67	7.67	7.67	7.67	7.67	5.75

Table 38: O‘ahu Maintenance Outage Rates for Thermal Resources (3 of 3)

Year	Airport DSG	Schofield 1	Schofield 2	Schofield 3	Schofield 4	Schofield 5	Schofield 6
%							

2021	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2022	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2023	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2024	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2025	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2026	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2027	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2028	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2029	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2030	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2031	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2032	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2033	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2034	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2035	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2036	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2037	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2038	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2039	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2040	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2041	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2042	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2043	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2044	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2045	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2046	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2047	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2048	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2049	1.92	1.90	1.90	1.90	1.90	1.90	1.90
2050	1.92	1.90	1.90	1.90	1.90	1.90	1.90

Hawai'i Island

Table 39: Hawai'i Island Minimum and Maximum Capacity for Thermal Resources

Unit	Operating Minimum (Net MW)	Normal Top Load (Net MW)	Fuel Type
PGV (2022)	20	46	Geothermal
PGV (2021, off-peak)	22.0	38.0	Geothermal
PGV (2021, on-peak)	33.9	38.0	Geothermal
Hill 5	4.0	14.2	IFO
Hill 6	8.0	20.2	IFO
Kanoelehua CT1	0.5	10.5	Diesel
Kanoelehua D11	2.0	2.0	ULSD
Kanoelehua D15	0.8	2.5	ULSD
Kanoelehua D16	0.8	2.5	ULSD
Kanoelehua D17	0.8	2.5	ULSD
Kapua D27	1.3	1.3	ULSD
Keahole CT2	5.0	13.8	Diesel
Keahole D21	0.8	2.5	ULSD
Keahole D22	0.8	2.5	ULSD
Keahole D23	0.8	2.5	ULSD
Ouli D25	1.3	1.3	ULSD
Panaewa D24	1.3	1.3	ULSD
Puna	6.0	15.7	IFO
Puna CT3	7.0	20.0	Diesel
Punaluu D26	1.3	1.3	ULSD
Waimea D12	0.8	2.5	ULSD
Waimea D13	0.8	2.5	ULSD
Waimea D14	0.8	2.5	ULSD
Keahole CT4	7.0	20.0	Diesel
Keahole CT5	7.0	20.0	Diesel
Keahole ST7	1.5	13.5	–
HEP CT1	5.0	20.8	Naphtha

HEP CT2	5.0	20.8	Naphtha
HEP ST	3.3	19.0	–

Table 40: Hawai'i Island Heat Rate Coefficients for Thermal Resources

Unit	A Coefficient (MMBTU/hr)	B Coefficient (MMBTU/hr-MW)	C Coefficient (MMBTU/hr-MW^2)
Hill 5	24.6229	8699.0000	0.2033
Hill 6	64.0000	4000.0000	0.2550
Kanoelehua CT1	74.0422	9150.1300	0.1272
Kanoelehua D11	6.1493	4323.1400	1.5805
Kanoelehua D15	7.6830	4326.1600	1.2637
Kanoelehua D16	7.6830	4326.1700	1.2637
Kanoelehua D17	7.6830	4326.1800	1.2637
Kapua D27	2.8000	3200.0300	3.2800
Keahole CT2	56.9838	8864.6600	0.0040
Keahole D21	7.6834	4326.1500	1.2637
Keahole D22	7.6834	4326.1400	1.2637
Keahole D23	7.6834	4326.1300	1.2637
Ouli D25	2.8000	3200.0400	3.2800
Panaewa D24	2.8000	3200.0100	3.2800
Puna	41.8152	7738.1000	0.2001
Puna CT3	49.3842	7680.7600	0.0310
Punaluu D26	2.8000	3200.0200	3.2800
Waimea D12	7.6830	4326.1600	1.2637
Waimea D13	7.6830	4326.1700	1.2637
Waimea D14	7.6830	4326.1500	1.2637
Keahole CT4	49.3842	7680.7600	0.0310
Keahole CT5	53.1791	6858.6800	0.0689
Keahole ST7	59.8609	20348.8000	0.0000
HEP CT1	56.5930	7544.0000	0.0504
HEP CT2	56.5930	7544.0000	0.0504

HEP ST	49.1130	14653.0000	0.0000

Table 41: Hawai'i Island Forced Outage Rates for Thermal Resources (1 of 4)

Year %	Hill 5	Hill 6	Puna Steam	Kanoelehua D11	Waimea D12	Waimea D13	Waimea D14	Kanoelehua D15
2021	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2022	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2023	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2024	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2025	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2026	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2027	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2028	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2029	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2030	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2031	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2032	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2033	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2034	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2035	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2036	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2037	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2038	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2039	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2040	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2041	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2042	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2043	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2044	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2045	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2046	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50

2047	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2048	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2049	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50
2050	1.78	1.38	1.58	17.31	19.44	12.04	14.85	0.50

Table 42: Hawai‘i Island Forced Outage Rates for Thermal Resources (2 of 4)

Year %	Kanoelehua D16	Kanoelehua D17	Keahole D21	Keahole D22	Keahole D23	Panaewa D24	Ouli D25	Punaluu D26
2021	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2022	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2023	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2024	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2025	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2026	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2027	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2028	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2029	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2030	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2031	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2032	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2033	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2034	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2035	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2036	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2037	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2038	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2039	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2040	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2041	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2042	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2043	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40

2044	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2045	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2046	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2047	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2048	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2049	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40
2050	17.65	7.09	6.73	8.33	7.99	4.14	1.65	6.40

Table 43: Hawai'i Island Forced Outage Rates for Thermal Resources (3 of 4)

Year %	Kapua D27	Kanoelehua CT1	Keahole CT2	Puna CT3	Keahole CT4	Keahole CT5	Keahole ST	HEP CT1
2021	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2022	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2023	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2024	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2025	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2026	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2027	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2028	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2029	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2030	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2031	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2032	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2033	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2034	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2035	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2036	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2037	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2038	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2039	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2040	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05

2041	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2042	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2043	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2044	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2045	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2046	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2047	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2048	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2049	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05
2050	0.61	0.94	4.18	1.81	4.68	6.30	2.93	2.05

Table 44: Hawai‘i Island Forced Outage Rates for Thermal Resources (4 of 4)

Year %	HEP CT2	HEP ST	PGV
2021	4.22	2.52	9.22
2022	4.22	2.52	9.22
2023	4.22	2.52	9.22
2024	4.22	2.52	9.22
2025	4.22	2.52	9.22
2026	4.22	2.52	9.22
2027	4.22	2.52	9.22
2028	4.22	2.52	9.22
2029	4.22	2.52	9.22
2030	4.22	2.52	9.22
2031	4.22	2.52	9.22
2032	4.22	2.52	9.22
2033	4.22	2.52	9.22
2034	4.22	2.52	9.22
2035	4.22	2.52	9.22
2036	4.22	2.52	9.22
2037	4.22	2.52	9.22

2038	4.22	2.52	9.22
2039	4.22	2.52	9.22
2040	4.22	2.52	9.22
2041	4.22	2.52	9.22
2042	4.22	2.52	9.22
2043	4.22	2.52	9.22
2044	4.22	2.52	9.22
2045	4.22	2.52	9.22
2046	4.22	2.52	9.22
2047	4.22	2.52	9.22
2048	4.22	2.52	9.22
2049	4.22	2.52	9.22
2050	4.22	2.52	9.22

Table 45: Hawai‘i Island Maintenance Outage Rates for Thermal Resources (1 of 4)

Year %	Hill 5	Hill 6	Puna Steam	Kanoelehua D11	Waimea D12	Waimea D13	Waimea D14	Kanoelehua D15
2021	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2022	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2023	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2024	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2025	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2026	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2027	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2028	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2029	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2030	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2031	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2032	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2033	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2034	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29

2035	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2036	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2037	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2038	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2039	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2040	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2041	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2042	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2043	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2044	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2045	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2046	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2047	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2048	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2049	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29
2050	8.75	9.44	4.78	4.18	3.62	3.08	3.20	3.29

Table 46: Hawai‘i Island Maintenance Outage Rates for Thermal Resources (2 of 4)

Year	Kanoelehua D16	Kanoelehua D17	Keahole D21	Keahole D22	Keahole D23	Panaewa D24	Ouli D25	Punaluu D26
%								
2021	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2022	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2023	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2024	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2025	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2026	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2027	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2028	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2029	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2030	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2031	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39

2032	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2033	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2034	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2035	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2036	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2037	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2038	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2039	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2040	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2041	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2042	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2043	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2044	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2045	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2046	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2047	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2048	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2049	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39
2050	3.64	3.23	1.86	2.46	3.69	0.41	0.19	0.39

Table 47: Hawai‘i Island Maintenance Outage Rates for Thermal Resources (3 of 4)

Year	Kapua D27	Kanoelehua CT1	Keahole CT2	Puna CT3	Keahole CT4	Keahole CT5	Keahole ST	HEP CT1
%								
2021	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2022	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2023	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2024	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2025	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2026	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2027	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2028	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09

2029	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2030	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2031	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2032	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2033	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2034	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2035	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2036	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2037	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2038	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2039	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2040	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2041	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2042	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2043	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2044	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2045	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2046	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2047	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2048	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2049	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09
2050	0.14	3.05	3.56	6.95	3.17	5.30	7.95	3.09

Table 48: Hawai‘i Island Maintenance Outage Rates for Thermal Resources (4 of 4)

Year %	HEP CT2	HEP ST	PGV
2021	3.47	3.62	3.94
2022	3.47	3.62	3.94
2023	3.47	3.62	3.94
2024	3.47	3.62	3.94
2025	3.47	3.62	3.94

2026	3.47	3.62	3.94
2027	3.47	3.62	3.94
2028	3.47	3.62	3.94
2029	3.47	3.62	3.94
2030	3.47	3.62	3.94
2031	3.47	3.62	3.94
2032	3.47	3.62	3.94
2033	3.47	3.62	3.94
2034	3.47	3.62	3.94
2035	3.47	3.62	3.94
2036	3.47	3.62	3.94
2037	3.47	3.62	3.94
2038	3.47	3.62	3.94
2039	3.47	3.62	3.94
2040	3.47	3.62	3.94
2041	3.47	3.62	3.94
2042	3.47	3.62	3.94
2043	3.47	3.62	3.94
2044	3.47	3.62	3.94
2045	3.47	3.62	3.94
2046	3.47	3.62	3.94
2047	3.47	3.62	3.94
2048	3.47	3.62	3.94
2049	3.47	3.62	3.94
2050	3.47	3.62	3.94

Maui

Table 49: Maui Minimum and Maximum Capacity for Thermal Resources

Unit[34]	Operating Minimum (Net MW)	Normal Top Load (Net MW)	Fuel Type
Kahului 1	2.26	4.71	IFO
Kahului 2	2.28	4.76	IFO
Kahului 3	3.00	11.50	IFO
Kahului 4	3.00	11.50	IFO
Maalaea 1	2.50	2.50	ULSD
Maalaea 2	2.50	2.50	ULSD
Maalaea 3	2.50	2.50	ULSD
Maalaea 4	1.86	5.51	Diesel
Maalaea 5	1.86	5.51	Diesel
Maalaea 6	1.86	5.51	Diesel
Maalaea 7	1.86	5.51	Diesel
Maalaea 8	1.86	5.48	Diesel
Maalaea 9	1.86	5.48	Diesel
Maalaea 10	7.87	12.34	Diesel
Maalaea 11	7.87	12.34	Diesel
Maalaea 12	7.87	12.34	Diesel
Maalaea 13	7.87	12.34	Diesel
Maalaea X1	2.50	2.50	ULSD
Maalaea X2	2.50	2.50	ULSD
Maalaea 14	5.88	21.13	Diesel
Maalaea 15	3.73	13.38	–
Maalaea 16	5.88	21.13	Diesel
Maalaea 17	5.93	21.47	Diesel
Maalaea 18	2.96	12.99	–
Maalaea 19	5.93	21.47	Diesel
Hana 1	0.00	0.97	ULSD

[34] Kahului 1–4 units retire in 2023.

Hana 2	0.00	0.97	ULSD

Table 50: Maui Heat Rate Coefficients for Thermal Resources

Unit	A Coefficient (MMBTU/hr)	B Coefficient (MMBTU/hr-MW)	C Coefficient (MMBTU/hr-MW^2)	Average Heat Rate (BTU/KWH) [35]
Kahului 1	10.5570	12.0740	0.2260	
Kahului 2	8.1530	12.7150	0.2130	
Kahului 3	20.6320	11.1090	0.0270	
Kahului 4	30.2160	8.4170	0.2860	
Maalaea 1	0.0000	10.2878	0.0000	
Maalaea 2	0.0000	10.2878	0.0000	
Maalaea 3	0.0000	10.2878	0.0000	
Maalaea 4	12.4800	4.1590	0.7290	
Maalaea 5	12.4800	4.1590	0.7290	
Maalaea 6	12.4800	4.1590	0.7290	
Maalaea 7	12.4800	4.1590	0.7290	
Maalaea 8	10.8880	4.7170	0.5900	
Maalaea 9	10.8880	4.7170	0.5900	
Maalaea 10	11.6310	6.7910	0.1320	
Maalaea 11	11.6310	6.7910	0.1320	
Maalaea 12	11.6310	6.7910	0.1320	
Maalaea 13	11.6310	6.7910	0.1320	
Maalaea X1	0.0000	10.2878	0.0000	
Maalaea X2	0.0000	10.2878	0.0000	
Maalaea 14	80.4330	4692.0000	0.1360	
Maalaea 15	28.5852	20758.1000	0.1072	
Maalaea 16	80.4330	4692.0000	0.1360	
Maalaea 17	48.5120	8439.0000	0.0120	

[35] Hana 1 and 2 are primarily used as backup generation only for line maintenance and repair work in Hana. Therefore, they are modeled using an average heat rate, which is based on the maximum monthly usage over a 5-year historical period.

Maalaea 18	66.9740	14784.0000	0.3347	
Maalaea 19	48.5120	8439.0000	0.0120	
Hana 1	–	–	–	11532.0000
Hana 2	–	–	–	11532.0000

Table 51: Maui Forced Outage Rates for Thermal Resources (1 of 3)

Year %	Kahului 1	Kahului 2	Kahului 3	Kahului 4	Maalaea 1	Maalaea 2	Maalaea 3	Maalaea 4
2021			0.08	0.34	3.93	3.93	3.93	1.45
2022			0.08	0.34	3.93	3.93	3.93	1.45
2023					3.93	3.93	3.93	1.45
2024					3.93	3.93	3.93	1.45
2025					3.93	3.93	3.93	1.45
2026					3.93	3.93	3.93	1.45
2027					3.93	3.93	3.93	1.45
2028					3.93	3.93	3.93	1.45
2029					3.93	3.93	3.93	1.45
2030					3.93	3.93	3.93	1.45
2031					3.93	3.93	3.93	1.45
2032					3.93	3.93	3.93	1.45
2033					3.93	3.93	3.93	1.45
2034					3.93	3.93	3.93	1.45
2035					3.93	3.93	3.93	1.45
2036					3.93	3.93	3.93	1.45
2037					3.93	3.93	3.93	1.45
2038					3.93	3.93	3.93	1.45
2039					3.93	3.93	3.93	1.45
2040					3.93	3.93	3.93	1.45
2041					3.93	3.93	3.93	1.45
2042					3.93	3.93	3.93	1.45
2043					3.93	3.93	3.93	1.45

2044					3.93	3.93	3.93	1.45
2045					3.93	3.93	3.93	1.45
2046					3.93	3.93	3.93	1.45
2047					3.93	3.93	3.93	1.45
2048					3.93	3.93	3.93	1.45
2049					3.93	3.93	3.93	1.45
2050					3.93	3.93	3.93	1.45

Table 52: Maui Forced Outage Rates for Thermal Resources (2 of 3)

Year	Maalaea 5	Maalaea 6	Maalaea 7	Maalaea 8	Maalaea 9	Maalaea 10	Maalaea 11	Maalaea 12
%								
2021	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2022	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2023	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2024	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2025	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2026	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2027	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2028	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2029	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2030	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2031	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2032	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2033	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2034	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2035	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2036	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2037	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2038	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2039	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2040	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63

2041	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2042	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2043	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2044	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2045	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2046	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2047	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2048	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2049	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63
2050	1.45	1.45	1.45	2.36	2.36	0.63	0.63	0.63

Table 53: Maui Forced Outage Rates for Thermal Resources (3 of 3)

Year	Maalaea	Maalaea	Maalaea	Maalaea	Maalaea	Maalaea	Maalaea	Maalaea	Maalaea
%	13	X1	X2	14	15	16	17	18	19
2021	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2022	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2023	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2024	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2025	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2026	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2027	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2028	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2029	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2030	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2031	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2032	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2033	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2034	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2035	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2036	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2037	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49

2038	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2039	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2040	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2041	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2042	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2043	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2044	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2045	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2046	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2047	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2048	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2049	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49
2050	0.63	3.93	3.93	0.16	0.41	0.16	0.49	0.30	0.49

Table 54: Maui Maintenance Outage Rates for Thermal Resources (1 of 3)

Year %	Kahului 1	Kahului 2	Kahului 3	Kahului 4	Maalaea 1	Maalaea 2	Maalaea 3	Maalaea 4
2021			0.49	1.34	1.29	1.29	1.29	1.17
2022			0.49	1.34	1.29	1.29	1.29	1.17
2023					1.29	1.29	1.29	1.17
2024					1.29	1.29	1.29	1.17
2025					1.29	1.29	1.29	1.17
2026					1.29	1.29	1.29	1.17
2027					1.29	1.29	1.29	1.17
2028					1.29	1.29	1.29	1.17
2029					1.29	1.29	1.29	1.17
2030					1.29	1.29	1.29	1.17
2031					1.29	1.29	1.29	1.17
2032					1.29	1.29	1.29	1.17
2033					1.29	1.29	1.29	1.17
2034					1.29	1.29	1.29	1.17

2035					1.29	1.29	1.29	1.17
2036					1.29	1.29	1.29	1.17
2037					1.29	1.29	1.29	1.17
2038					1.29	1.29	1.29	1.17
2039					1.29	1.29	1.29	1.17
2040					1.29	1.29	1.29	1.17
2041					1.29	1.29	1.29	1.17
2042					1.29	1.29	1.29	1.17
2043					1.29	1.29	1.29	1.17
2044					1.29	1.29	1.29	1.17
2045					1.29	1.29	1.29	1.17
2046					1.29	1.29	1.29	1.17
2047					1.29	1.29	1.29	1.17
2048					1.29	1.29	1.29	1.17
2049					1.29	1.29	1.29	1.17
2050					1.29	1.29	1.29	1.17

Table 55: Maui Maintenance Outage Rates for Thermal Resources (2 of 3)

Year %	Maalaea 5	Maalaea 6	Maalaea 7	Maalaea 8	Maalaea 9	Maalaea 10	Maalaea 11	Maalaea 12
2021	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2022	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2023	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2024	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2025	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2026	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2027	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2028	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2029	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2030	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2031	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17

2032	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2033	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2034	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2035	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2036	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2037	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2038	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2039	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2040	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2041	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2042	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2043	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2044	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2045	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2046	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2047	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2048	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2049	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17
2050	1.17	1.17	1.17	1.39	1.39	2.17	2.17	2.17

Table 56: Maui Maintenance Outage Rates for Thermal Resources (3 of 3)

Year	Maalaea 13	Maalaea X1	Maalaea X2	Maalaea 14	Maalaea 15	Maalaea 16	Maalaea 17	Maalaea 18	Maalaea 19
%									
2021	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2022	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2023	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2024	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2025	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2026	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2027	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2028	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32

2029	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2030	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2031	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2032	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2033	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2034	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2035	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2036	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2037	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2038	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2039	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2040	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2041	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2042	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2043	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2044	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2045	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2046	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2047	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2048	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2049	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32
2050	2.17	1.29	1.29	1.69	0.48	1.69	1.32	0.92	1.32

Molokaʻi

Table 57: Molokaʻi Minimum and Maximum Capacity for Thermal Resources

Unit	Operating Minimum (Net MW)	Normal Top Load (Net MW)	Fuel Type
Palaau 01	0.31	1.25	ULSD
Palaau 02	0.31	1.25	ULSD
Palaau 03	0.31	0.97	ULSD
Palaau 04	0.31	0.97	ULSD

Palaau 05	0.31	0.97	ULSD
Palaau 06	0.31	0.97	ULSD
Palaau 07	0.30	2.20	ULSD
Palaau 08	0.30	2.20	ULSD
Palaau 09	0.30	2.20	ULSD
Palaau GT1	1.10	2.20	ULSD

Table 58: Moloka'i Heat Rate Coefficients for Thermal Resources

Unit	A Coefficient (MMBTU/hr)	B Coefficient (MMBTU/hr-MW)	C Coefficient (MMBTU/hr-MW^2)
Palaau 01	1.3894	9.6947	-0.8835
Palaau 02	0.8831	10.4922	-1.7433
Palaau 03	5.4111	-4.6487	10.2493
Palaau 04	4.5017	1.8072	5.8410
Palaau 05	1.3975	9.3826	-0.3959
Palaau 06	1.5392	8.5616	0.1192
Palaau 07	3.1052	6.6925	0.8483
Palaau 08	2.0900	8.2860	0.2125
Palaau 09	2.1250	8.0170	0.3328
Palaau GT1	0.0000	18.8310	0.0000

Table 59: Moloka'i Forced Outage Rates for Thermal Resources

Year %	Palaau 01	Palaau 02	Palaau 03	Palaau 04	Palaau 05	Palaau 06	Palaau 07	Palaau 08	Palaau 09	Palaau GT1
2021	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2022	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2023	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2024	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2025	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2026	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2027	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00

2028	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2029	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2030	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2031	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2032	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2033	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2034	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2035	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2036	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2037	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2038	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2039	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2040	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2041	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2042	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2043	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2044	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2045	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2046	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2047	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2048	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2049	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00
2050	5.39	5.39	0.73	0.73	0.73	0.73	0.31	0.31	0.31	0.00

Table 60: Moloka‘i Maintenance Outage Rates for Thermal Resources

Year %	Palaau 01	Palaau 02	Palaau 03	Palaau 04	Palaau 05	Palaau 06	Palaau 07	Palaau 08	Palaau 09	Palaau GT1
2021	4.57	4.57	5.53	5.53	5.53	5.53	1.13	15.65	1.13	0.00
2022	4.57	15.80	5.53	5.53	5.53	5.53	1.13	4.69	16.20	0.00
2023	4.57	4.57	5.53	9.09	5.53	5.53	19.21	1.13	1.13	0.00
2024	10.05	4.57	11.01	5.53	5.53	14.57	1.13	1.13	1.13	0.00

2025	4.57	4.57	5.53	5.53	14.57	5.53	1.13	4.69	4.69	1.37
2026	4.57	10.05	5.53	9.09	5.53	5.53	4.69	1.13	1.13	0.00
2027	8.13	4.57	9.09	5.53	5.53	9.09	1.13	1.13	1.13	0.00
2028	4.57	4.57	5.53	5.53	9.09	5.53	1.13	4.69	4.69	0.00
2029	4.57	8.13	5.53	14.85	5.53	5.53	4.69	1.13	1.13	0.00
2030	10.05	4.57	11.01	5.53	5.53	11.01	1.13	1.13	1.13	1.37
2031	4.57	4.57	5.53	5.53	11.01	5.53	1.13	4.69	4.69	0.00
2032	4.57	10.05	5.53	9.09	5.53	5.53	4.69	1.13	1.13	0.00
2033	8.13	4.57	9.09	5.53	5.53	9.09	1.13	1.13	1.13	0.00
2034	4.57	4.57	5.53	5.53	9.09	5.53	1.13	4.69	4.69	0.00
2035	4.57	8.13	5.53	18.41	5.53	5.53	4.69	1.13	1.13	1.37
2036	10.05	4.57	11.01	5.53	5.53	11.01	1.13	1.13	1.13	0.00
2037	4.57	4.57	5.53	5.53	14.57	5.53	1.13	4.69	4.69	0.00
2038	4.57	10.05	5.53	9.09	5.53	5.53	4.69	1.13	1.13	0.00
2039	8.13	4.57	9.09	5.53	5.53	9.09	1.13	1.13	1.13	0.00
2040	4.57	4.57	5.53	5.53	9.09	5.53	1.13	4.69	4.69	1.37
2041	4.57	8.13	5.53	14.85	5.53	5.53	4.69	1.13	1.13	0.00
2042	13.61	4.57	11.01	5.53	5.53	11.01	1.13	1.13	1.13	0.00
2043	4.57	4.57	5.53	5.53	11.01	5.53	1.13	4.69	4.69	0.00
2044	4.57	10.05	5.53	9.09	5.53	5.53	4.69	1.13	1.13	0.00
2045	8.13	4.57	9.09	5.53	5.53	5.53	1.13	1.13	1.13	1.37
2046	8.13	4.57	9.09	5.53	5.53	5.53	1.13	1.13	1.13	1.37
2047	8.13	4.57	9.09	5.53	5.53	5.53	1.13	1.13	1.13	1.37
2048	8.13	4.57	9.09	5.53	5.53	5.53	1.13	1.13	1.13	1.37
2049	8.13	4.57	9.09	5.53	5.53	5.53	1.13	1.13	1.13	1.37
2050	8.13	4.57	9.09	5.53	5.53	5.53	1.13	1.13	1.13	1.37

Lānaʻi

Table 61: Lānaʻi Minimum and Maximum Capacity for Thermal Resources

Unit	Operating Minimum (Net MW)	Normal Top Load (Net MW)	Fuel Type

LL 1	0.5	1.0	ULSD
LL 2	0.5	1.0	ULSD
LL 3	0.5	1.0	ULSD
LL 4	0.5	1.0	ULSD
LL 5	0.5	1.0	ULSD
LL 6	0.5	1.0	ULSD
LL 7	0.3	2.2	ULSD
LL 8	0.3	2.2	ULSD
CHP	0.83	0.83	ULSD

Table 62: Lāna‘i Heat Rate Coefficients for Thermal Resources

Unit	A Coefficient (MMBTU/hr)	B Coefficient (MMBTU/hr-MW)	C Coefficient (MMBTU/hr-MW^2)
LL 1	1.9016	6.6910	1.9235
LL 2	1.9054	6.9548	2.1515
LL 3	0.9656	10.5671	-0.8720
LL 4	0.6577	11.5526	-1.6507
LL 5	1.2913	9.0183	0.3364
LL 6	0.9302	10.1353	-0.6496
LL 7	3.4169	6.6148	0.6626
LL 8	3.1015	7.1223	0.3705
CHP	0	11.380	0

Table 63: Lāna‘i Forced Outage Rates for Thermal Resources

Year	LL 1	LL 2	LL 3	LL 4	LL 5	LL 6	LL 7	LL 8	CHP
%									
2021	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2022	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2023	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2024	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2025	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35

2026	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2027	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2028	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2029	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2030	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2031	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2032	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2033	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2034	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2035	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2036	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2037	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2038	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2039	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2040	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2041	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2042	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2043	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2044	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2045	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2046	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2047	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2048	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2049	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35
2050	4.93	4.93	4.93	4.93	4.93	4.93	4.30	4.30	16.35

Table 64: Lāna‘i Maintenance Outage Rates for Thermal Resources

Year %	LL 1	LL 2	LL 3	LL 4	LL 5	LL 6	LL 7	LL 8	CHP
2021	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2022	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12

2023	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2024	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2025	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2026	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2027	1.57	1.57	1.57	1.57	1.57	1.57	3.04%	3.04	8.12
2028	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2029	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2030	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2031	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2032	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2033	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2034	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2035	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2036	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2037	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2038	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2039	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2040	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2041	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2042	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2043	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2044	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2045	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2046	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2047	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2048	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2049	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12
2050	1.57	1.57	1.57	1.57	1.57	1.57	3.04	3.04	8.12

6. VARIABLE RENEWABLE, STORAGE, AND GRID SERVICE RESOURCE PORTFOLIOS

In addition to the thermal generating units, Hawaiian Electric has a diverse range of variable renewable resources including wind, solar, and hydro in its portfolio. Several upcoming projects will also add storage to the resource mix, paired with solar or as a standalone resource. More information on the status of these new renewable energy projects can be found on the Renewable Project Status Board.[36] The planned resource portfolio will be updated for the projects resulting from the Community-Based Renewable Energy (CBRE) Phase 2 once they are known.

O'ahu

Table 65: O'ahu Variable Renewable, Storage, and Grid Service Resources

Unit	Year in Service	Capacity (MW)	Storage Capacity (MWh)	Capacity Factor (%)
Kapolei Sustainable Energy Park	2012	1.0	-	21.9%
Kalaeloa Solar Two	2013	5.0	-	25.7%
Kalaeloa Renewable Energy Park	2014	5.0	-	20.5%
Kahuku Wind	2011	30.0	-	27.2%
Kawailoa Wind	2013	69.0	-	19.7%
West Loch	2019	20.0	-	25.1%
Lanikuhana Solar	2019	14.7	-	27.1%
Waipio PV	2019	45.9	-	27.1%
Kawailoa Solar	2019	49.0	-	27.1%
Na Pua Makani	2020	24.0	-	42.5%
Waianae Solar	2017	27.6	-	27.1%
Feed-In-Tariff Tier 1 and 2		24.8	-	19.3%
Feed-In-Tariff Tier 3		20.0	-	
Aloha Solar Energy Fund 1 & 2	2020	10.0	-	19.3%
Mauka FIT 1	2020	3.5	-	19.3%
Waihonu Solar	2016	6.5	-	19.3%
CBRE Phase 1	2021	5.0	-	24.5%

[36] See https://www.hawaiianelectric.com/clean-energy-hawaii/our-clean-energy-portfolio/renewable-project-status-board

Stage 1				
Hoohana Solar 1	2021	52.0	208.0	25.1%
AES West Oahu Solar	2023	12.5	50.0	25.2%
Mililani 1 Solar	2023	39.0	156.0	27.2%
Waiawa Solar Power	2023	36.0	144.0	27.9%
Stage 2				
Kupehau Solar	2022	60.0	240.0	21.2%
Waiawa Phase 2 Solar	2023	30.0	240.0	20.5%
Mountain View Solar	2023	7.0	35.0	17.3%
Kupono Solar	2022	42.0	42.0	25.3%
Barber's Point Solar	2023	15.0	60.0	22.2%
Mahi Solar	2023	120.0	480.0	25.8%
Kapolei Energy Storage	2022	185.0	565.0	–
Grid Services RFP				
Load Build	2023	14.5	–	–
Load Reduce	2023	19.4	–	–
FFR	2023	26.7	–	–

Hawai'i Island

Table 66: Hawai'i Island Variable Renewable, Storage, and Grid Service Resources

Unit	Year in Service	Capacity (MW)	Storage Capacity (MWh)	Capacity Factor (%)
Small Hydros		0.2	–	85.7%
Wailuku Hydro	1993	12.1	–	18.9%
HRD Wind	2006	10.5	–	42.4%
Tawhiri	2007	20.5		63.6%
SIA Wind		3.5	–	30.3%
Feed-In-Tariff		9.1		18.1%
Puueo Hydro	2005	3.3	–	54.8%
Waiau Hydro	1920	2.0	–	53.2%

CBRE Phase 1	2022	1.0	–	16.9%
Stage 1 RFP				
Hale Kuawehi Solar	2023	30.0	120.0	33.2%
Waikoloa Solar	2023	30.0	120.0	30.9%
Stage 2 RFP				
Waikoloa Village Solar	2023	60.0	240.0	32.8%
Puako Solar	2023	60.0	240.0	32.2%
Keahole Battery Energy Storage	2022	12.0	12.0	–
Grid Services RFP				
FFR	2023	6.0	–	–
Load Reduce	2023	4.3	–	–
Load Build	2023	3.2	–	–

Maui

Table 67: Maui Variable Renewable, Storage, and Grid Service Resources

Unit	Year in Service	Capacity (MW)	Storage Capacity (MWh)	Capacity Factor (%)
Feed-In-Tariff		6.75	–	17%
Kaheawa Wind Farm I	2006	30.0	–	43%
Kaheawa Wind Farm II	2012	21.0	–	47%
Auwahi Wind Farm	2012	21.0	–	51%
South Maui Renewable Resources	2018	2.9	–	29%
Kuia Solar	2018	2.9	–	29%
CBRE Phase 1	2021	0.025	–	28%
Stage 1 RFP				
Kuihelani	2021	60.0	240.0	31%
Paeahu Solar	2023	15.0	60.0	31%
Stage 2 RFP				
Kahana Solar	2023	20.0	80.0	43%
Pulehu Solar	2023	40.0	160.0	31%

Waena BESS	2023	40.0	160.0	–
Grid Services RFP				
Load Build	2022	3.7	–	–
Load Reduce	2022	6.8	–	–
FFR1	2022	6.1	–	–

Molokaʻi

Table 68: Molokaʻi Variable Renewable, Storage, and Grid Service Resources

Unit	Year in Service	Capacity (MW)	Storage Capacity (MWh)	Capacity Factor (%)
CBRE Phase 1	2021	0.25	–	27.60%

Lānaʻi

Table 69: Lānaʻi Variable Renewable, Storage, and Grid Service Resources

Unit	Year in Service	Capacity (MW)	Storage Capacity (MWh)	Capacity Factor (%)
Lanai Sustainability Research	2009	1.2	–	26.15%

Appendix A: Resource Cost Forecasts (2020 – 2050)

Table 70: Capital and O&M Costs for Resource Options (Grid-Scale PV, Commercial-Scale PV)

Year	Grid-Scale PV (Fixed tilt)		Grid-Scale PV (Single axis tracking)		Commercial-Scale PV	
	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kW)	O&M ($/kW-year)
2020	575	14	620	15	1,405	20
2021	651	13	705	15	1,404	20
2022	742	13	806	14	1,613	19
2023	692	13	754	14	1,536	19
2024	708	13	772	14	1,575	19
2025	705	13	769	14	1,572	19
2026	700	13	764	14	1,570	19
2027	730	13	797	14	1,642	19
2028	733	13	801	14	1,651	19
2029	737	13	805	14	1,662	20
2030	742	13	810	15	1,672	20
2031	746	13	814	15	1,684	20
2032	751	13	820	15	1,696	20
2033	755	14	824	15	1,707	20
2034	755	14	824	15	1,712	20
2035	756	14	825	15	1,718	21
2036	756	14	825	15	1,724	21
2037	757	14	827	15	1,730	21
2038	757	14	827	16	1,738	21
2039	760	14	830	16	1,745	21
2040	761	14	831	16	1,754	22
2041	763	15	833	16	1,765	22

2042	765	15	836	16	1,776	22
2043	769	15	840	16	1,787	22
2044	773	15	844	17	1,800	23
2045	776	15	848	17	1,813	23
2046	780	16	852	17	1,827	23
2047	784	16	857	17	1,842	23
2048	791	16	864	18	1,858	24
2049	796	16	870	18	1,875	24
2050	801	16	876	18	1,893	24

Table 71: Capital and O&M Costs for Resource Options (Residential PV, Onshore Wind, Distributed Wind)

Year	Residential PV		Onshore Wind		Distributed Wind	
	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kW)	O&M ($/kW-year)
2020	1,956	20	2,017	47	6,231	67
2021	2,136	20	1,992	48	6,684	69
2022	2,842	19	1,945	49	9,040	70
2023	2,760	19	1,968	50	9,082	72
2024	2,861	19	1,990	51	9,120	73
2025	2,859	19	2,012	53	9,156	75
2026	2,859	19	2,035	54	9,187	77
2027	2,983	19	2,059	55	9,603	79
2028	3,001	19	2,085	56	9,629	81
2029	3,022	20	2,112	58	9,650	82
2030	3,044	20	2,141	59	9,668	84
2031	3,069	20	2,172	60	9,788	86
2032	3,093	20	2,205	62	9,909	88
2033	3,116	20	2,241	63	10,030	90
2034	3,132	20	2,277	65	10,151	92
2035	3,148	21	2,315	66	10,272	95
2036	3,166	21	2,355	68	10,393	97

2037	3,184	21	2,396	69	10,514	99
2038	3,202	21	2,438	71	10,634	101
2039	3,221	21	2,481	73	10,755	104
2040	3,244	22	2,533	74	10,875	106
2041	3,266	22	2,579	76	10,994	109
2042	3,292	22	2,629	78	11,113	111
2043	3,318	22	2,680	80	11,231	114
2044	3,346	23	2,732	81	11,348	116
2045	3,377	23	2,784	83	11,465	119
2046	3,407	23	2,838	85	11,580	122
2047	3,440	23	2,894	87	11,694	125
2048	3,474	24	2,952	89	11,808	128
2049	3,511	24	3,010	91	11,919	131
2050	3,548	24	3,069	94	12,029	134

Table 72: Capital and O&M Costs for Resource Options (Offshore Wind, Grid-Scale Storage)

Year	Offshore Wind		Grid-Scale Storage		
	Capital ($/kW)	O&M ($/kW-year)	Balance of System ($/kW)	Modules ($/kWh)	O&M ($/kW-year)
2020	6,164	91	621	278	28
2021	5,956	85	600	266	28
2022	5,574	73	584	254	29
2023	5,559	74	569	242	30
2024	5,370	70	557	226	30
2025	5,187	66	546	211	31
2026	5,011	62	552	203	32
2027	4,976	63	558	197	32
2028	4,678	55	566	192	33
2029	4,521	52	573	187	34
2030	4,371	50	580	183	35
2031	4,226	48	588	179	36

2032	4,047	45	596	177	36
2033	3,973	45	604	174	37
2034	3,901	45	612	172	38
2035	3,830	44	621	170	39
2036	3,760	44	630	169	40
2037	3,691	44	639	167	41
2038	3,624	44	647	166	42
2039	3,558	44	656	165	43
2040	3,493	43	666	164	44
2041	3,429	43	676	163	45
2042	3,366	43	686	163	46
2043	3,305	43	698	162	47
2044	3,244	42	709	162	48
2045	3,185	42	721	162	49
2046	3,127	42	734	162	50
2047	3,070	42	747	162	51
2048	3,014	42	760	163	53
2049	2,959	41	774	163	54
2050	2,905	41	788	164	55

Table 73: Capital and O&M Costs for Resource Options (Commercial Storage, Residential Storage, Synchronous Condenser)

Year	Commercial Scale Storage (2 hours)		Residential Storage (2 hours)		Synchronous Condenser
	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kVar)
2020	2,457	28	2,685	28	682
2021	2,422	28	2,645	28	689
2022	2,395	29	2,615	29	700
2023	2,370	30	2,586	30	703
2024	2,339	30	2,551	30	712
2025	2,315	31	2,524	31	725

2026	2,324	32	2,533	32	738
2027	2,339	32	2,548	32	751
2028	2,359	33	2,570	33	765
2029	2,381	34	2,593	34	778
2030	2,405	35	2,618	35	793
2031	2,431	36	2,647	36	809
2032	2,460	36	2,677	36	824
2033	2,490	37	2,710	37	841
2034	2,522	38	2,744	38	858
2035	2,554	39	2,779	39	874
2036	2,588	40	2,816	40	891
2037	2,623	41	2,854	41	909
2038	2,659	42	2,892	42	928
2039	2,696	43	2,932	43	948
2040	2,735	44	2,974	44	967
2041	2,776	45	3,019	45	988
2042	2,819	46	3,066	46	1,008
2043	2,865	47	3,115	47	1,030
2044	2,912	48	3,166	48	1,051
2045	2,961	49	3,219	49	1,074
2046	3,013	50	3,275	50	1,096
2047	3,066	51	3,332	51	1,119
2048	3,121	53	3,392	53	1,143
2049	3,178	54	3,454	54	1,167
2050	3,236	55	3,517	55	1,182

Table 74: Capital and O&M Costs for Resource Options (Geothermal, Municipal Solid Waste)

Year	Geothermal		Municipal Solid Waste (MSW)		
	Capital ($/kW)	O&M ($/kW-year)	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)
2020	6,358	225	10,275	525	12

2021	6,475	230	10,850	537	12
2022	6,593	236	10,843	550	12
2023	6,713	241	11,031	562	13
2024	6,836	247	11,227	575	13
2025	6,961	252	11,472	589	13
2026	7,088	258	11,719	603	13
2027	7,218	264	11,964	617	14
2028	7,350	270	12,202	631	14
2029	7,484	277	12,419	646	14
2030	7,621	283	12,660	661	15
2031	7,761	290	12,906	676	15
2032	7,902	297	13,149	692	15
2033	8,047	303	13,403	708	16
2034	8,194	311	13,671	724	16
2035	8,344	318	13,927	741	17
2036	8,496	325	14,194	758	17
2037	8,652	333	14,463	776	17
2038	8,810	340	14,744	794	18
2039	8,971	348	15,022	813	18
2040	9,135	357	15,308	832	19
2041	9,302	365	15,614	851	19
2042	9,472	373	15,891	871	19
2043	9,645	382	16,217	891	20
2044	9,821	391	16,507	912	20
2045	10,001	400	16,842	933	21
2046	10,184	409	17,149	955	21
2047	10,370	419	17,478	977	22
2048	10,560	429	17,812	1,000	22
2049	10,753	439	18,151	1,023	23
2050	10,949	449	18,357	1,047	23

Table 75: Capital and O&M Costs for Resource Options (Biomass, Pumped Storage Hydro)

Year	Biomass				Pumped Storage Hydro	
	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)	Fuel Cost ($/MWH)	Capital ($/kW)	O&M ($/kW-year)
2020	5,838	141	7	52	3,803	33
2021	6,165	144	7	53	3,892	33
2022	6,161	148	7	55	3,982	34
2023	6,268	151	8	56	4,075	35
2024	6,379	155	8	57	4,170	36
2025	6,518	158	8	59	4,267	37
2026	6,658	162	8	60	4,366	37
2027	6,798	166	8	61	4,468	38
2028	6,933	170	8	63	4,572	39
2029	7,056	174	9	64	4,678	40
2030	7,193	178	9	66	4,787	41
2031	7,333	182	9	67	4,899	42
2032	7,471	186	9	69	5,013	43
2033	7,615	190	9	70	5,129	44
2034	7,768	195	10	72	5,249	45
2035	7,913	199	10	74	5,371	46
2036	8,065	204	10	76	5,496	47
2037	8,217	209	10	77	5,624	48
2038	8,377	214	11	79	5,755	49
2039	8,535	219	11	81	5,889	50
2040	8,698	224	11	83	6,026	52
2041	8,872	229	11	85	6,166	53
2042	9,029	234	12	87	6,310	54
2043	9,214	240	12	89	6,457	55
2044	9,379	245	12	91	6,607	57
2045	9,569	251	13	93	6,761	58
2046	9,744	257	13	95	6,918	59
2047	9,931	263	13	97	7,079	61

2048	10,121	269	13	100	7,244	62
2049	10,313	275	14	102	7,413	64
2050	10,430	282	14	104	7,586	65

Table 76: Capital and O&M Costs for Resource Options (Concentrated Solar, 2x1 Combined Cycle)

Year	Concentrated Solar			153 MW 2x1 Combined Cycle		
	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)
2020	8,116	83	5	3,117	13	4
2021	8,360	85	5	3,185	14	4
2022	9,598	87	5	3,254	14	4
2023	9,450	89	6	3,320	14	4
2024	9,319	91	6	3,393	15	4
2025	9,205	94	6	3,469	15	4
2026	9,108	96	6	3,547	15	4
2027	9,030	98	6	3,627	16	4
2028	8,972	100	6	3,709	16	4
2029	8,928	103	6	3,791	16	4
2030	8,905	105	7	3,877	17	4
2031	8,900	107	7	3,965	17	5
2032	8,912	110	7	4,054	18	5
2033	8,944	113	7	4,146	18	5
2034	8,992	115	7	4,240	18	5
2035	9,060	118	7	4,336	19	5
2036	9,142	121	7	4,434	19	5
2037	9,241	123	8	4,535	20	5
2038	9,358	126	8	4,638	20	5
2039	9,489	129	8	4,744	21	5
2040	9,635	132	8	4,852	21	6
2041	9,792	135	8	4,964	22	6
2042	9,962	138	9	5,076	22	6

2043	10,144	142	9	5,193	23	6
2044	10,335	145	9	5,310	23	6
2045	10,531	148	9	5,433	24	6
2046	10,738	152	9	5,556	24	6
2047	10,944	155	10	5,683	25	7
2048	11,155	159	10	5,813	25	7
2049	11,367	163	10	5,946	26	7
2050	11,571	166	10	6,073	27	7

Table 77: Capital and O&M Costs for Resource Options (1x1 Combined Cycle, Simple Cycle CT)

Year	48 MW 1x1 Combined Cycle			34 MW Simple Cycle CT		
	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)
2020	3,623	13	4	2,484	15	9
2021	3,702	14	4	2,536	16	9
2022	3,782	14	4	2,591	16	9
2023	3,857	14	4	2,641	17	10
2024	3,941	15	4	2,697	17	10
2025	4,029	15	4	2,757	17	10
2026	4,120	15	4	2,818	18	10
2027	4,212	16	4	2,880	18	11
2028	4,307	16	4	2,945	19	11
2029	4,402	16	4	3,009	19	11
2030	4,501	17	4	3,077	19	11
2031	4,603	17	5	3,147	20	12
2032	4,706	18	5	3,217	20	12
2033	4,813	18	5	3,290	21	12
2034	4,922	18	5	3,365	21	12
2035	5,033	19	5	3,440	22	13
2036	5,146	19	5	3,518	22	13
2037	5,263	20	5	3,597	23	13

2038	5,383	20	5	3,680	23	14
2039	5,505	21	5	3,764	24	14
2040	5,630	21	6	3,849	24	14
2041	5,760	22	6	3,938	25	15
2042	5,889	22	6	4,027	26	15
2043	6,025	23	6	4,120	26	15
2044	6,161	23	6	4,213	27	16
2045	6,303	24	6	4,310	27	16
2046	6,445	24	6	4,408	28	16
2047	6,592	25	7	4,509	29	17
2048	6,743	25	7	4,612	29	17
2049	6,897	26	7	4,717	30	18
2050	7,043	27	7	4,818	31	18

Table 78: Capital and O&M Costs for Resource Options (Simple Cycle CT, Internal Combustion Engine)

Year	55 MW Simple Cycle CT			Internal Combustion Engine		
	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)	Capital ($/kW)	O&M ($/kW-year)	Var O&M ($/MWH)
2020	2,485	15	9	2,680	37	28
2021	2,537	16	9	2,710	38	28
2022	2,592	16	9	2,753	39	29
2023	2,641	17	10	2,763	40	30
2024	2,698	17	10	2,801	41	31
2025	2,757	17	10	2,851	42	31
2026	2,819	18	10	2,901	42	32
2027	2,881	18	11	2,952	43	33
2028	2,946	19	11	3,008	44	33
2029	3,010	19	11	3,059	46	34
2030	3,078	19	11	3,119	47	35
2031	3,148	20	12	3,182	48	36
2032	3,218	20	12	3,241	49	37

2033	3,291	21	12	3,305	50	38
2034	3,366	21	12	3,372	51	38
2035	3,441	22	13	3,437	52	39
2036	3,519	22	13	3,504	53	40
2037	3,598	23	13	3,574	55	41
2038	3,681	23	14	3,650	56	42
2039	3,765	24	14	3,726	57	43
2040	3,851	24	14	3,803	59	44
2041	3,939	25	15	3,887	60	45
2042	4,028	26	15	3,963	61	46
2043	4,121	26	15	4,052	63	47
2044	4,214	27	16	4,132	64	48
2045	4,312	27	16	4,224	66	49
2046	4,409	28	16	4,309	67	51
2047	4,510	29	17	4,400	69	52
2048	4,613	29	17	4,493	70	53
2049	4,719	30	18	4,587	72	54
2050	4,820	31	18	4,648	74	56

Appendix B: Distributed Energy Resource Forecasts (2020 – 2050)

Table 79: Cumulative Distributed PV Capacity (kW)

Year	O'ahu	Hawai'i Island	Maui	Moloka'i	Lāna'i	Consolidated
MW	A	B	C	D	E	F =A + B + C + D +E
2020	534,704	110,108	119,232	2,678	833	767,555
2021	565,107	118,283	128,567	2,824	870	815,651
2022	601,702	122,997	131,907	2,896	877	860,379
2023	618,835	127,691	136,773	2,952	897	887,147
2024	636,514	131,481	141,221	3,068	926	913,210
2025	655,712	135,631	145,757	3,112	1,006	941,218
2026	675,603	140,212	150,356	3,168	1,026	970,365
2027	695,495	144,658	154,651	3,208	1,046	999,058
2028	716,340	148,650	159,069	3,264	1,066	1,028,389
2029	737,067	152,672	163,613	3,392	1,103	1,057,848
2030	757,845	156,486	168,105	3,440	1,187	1,087,064
2031	778,022	160,105	172,688	3,500	1,211	1,115,526
2032	797,664	163,684	177,069	3,552	1,248	1,143,218
2033	816,292	167,474	181,111	3,608	1,268	1,169,753
2034	834,767	171,437	185,115	3,728	1,288	1,196,335
2035	852,922	175,586	189,077	3,768	1,368	1,222,721
2036	870,329	179,801	192,966	3,824	1,388	1,248,308
2037	887,436	184,047	196,883	3,868	1,421	1,273,656
2038	904,167	188,540	200,786	3,924	1,441	1,298,858
2039	920,312	193,032	204,136	4,044	1,461	1,322,985
2040	936,374	197,218	207,486	4,088	1,545	1,346,711
2041	952,402	201,997	211,111	4,144	1,582	1,371,237

2042	968,095	206,471	214,395	4,188	1,606	1,394,755
2043	983,174	211,196	217,814	4,244	1,626	1,418,055
2044	997,406	215,876	220,958	4,348	1,646	1,440,234
2045	1,011,101	220,219	223,980	4,400	1,739	1,461,440
2046	1,024,363	224,815	226,932	4,440	1,759	1,482,309
2047	1,037,199	229,056	230,054	4,488	1,779	1,502,576
2048	1,049,547	233,467	232,821	4,524	1,799	1,522,158
2049	1,061,511	237,512	235,751	4,636	1,819	1,541,229
2050	1,073,105	241,791	238,385	4,668	1,912	1,559,861

Table 80: Cumulative Distributed BESS Capacity (kWH)

Year	O'ahu	Hawai'i Island	Maui	Moloka'i	Lāna'i	Consolidated
MW	A	B	C	D	E	F =A + B + C + D +E
2020	54,034	37,313	41,409	173	114	133,043
2021	65,031	50,121	55,946	299	215	171,613
2022	72,813	56,282	61,629	412	236	191,372
2023	90,228	60,872	68,863	544	281	220,787
2024	109,710	65,008	75,778	664	317	251,477
2025	133,409	69,805	82,955	796	362	287,326
2026	159,502	75,392	90,268	928	407	326,497
2027	186,584	80,833	97,019	1,048	452	365,936
2028	215,901	85,545	104,122	1,180	497	407,244
2029	245,942	90,311	111,485	1,336	551	449,624
2030	276,352	94,799	118,891	1,480	605	492,127
2031	306,418	99,031	126,452	1,624	659	534,183
2032	336,513	103,084	133,559	1,780	713	575,649
2033	365,350	107,523	140,023	1,912	758	615,566
2034	393,977	112,279	146,501	2,044	803	655,603
2035	422,151	117,376	152,886	2,164	848	695,425
2036	449,654	122,594	159,195	2,296	893	734,631
2037	476,620	127,971	165,535	2,428	938	773,492
2038	503,011	133,800	171,872	2,560	983	812,225
2039	528,360	139,627	178,102	2,692	1,028	849,809
2040	553,654	145,443	184,317	2,824	1,082	887,319
2041	579,001	151,796	190,621	2,956	1,136	925,510
2042	603,735	158,139	196,772	3,088	1,190	962,923
2043	627,365	164,393	202,709	3,220	1,235	998,922
2044	649,979	170,666	208,538	3,340	1,280	1,033,802
2045	671,661	176,872	214,197	3,460	1,325	1,067,515
2046	692,512	182,991	219,702	3,580	1,370	1,100,154
047	712,548	189,009	225,054	3,688	1,415	1,131,713

2048	731,763	194,891	230,222	3,796	1,460	1,162,131
2049	750,256	200,652	235,251	3,904	1,505	1,191,567
2050	768,058	206,292	240,143	4,000	1,550	1,220,042

Appendix C: Sales Forecasts (2020 – 2050)

Table 81: Oʻahu Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2020	8,106	(937)	(1,396)	30	5,804
2021	8,690	(986)	(1,509)	38	6,233
2022	8,936	(1,043)	(1,613)	49	6,329
2023	9,094	(1,086)	(1,703)	61	6,366
2024	9,276	(1,115)	(1,793)	75	6,442
2025	9,456	(1,141)	(1,887)	92	6,521
2026	9,638	(1,170)	(1,980)	111	6,599
2027	9,745	(1,200)	(2,067)	134	6,612
2028	9,873	(1,234)	(2,153)	159	6,645
2029	9,988	(1,263)	(2,232)	187	6,681
2030	10,133	(1,293)	(2,307)	221	6,753
2031	10,237	(1,324)	(2,383)	257	6,788
2032	10,345	(1,356)	(2,462)	297	6,824
2033	10,447	(1,380)	(2,530)	342	6,879
2034	10,533	(1,407)	(2,595)	392	6,923
2035	10,617	(1,433)	(2,654)	447	6,977
2036	10,731	(1,461)	(2,713)	501	7,058
2037	10,792	(1,481)	(2,760)	561	7,112
2038	10,875	(1,504)	(2,809)	624	7,186
2039	10,972	(1,526)	(2,861)	700	7,286
2040	11,110	(1,551)	(2,917)	789	7,432
2041	11,152	(1,568)	(2,963)	892	7,512
2042	11,232	(1,588)	(3,012)	1,006	7,637

2043	11,322	(1,608)	(3,058)	1,120	7,776
2044	11,443	(1,630)	(3,105)	1,238	7,946
2045	11,499	(1,643)	(3,142)	1,366	8,079
2046	11,582	(1,659)	(3,183)	1,498	8,237
2047	11,662	(1,674)	(3,223)	1,631	8,396
2048	11,773	(1,692)	(3,266)	1,760	8,574
2049	11,823	(1,701)	(3,297)	1,872	8,696
2050	11,905	(1,714)	(3,332)	1,964	8,822

Table 82: Hawai'i Island Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2020	1,345	(179)	(185)	2	983
2021	1,373	(195)	(204)	3	978
2022	1,410	(205)	(221)	4	988
2023	1,433	(211)	(237)	5	989
2024	1,456	(218)	(253)	6	992
2025	1,471	(223)	(268)	10	990
2026	1,483	(229)	(284)	15	985
2027	1,496	(236)	(300)	19	980
2028	1,516	(242)	(316)	25	983
2029	1,524	(247)	(331)	32	978
2030	1,535	(252)	(345)	39	977
2031	1,547	(257)	(359)	47	978
2032	1,561	(263)	(374)	56	980
2033	1,566	(267)	(387)	66	978
2034	1,575	(272)	(400)	77	981
2035	1,584	(278)	(411)	93	989
2036	1,598	(284)	(422)	107	999
2037	1,603	(289)	(431)	121	1,005
2038	1,612	(295)	(440)	137	1,013
2039	1,621	(301)	(450)	154	1,024
2040	1,634	(307)	(461)	172	1,038
2041	1,637	(312)	(469)	192	1,048
2042	1,646	(318)	(478)	214	1,063
2043	1,654	(325)	(486)	238	1,081
2044	1,666	(332)	(495)	262	1,102

2045	1,670	(337)	(501)	288	1,120
2046	1,678	(342)	(509)	315	1,142
2047	1,685	(348)	(516)	345	1,166
2048	1,698	(354)	(524)	374	1,194
2049	1,700	(359)	(529)	404	1,216
2050	1,708	(364)	(535)	435	1,244

Table 83: Maui Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2020	1,343	(202)	(219)	3	925
2021	1,409	(221)	(238)	4	953
2022	1,415	(231)	(255)	6	934
2023	1,425	(237)	(270)	8	926
2024	1,453	(245)	(285)	10	933
2025	1,474	(251)	(300)	14	937
2026	1,499	(258)	(315)	20	946
2027	1,521	(265)	(329)	28	955
2028	1,542	(272)	(344)	37	963
2029	1,556	(278)	(358)	46	966
2030	1,572	(285)	(371)	56	973
2031	1,586	(291)	(384)	70	981
2032	1,606	(299)	(397)	87	997
2033	1,620	(304)	(409)	107	1,013
2034	1,635	(309)	(421)	127	1,031
2035	1,649	(315)	(431)	147	1,051
2036	1,668	(321)	(440)	168	1,075
2037	1,678	(326)	(448)	189	1,093
2038	1,693	(331)	(456)	211	1,116
2039	1,707	(336)	(464)	233	1,140
2040	1,726	(341)	(473)	255	1,166
2041	1,733	(345)	(480)	277	1,185
2042	1,746	(349)	(486)	299	1,209
2043	1,760	(354)	(493)	319	1,233
2044	1,778	(359)	(500)	338	1,258
2045	1,787	(362)	(505)	357	1,277
2046	1,800	(365)	(510)	375	1,299

2047	1,813	(369)	(516)	392	1,321
2048	1,832	(373)	(521)	410	1,346
2049	1,839	(376)	(525)	426	1,365
2050	1,852	(379)	(529)	443	1,388

Table 84: Moloka'i Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2020	35.6	(4.6)	(2.7)	0.1	28.4
2021	36.2	(5.1)	(2.8)	0.1	28.4
2022	36.0	(5.3)	(2.9)	0.1	27.9
2023	36.0	(5.4)	(2.9)	0.1	27.7
2024	36.1	(5.5)	(3.0)	0.1	27.6
2025	36.0	(5.6)	(3.1)	0.1	27.4
2026	36.1	(5.7)	(3.2)	0.1	27.3
2027	36.2	(5.7)	(3.3)	0.2	27.3
2028	36.3	(5.8)	(3.4)	0.2	27.3
2029	36.3	(5.9)	(3.5)	0.2	27.1
2030	36.4	(6.1)	(3.6)	0.3	27.0
2031	36.5	(6.2)	(3.7)	0.3	27.0
2032	36.7	(6.2)	(3.7)	0.3	27.0
2033	36.8	(6.3)	(3.8)	0.4	27.1
2034	37.0	(6.4)	(3.9)	0.5	27.1
2035	37.1	(6.6)	(4.0)	0.5	27.1
2036	37.3	(6.6)	(4.0)	0.6	27.3
2037	37.4	(6.7)	(4.1)	0.7	27.4
2038	37.5	(6.7)	(4.1)	0.8	27.5
2039	37.6	(6.9)	(4.2)	0.9	27.5
2040	37.8	(7.0)	(4.2)	1.1	27.7
2041	37.8	(7.0)	(4.3)	1.3	27.8
2042	37.9	(7.1)	(4.3)	1.4	27.9
2043	38.1	(7.2)	(4.4)	1.7	28.2
2044	38.3	(7.3)	(4.4)	1.9	28.4
2045	38.3	(7.4)	(4.5)	2.1	28.5
2046	38.4	(7.4)	(4.5)	2.3	28.8

2047	38.5	(7.5)	(4.6)	2.6	29.0
2048	38.8	(7.6)	(4.6)	2.8	29.4
2049	38.8	(7.6)	(4.7)	3.0	29.5
2050	38.9	(7.7)	(4.7)	3.2	29.7

Table 85: Lānaʻi Sales Forecast

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Customer Level Sales Forecast
GWH	A	B	C	D	E =A + B + C + D
2020	39.2	(1.4)	(1.1)	0.1	36.8
2021	40.0	(1.4)	(1.2)	0.1	37.5
2022	40.1	(1.5)	(1.3)	0.1	37.4
2023	40.2	(1.5)	(1.4)	0.1	37.4
2024	40.6	(1.5)	(1.5)	0.1	37.7
2025	40.8	(1.6)	(1.6)	0.1	37.7
2026	41.1	(1.7)	(1.7)	0.1	37.8
2027	41.4	(1.7)	(1.8)	0.1	38.1
2028	41.9	(1.7)	(1.9)	0.1	38.4
2029	42.0	(1.8)	(1.9)	0.1	38.5
2030	42.2	(1.9)	(2.0)	0.2	38.5
2031	42.4	(1.9)	(2.1)	0.2	38.5
2032	42.7	(2.0)	(2.2)	0.2	38.7
2033	42.8	(2.0)	(2.3)	0.3	38.7
2034	43.0	(2.1)	(2.4)	0.3	38.8
2035	43.1	(2.1)	(2.4)	0.4	38.9
2036	43.4	(2.2)	(2.5)	0.4	39.1
2037	43.5	(2.2)	(2.6)	0.5	39.2
2038	43.6	(2.3)	(2.6)	0.5	39.3
2039	43.8	(2.3)	(2.7)	0.6	39.5
2040	44.1	(2.4)	(2.8)	0.7	39.7
2041	44.1	(2.5)	(2.8)	0.8	39.6
2042	44.3	(2.5)	(2.9)	0.9	39.8
2043	44.4	(2.5)	(2.9)	1.0	40.0
2044	44.7	(2.5)	(3.0)	1.1	40.3
2045	44.7	(2.6)	(3.0)	1.3	40.4
2046	44.9	(2.7)	(3.1)	1.4	40.5

2047	45.1	(2.7)	(3.2)	1.6	40.7
2048	45.3	(2.8)	(3.2)	1.7	41.1
2049	45.4	(2.8)	(3.3)	1.8	41.2
2050	45.6	(2.9)	(3.3)	1.9	41.3

Appendix D:Peak Forecasts (2020 – 2050)

Table 86: O‘ahu Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2020	1330	(3)	(258)	15	1084
2021	1400	(8)	(283)	18	1127
2022	1491	(10)	(298)	20	1203
2023	1511	(12)	(311)	23	1212
2024	1547	(15)	(335)	27	1224
2025	1574	(14)	(340)	31	1251
2026	1564	(16)	(352)	36	1232
2027	1584	(20)	(367)	43	1240
2028	1593	(23)	(379)	50	1240
2029	1612	(30)	(389)	58	1252
2030	1637	(30)	(403)	68	1272
2031	1662	(29)	(415)	77	1295
2032	1678	(35)	(425)	90	1308
2033	1698	(38)	(435)	104	1329
2034	1707	(45)	(441)	119	1340
2035	1713	(44)	(449)	134	1353
2036	1733	(42)	(456)	152	1387
2037	1757	(42)	(466)	171	1421
2038	1775	(52)	(477)	193	1439
2039	1787	(54)	(484)	217	1466
2040	1791	(58)	(488)	245	1489
2041	1795	(59)	(496)	279	1520
2042	1813	(57)	(502)	316	1571

2043	1847	(55)	(509)	352	1634
2044	1862	(66)	(510)	392	1678
2045	1868	(68)	(528)	432	1703
2046	1867	(67)	(532)	479	1747
2047	1878	(72)	(539)	527	1793
2048	1919	(64)	(546)	566	1876
2049	1938	(78)	(551)	596	1906
2050	1947	(78)	(556)	621	1935

Table 87: Hawaiʻi Island Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2020	221.7	(0.8)	(29.5)	0.6	191.9
2021	218.8	(2.8)	(36.8)	0.9	180.1
2022	219.8	(4.2)	(35.7)	1.1	181.1
2023	228.1	(4.0)	(43.0)	1.7	182.7
2024	229.7	(4.7)	(45.9)	2.2	181.3
2025	228.2	(4.9)	(44.7)	3.0	181.6
2026	229.4	(5.6)	(45.8)	4.1	182.2
2027	233.4	(6.0)	(50.2)	6.3	183.6
2028	234.5	(7.4)	(50.7)	7.4	183.8
2029	235.4	(8.0)	(53.7)	9.8	183.5
2030	236.8	(8.5)	(55.5)	11.9	184.7
2031	239.8	(9.4)	(59.8)	14.6	185.2
2032	239.3	(8.2)	(60.7)	16.7	187.2
2033	243.8	(10.0)	(62.3)	20.2	191.6
2034	233.9	(8.8)	(62.6)	29.0	191.4
2035	244.7	(11.2)	(67.3)	27.3	193.5
2036	247.4	(15.2)	(67.1)	31.0	196.2
2037	240.2	(3.4)	(72.8)	43.4	207.5
2038	240.1	(3.4)	(74.0)	49.1	211.8
2039	240.7	(3.4)	(76.1)	55.0	216.2
2040	241.2	(12.4)	(76.3)	63.0	215.5
2041	237.3	(6.3)	(78.6)	67.5	220.0
2042	240.4	(14.3)	(74.1)	73.9	225.9
2043	247.7	(3.5)	(82.2)	85.7	247.7
2044	247.2	(15.5)	(77.2)	96.5	251.0
2045	247.2	(3.5)	(85.3)	103.7	262.1
2046	242.9	(3.6)	(85.7)	113.7	267.4

2047	249.3	(19.9)	(87.2)	125.9	268.2
2048	253.4	(3.6)	(89.0)	125.8	286.5
2049	253.0	(3.6)	(90.7)	145.6	304.3
2050	253.3	(3.7)	(90.5)	156.7	315.8

Table 88: Maui Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2020	229.9	(1.8)	(34.2)	0.2	194.1
2021	237.4	(2.6)	(38.6)	0.4	196.6
2022	237.3	(3.6)	(41.7)	0.9	192.9
2023	238.2	(3.8)	(42.6)	1.7	193.5
2024	242.7	(5.2)	(44.9)	2.5	195.1
2025	247.0	(5.4)	(47.6)	3.8	197.8
2026	251.2	(6.3)	(52.4)	5.7	198.2
2027	254.2	(6.6)	(52.9)	8.6	203.3
2028	256.1	(6.9)	(54.8)	11.7	206.1
2029	259.7	(7.5)	(57.0)	14.8	210.0
2030	261.5	(8.8)	(58.5)	18.4	212.6
2031	264.9	(9.5)	(61.3)	23.2	217.3
2032	267.3	(10.0)	(64.1)	28.5	221.7
2033	270.0	(12.1)	(65.2)	35.6	228.3
2034	272.0	(10.7)	(67.1)	42.7	236.9
2035	275.2	(11.3)	(68.8)	49.7	244.8
2036	277.7	(12.6)	(69.4)	57.1	252.8
2037	280.7	(14.5)	(76.4)	63.4	253.2
2038	282.3	(13.6)	(73.7)	71.4	266.4
2039	284.2	(16.2)	(74.0)	78.5	272.5
2040	287.0	(14.1)	(74.5)	85.8	284.2
2041	287.8	(15.6)	(75.8)	93.7	290.1
2042	291.3	(16.2)	(78.0)	101.1	298.2
2043	285.1	(20.1)	(77.8)	114.4	301.6
2044	286.9	(16.4)	(78.7)	120.8	312.6
2045	297.0	(16.8)	(80.9)	121.1	320.4
2046	300.1	(17.3)	(82.3)	127.4	327.9

2047	302.3	(20.8)	(83.3)	134.2	332.4
2048	300.6	(19.5)	(83.8)	139.5	336.8
2049	306.6	(19.6)	(84.4)	143.7	346.3
2050	304.1	(22.6)	(87.4)	160.2	354.3

Table 89: Moloka'i Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2020	6.0	–	(0.1)	0.1	6.0
2021	6.0	–	(0.1)	–	5.9
2022	5.9	–	(0.1)	0.1	5.9
2023	5.9	–	(0.1)	–	5.8
2024	5.9	–	(0.1)	–	5.8
2025	6.0	(0.1)	(0.2)	0.1	5.8
2026	6.0	(0.1)	(0.2)	0.1	5.8
2027	6.0	(0.1)	(0.2)	–	5.7
2028	6.0	(0.1)	(0.2)	–	5.7
2029	6.0	(0.1)	(0.2)	–	5.7
2030	6.0	(0.1)	(0.3)	0.1	5.7
2031	6.0	(0.1)	(0.3)	0.1	5.7
2032	6.1	(0.2)	(0.3)	0.1	5.7
2033	6.1	(0.2)	(0.3)	0.1	5.7
2034	6.1	(0.2)	(0.3)	0.1	5.7
2035	6.1	(0.2)	(0.3)	0.2	5.8
2036	6.2	(0.3)	(0.3)	0.2	5.8
2037	6.2	(0.3)	(0.3)	0.2	5.8
2038	6.2	(0.3)	(0.3)	0.3	5.9
2039	6.2	(0.3)	(0.3)	0.3	5.9
2040	6.3	(0.4)	(0.3)	0.3	5.9
2041	6.3	(0.4)	(0.3)	0.3	5.9
2042	6.3	(0.4)	(0.3)	0.4	6.0
2043	6.3	(0.4)	(0.3)	0.4	6.0
2044	6.3	(0.4)	(0.3)	0.5	6.1
2045	6.4	(0.4)	(0.4)	0.5	6.1
2046	6.4	(0.4)	(0.4)	0.6	6.2

2047	6.4	(0.4)	(0.4)	0.7	6.3
2048	6.4	(0.4)	(0.4)	0.7	6.3
2049	6.4	(0.4)	(0.4)	0.8	6.4
2050	6.5	(0.5)	(0.4)	0.9	6.5

Table 90: Lāna‘i Peak Forecast (MW)

Year	Underlying	Distributed Energy Resources (PV and BESS)	Energy Efficiency	Electric Vehicles	Peak Forecast
MW	A	B	C	D	E =A + B + C + D
2020	6.5	–	–	–	6.5
2021	6.6	–	–	–	6.6
2022	6.6	–	–	–	6.6
2023	6.8	–	(0.1)	–	6.7
2024	6.8	–	(0.1)	–	6.7
2025	6.8	–	(0.1)	–	6.7
2026	6.8	–	(0.1)	–	6.7
2027	6.9	–	(0.1)	–	6.8
2028	7.0	–	(0.2)	–	6.8
2029	7.1	–	(0.2)	–	6.9
2030	7.1	–	(0.2)	–	6.9
2031	7.1	–	(0.2)	–	6.9
2032	7.1	–	(0.2)	–	6.9
2033	7.1	(0.1)	(0.2)	0.1	6.9
2034	7.2	(0.1)	(0.2)	0.1	7.0
2035	7.3	(0.1)	(0.2)	0.1	7.1
2036	7.3	(0.1)	(0.2)	0.1	7.1
2037	7.3	(0.1)	(0.2)	0.1	7.1
2038	7.3	(0.1)	(0.3)	0.2	7.1
2039	7.4	(0.1)	(0.3)	0.2	7.2
2040	7.5	(0.1)	(0.3)	0.2	7.3
2041	7.5	(0.1)	(0.3)	0.2	7.3
2042	7.5	(0.1)	(0.3)	0.2	7.3
2043	7.5	(0.1)	(0.3)	0.3	7.4
2044	7.5	(0.1)	(0.3)	0.3	7.4
2045	7.6	(0.1)	(0.4)	0.4	7.5
2046	7.7	(0.1)	(0.4)	0.4	7.6

2047	7.8	(0.1)	(0.4)	0.4	7.7
2048	7.7	(0.1)	(0.4)	0.5	7.7
2049	7.6	(0.1)	(0.3)	0.5	7.7
2050	7.8	(0.1)	(0.4)	0.5	7.8

A.2. IGP TECHNICAL ADVISORY PANEL MEETING PRESENTATION FROM AUGUST 14, 2020

Integrated Grid Planning

Technical Advisory Panel Meeting

August 14, 2020

Objective Today is to Review the Forecasts Developed with Input from the Forecast Assessment Working Group ("FAWG")

- Overview of the forecast process
- Developing the sales forecast by layer
  - Underlying
  - DER
  - Energy efficiency
  - EoT
- Shaping the sales to arrive at an hourly load forecast
- Results including uncertainty around the layers
- Key questions/concerns for TAP consideration

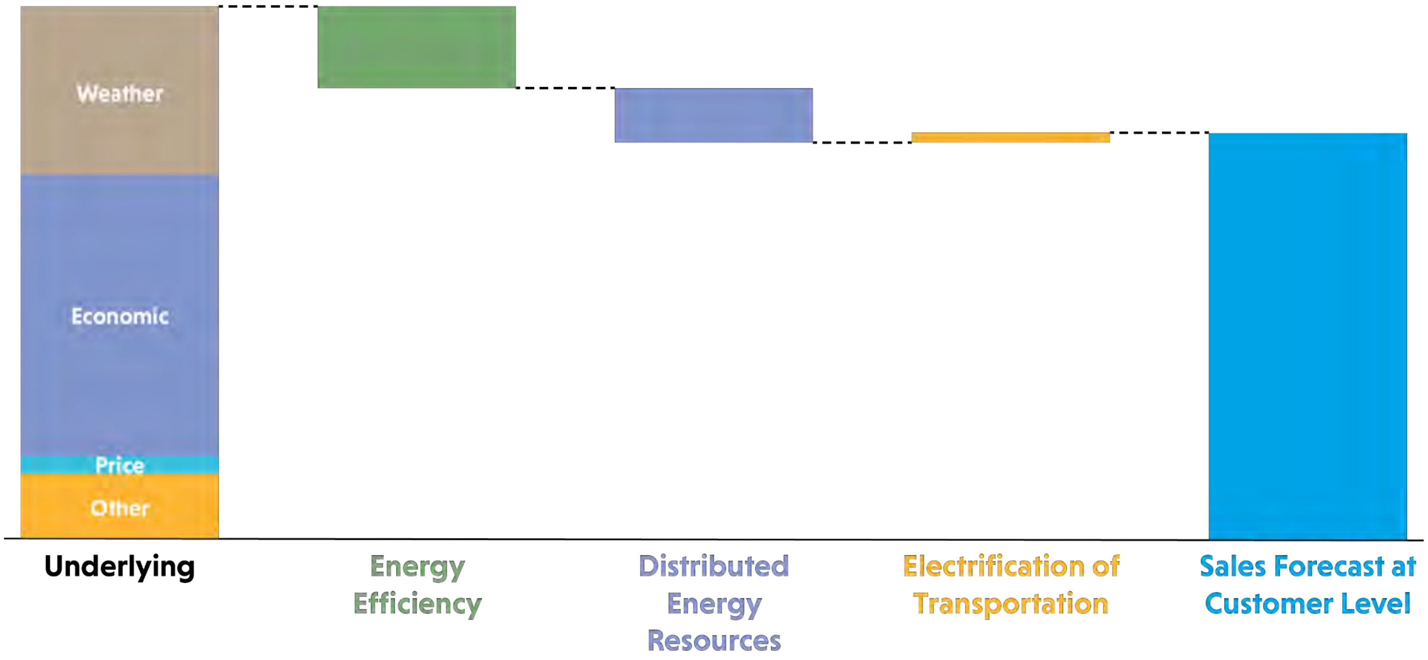
Feedback Sought from the TAP

- Is the approach to developing the forecasts appropriate to use to start the resource planning analysis?
- Given the results, what sensitivity analyses might be useful to provide better understanding of the impact of the uncertainty?
- For use in the resource planning modeling to test the robustness of the plans, is it necessary to run models for all permutations of the sensitivities or should the "bookend" approach be used?
- Specific questions/concerns to be raised during the presentation

Verbal feedback today with written summary/follow up as appropriate

Illustrative Example

The forecast is developed in layers.



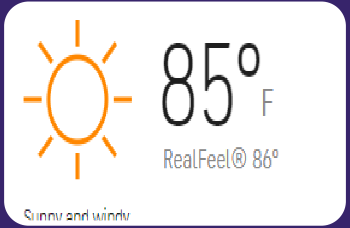
Forecast will be further modified by demand response (DR) and controllable DER.

Underlying Forecast

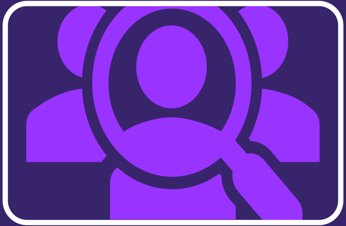
Key Assumptions

- Economic Drivers from the University of Hawaii Economic Research Organization
  - Jobs, Income, Population, Visitor Arrivals
- Electricity Price
  - Developed by Corporate Energy Planning
- Weather variables considered:
  - Temperature (average temperature, cooling degree days)
  - Humidity (relative humidity, dew point)
  - Combination of temperature and humidity
  - Warming trend factored into the temperature variable
  - Precipitation
- Addition of large new projects or loss of large loads

Feedback from FAWG



- Getting hotter
  - Included a warming trend in the temperature variable



Consider all perspectives when developing forecasts and plans

- Increasing amounts of dialysis centers
  - Reviewed the increasing trend in dialysis centers – was not significant enough to make an adjustment to the forecast
- Consider the rate impacts of resource plans on the income constrained
  - Acknowledged this is important for everyone

Various methods are evaluated

Market Analysis

- Focus on individual large customers, projects or events

Customer Service

- Analyze trends in number of customers, sales or use/customer

Trending

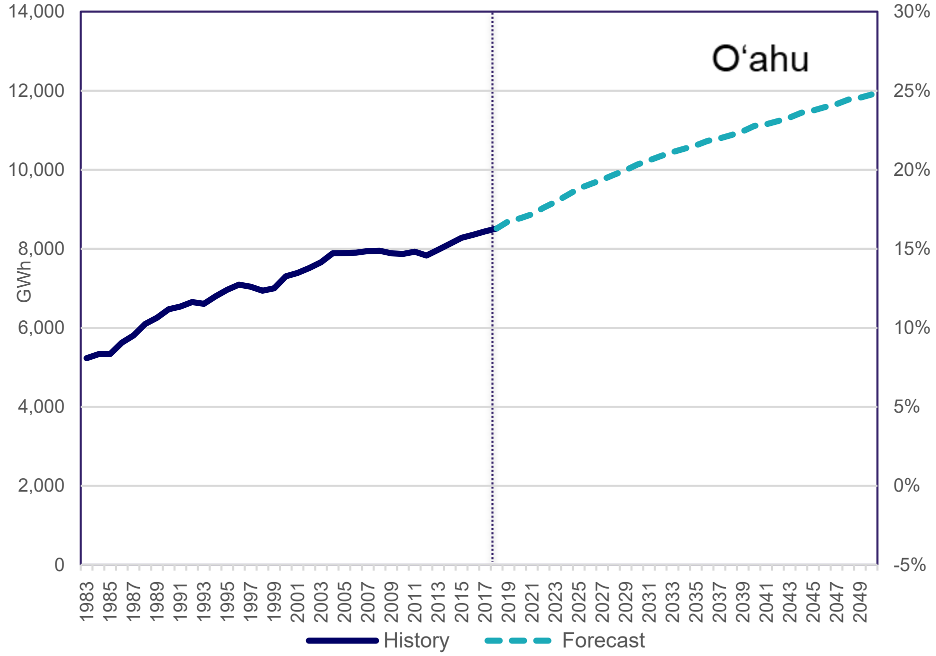
- Uses historical data to project future sales, customer counts or use/customer

Econometric

- Relationships between external drivers and underlying sales
  e.g. Sales = f(electricity price, jobs, weather variables)

- Tools used
  - Itron Inc. MetrixND
  - Microsoft Excel
  - Microsoft Access

Underlying sales is primarily driven by the economy, weather and electricity price.



- Uncertainty in the sales forecast is primarily driven by uncertainty in the impacts of DER, EE and EVs in which we perform sensitivities around those layers.

Discussion Topics

- What role do future unpredictable disruptions like a recession, terrorist attack, or pandemic play?
- Is the use of high and low forecasts that bracket the reference forecast sufficient to test robustness of resource plans to uncertainty in the long-term trend and short-term disruptions?

Distributed Energy Resource Forecast “DER”

DER – Methods and Assumptions

- Near term (to 2022)
  - Input from the Customer Energy Resources program administrators
  - Planned projects and build-out of existing programs
  - Recent pace of installations and incoming applications
  - Recent average system sizes with and without BESS
- Longer term
  - Economic choice model considers
    - Installed cost of PV and battery
    - Incentives
    - Electricity price
    - Program structure that affect the economic benefit to the customer
    - Addressable market
- Solar resource
  - Unitized profiles for solar production
  - Monthly capacity factors

Economic choice model

- Analyze historical relationship between adoption rate and economics
  - Dependent variable: Percent of potential PV customers that installed a system
  - Independent variable: Payback time (years)
- New capacity additions derived by incorporating 2 additional key assumptions:

  (% adoption) x (number of potential adopters) x (average system size)

- Tools: Excel

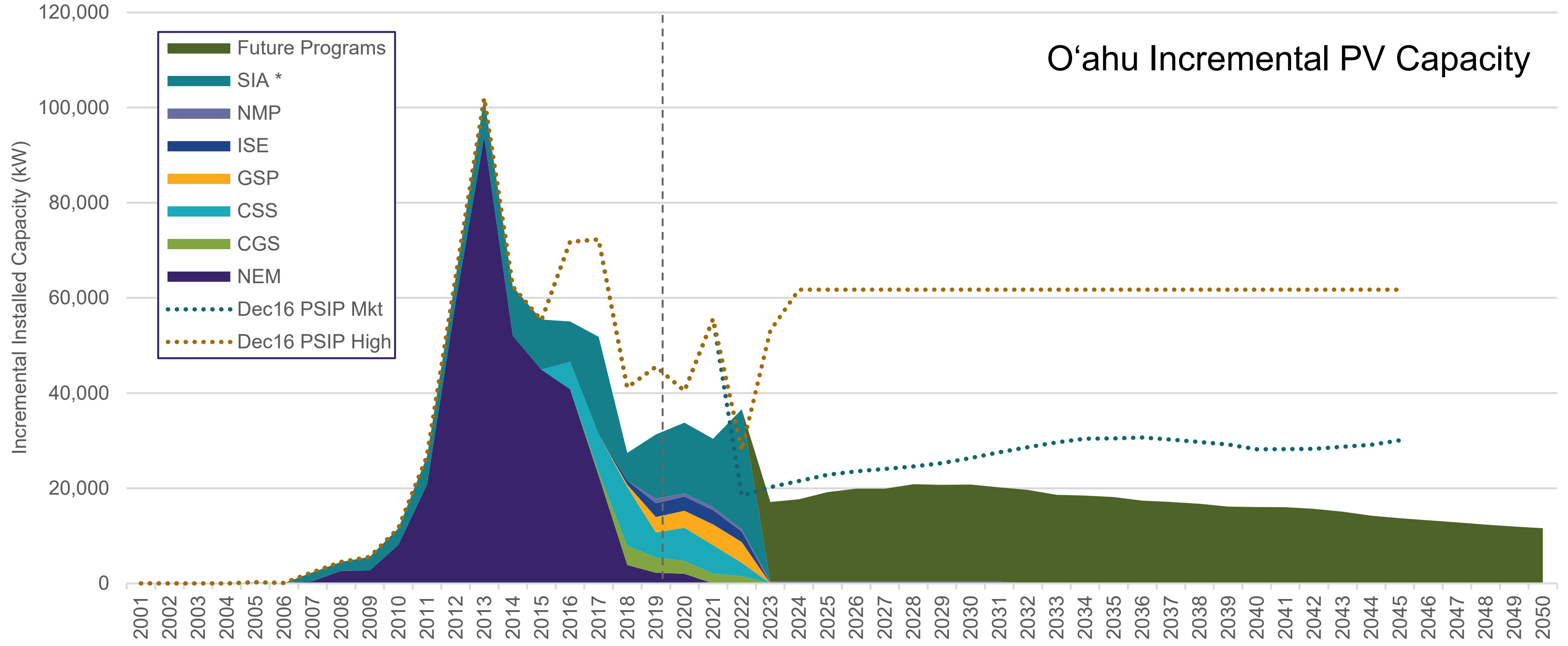
The structure of DER programs affects level of adoption, type of technology adopted and shape of the load

- Standard DER Tariff
  - Time-variant compensation for export aligned with system needs
  - Controllable by utility for system stability emergency
- Standard Interconnection Agreement (SIA)
- Future Consideration (DER Docket)
  - Advanced Rate Design
  - Update DER forecast when information is available
- Lower compensation for daytime export increases adoption of battery storage
- Battery storage changes DER impact to system load shape

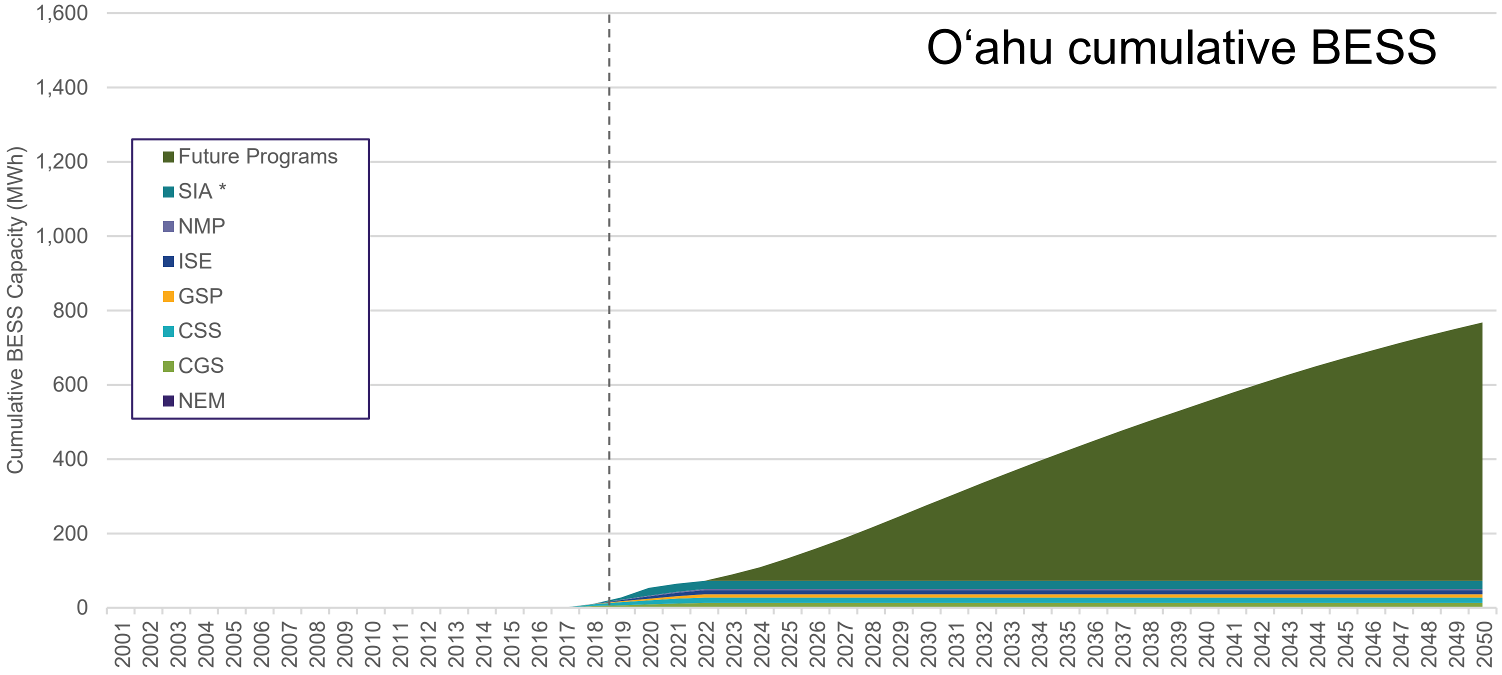
Feedback from FAWG and industry experts

- Most PV systems are now installed with batteries
  - Included in forecast
- Drivers should include: installed costs, incentives, program structure/rate design
  - Included except for rate design changes which are not available yet
- Barriers are lack of or shared roof space, short term lease, home ownership, should make financial sense
  - Considered when determining the addressable market
- Outlook of new homes having PV regardless of home ownership. Programs that are simpler to understand and implement
  - To be considered when developing future programs addressed in DER Docket

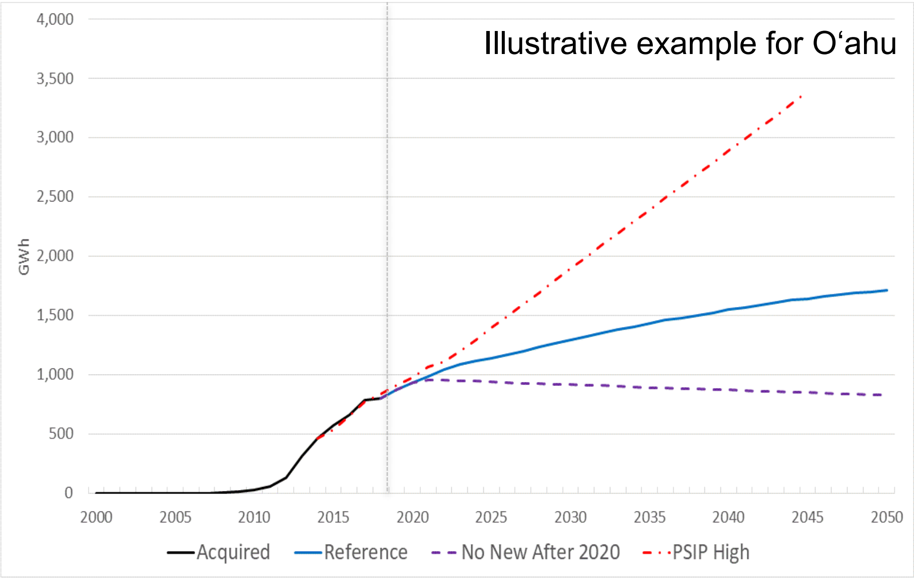
The near term reflects the build-out of the existing programs and the long term is based on assumptions about future programs yet to be identified in the DER Policies Docket.



Future DER programs are forecasted to result in strong growth in distributed BESS paired with PV



DER Sensitivities and Discussion



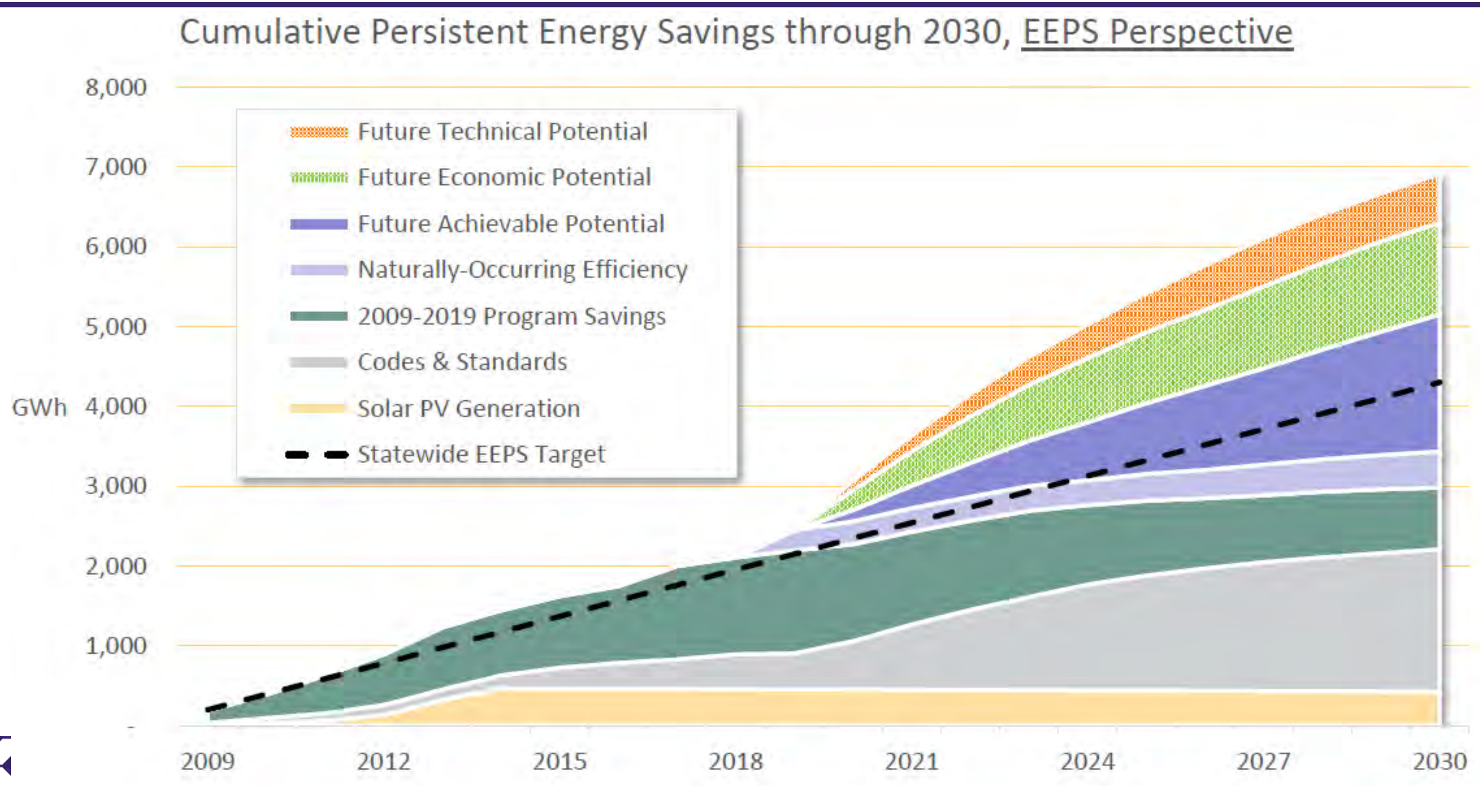
- High and low sensitivities suggested by SEOWG
- Key sources of forecast uncertainty:
  - Costs
  - Policies
  - Customer behavior
  - Solar resource
- Does the range of sensitivities based on high and low levels of installed capacity provide a sufficient range of future distributed generation to address these uncertainties?

Energy Efficiency Forecast

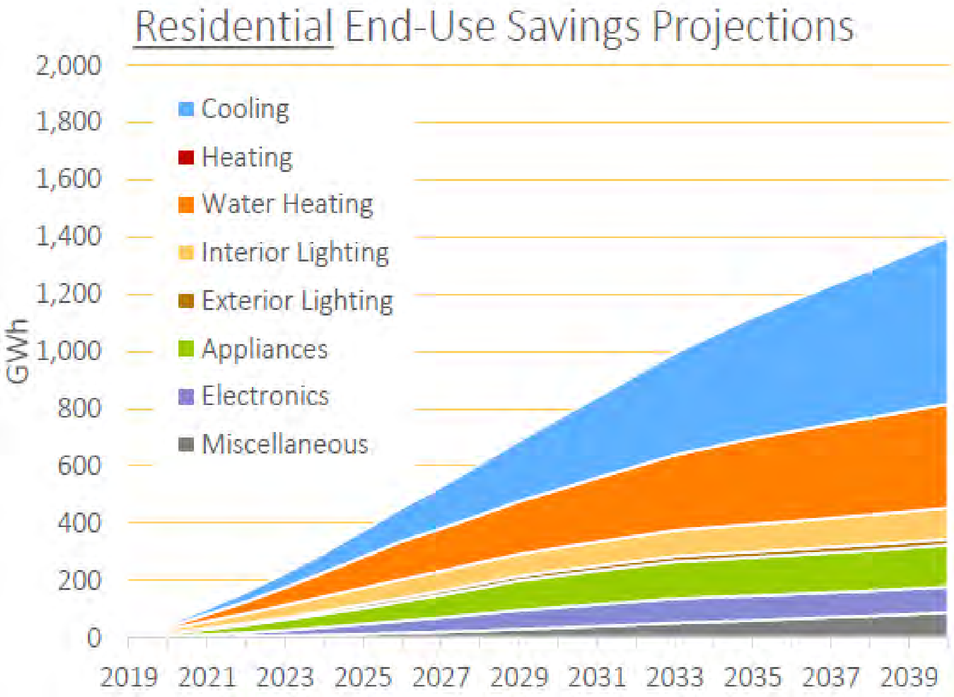
Energy Efficiency– Methods and Assumptions

- AEG conducted a Statewide Market Potential Study for the HPUC
- Developed a technical, economic and (2) achievable savings estimates
- Also developed codes and standard savings estimates

EEPS target (4,300 GWh by 2030) appears to be attainable

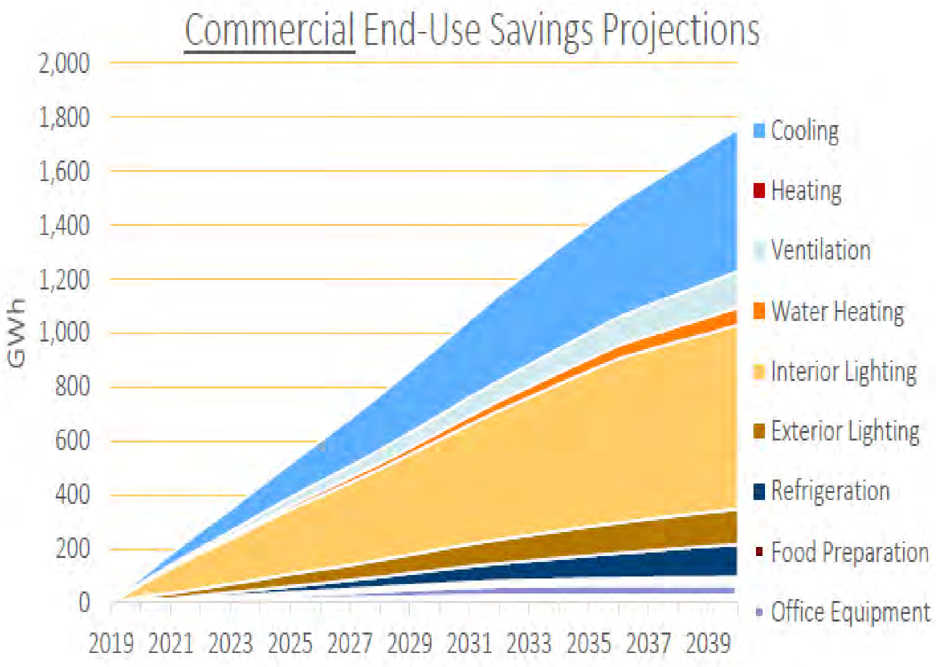


Residential savings potential



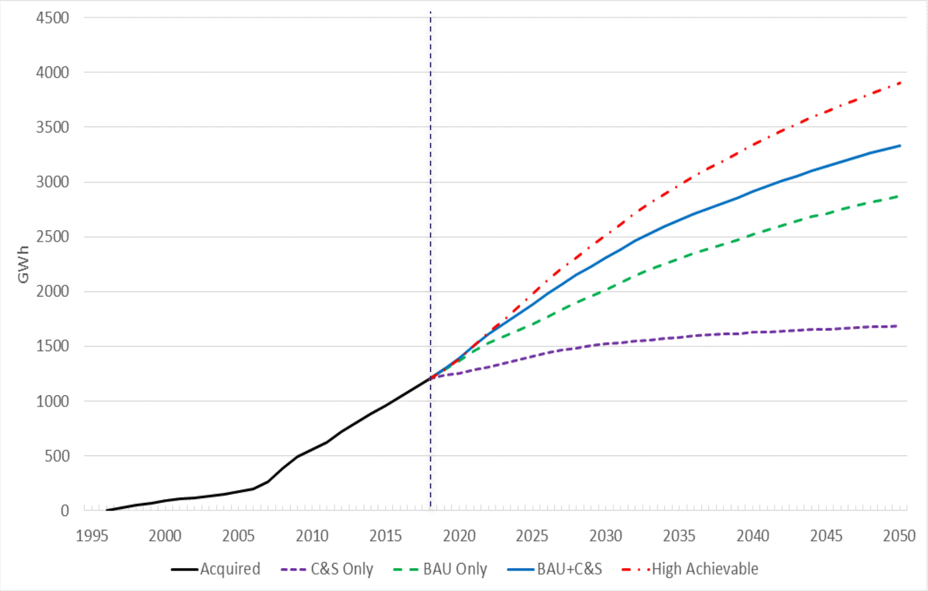
- Potential estimates are from a codes and standards compliant baseline
- Cooling and water heating make up most of the savings
- Lighting shifts substantial potential into the baseline

Commercial savings potential



- Potential estimates are from a codes and standards compliant baseline
- Cooling and lighting comprise the majority of the savings
- High hours of use drive lighting to be top saving end use
- Substantial HVAC potential in chiller and roof-top upgrades

Energy Efficiency Sensitivities



- This is the largest layer contributing to energy reduction
- We received feedback from stakeholders that the BAU + C&S seemed aggressive.
- Should a lower forecast be considered?
  - If yes, is it OK to use the BAU or C&S only forecast?
  - Suggestions?

Electrification of Transportation ("EoT")

Process to Derive the Light Duty Electric Vehicle (“EV”) Forecast

Light Duty Vehicle Forecast

↓

EV Saturation & EV Count Forecast

↓

Daily Vehicle Miles Traveled & kWh per Vehicle

↓

Charging Profiles

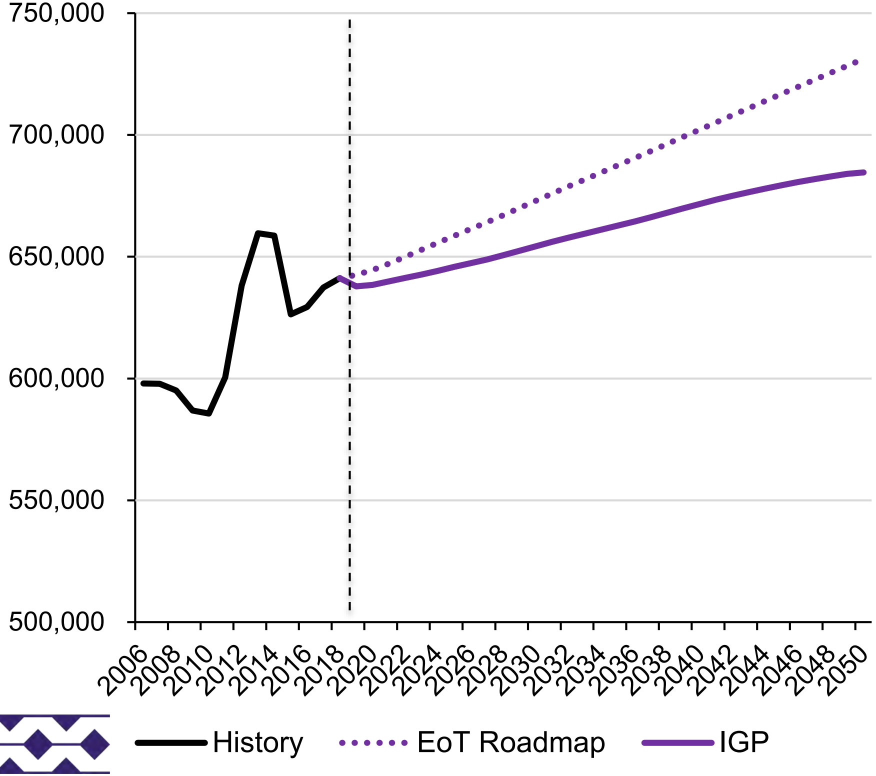
↓

Total Energy Sales

Feedback from the FAWG

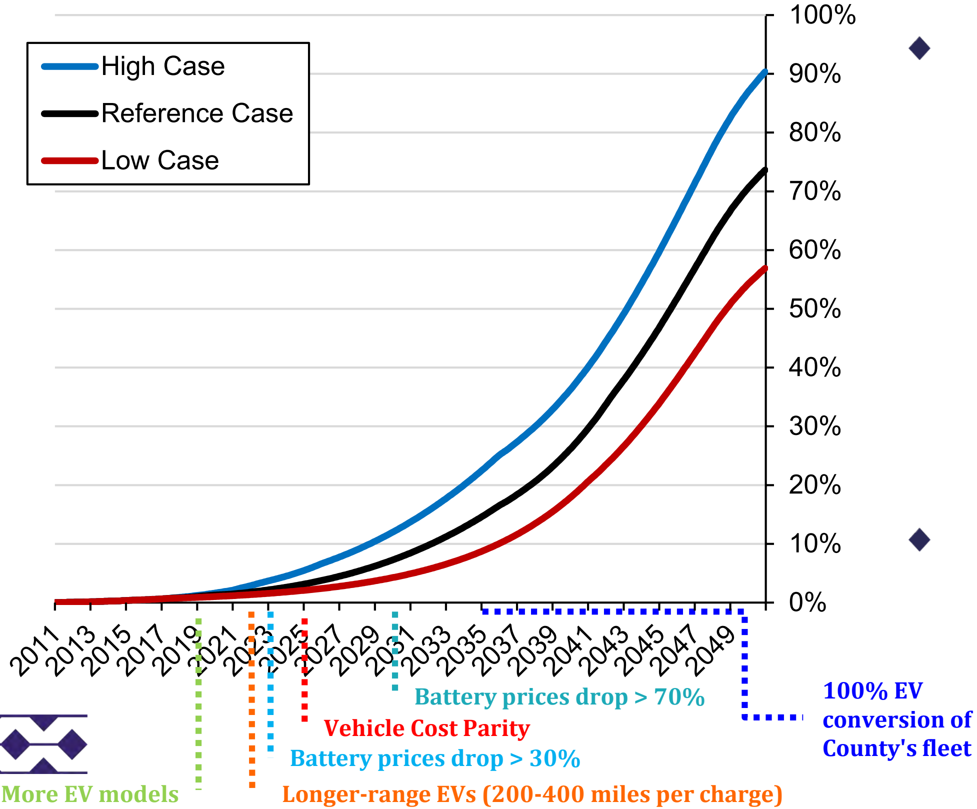
- Light duty EV forecast for total light duty vehicles looked too aggressive
  - Lowered LDEV forecast using updated lower population forecast
- Electric buses on the neighbor islands not just Oahu
  - Included Ebuses for Maui and Hawaii islands
- Consider drivers for adoption: cost parity, variety, increased charging opportunities, incentives
  - Included in the forecast
- Need to consider managed charging – don't want to overbuild system
  - Considered in the resource planning

LDV Forecast – O‘ahu



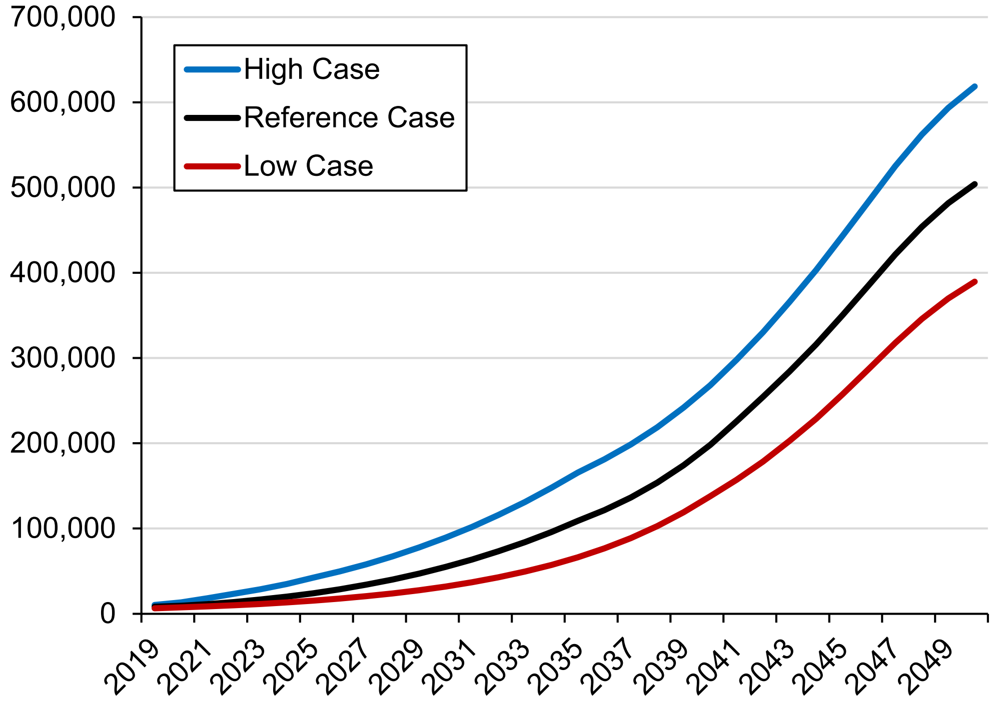
- FAWG felt initial LDV forecast was too aggressive
  - Expects lower vehicle ownership, increased rideshare, and population decline in the near-term
- LDV forecast developed using a regression model driven by population and jobs
  - Revised after receiving updated economic forecast

EV Saturation Scenarios Provide a Range



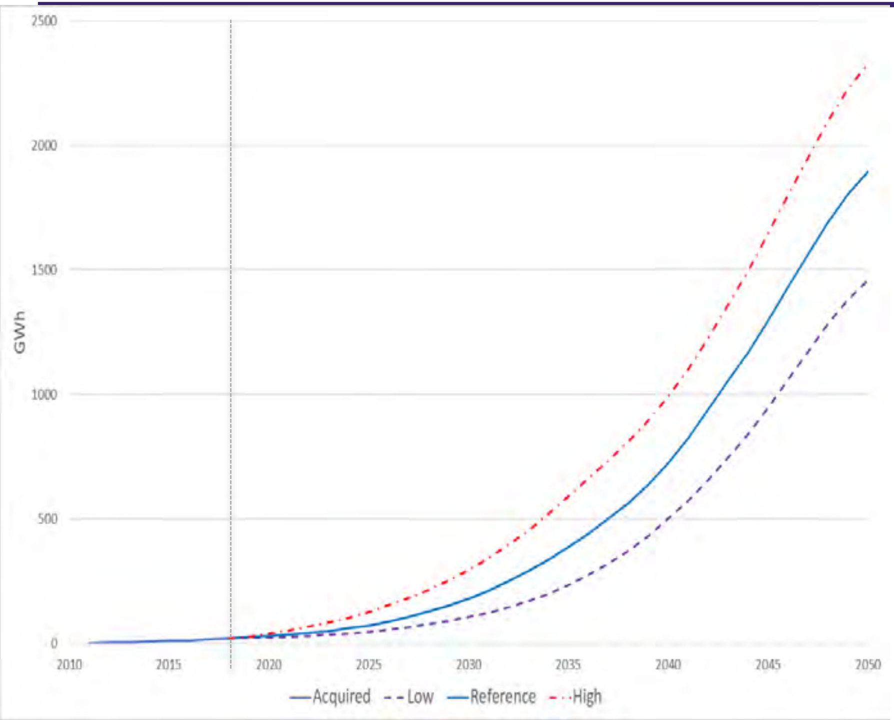
- EV saturations developed using a Bass Diffusion model combined with a geospatial, customer level agent-based model
  - Variables included vehicle cost (electric and ICE), gasoline and electricity price, vehicle fuel economies, income, EV tax credits, and PV installations
  - Use publicly available data
- Tools: Excel models developed by Integral Analytics

EV Count – O‘ahu



- Still relatively new technology so developed sensitivities to address the uncertainty
  - Huge uncertainty in developing a 30-year forecast
- High and low EV adoption driven by adjusting variables such as vehicle costs, gas prices, and tax credits

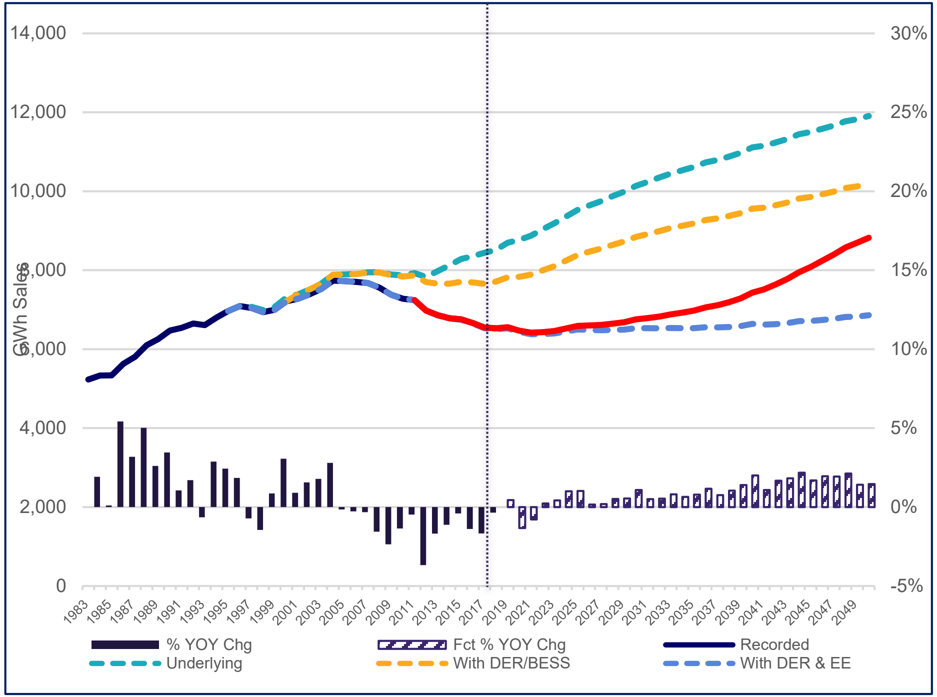
EV Sales and Discussion Topics



- Are there other sources of charging profile data that we should consider?
- How can we diversify charging patterns as battery technology improves and customer charging behavior changes?
- HECO is developing managed charging profiles through time varying rates to shift peaks to daytime and off-peak hours. RESOLVE sensitivities to run unmanaged vs managed charging.

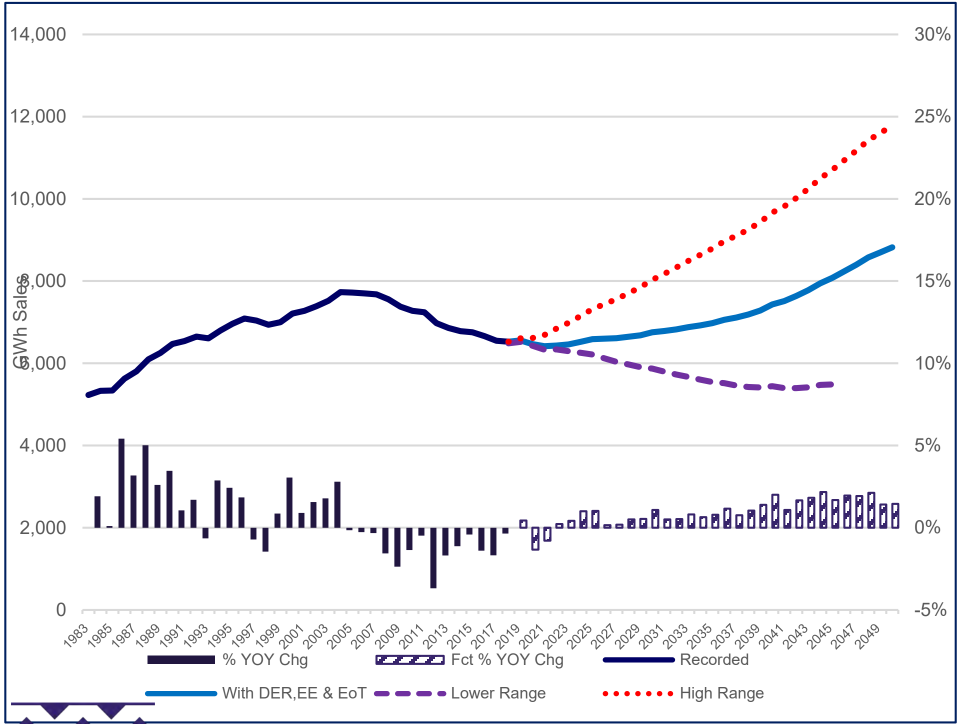
Putting all together

Energy efficiency exerts the largest downward pressure on sales. Electric Vehicle Charging Offsets the Impacts from DER and Energy Efficiency.



- The results of several dockets will have an impact on our forecast (e.g. DER Policy, EoT)
- Government policies such as renewable fuel for transportation will also impact our forecasts
- Having PV influences the adoption of behind the meter technology such as EVs and air conditioning

Sensitivities Around the Layers Provide a Range



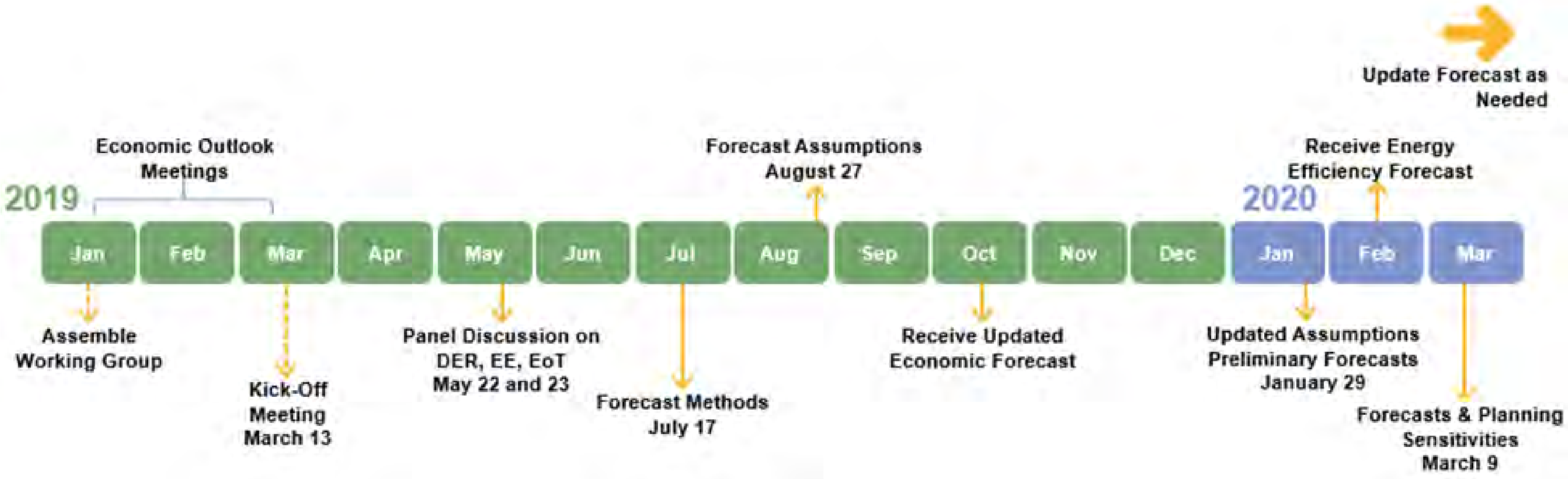
- Not able to develop a confidence interval around the net forecast so we develop sensitivities around the layers that have the highest uncertainties – DER, EE and EoT.
- Stacking the layers to get a high and low range however, there are the various permutations of the layer sensitivities to arrive at other forecasts.
- Additional sensitivities that don't require a 30-year forecast will be done in the modeling stage to test the robustness of the resource plans such as extreme conditions and how much PV can the system take

References for more information

- Forecasts used to start the resource planning analysis
  - O’ahu
    https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/oahu_IGP_forecast_by_layer.xlsx
  - Maui County
    https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/MECO_IGP_forecast_by_layer.xlsx
  - Hawaii Island
    https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/hawaii_island_IGP_forecast_by_layer.xlsx
- Detailed description of developing the forecasts including the data sources and models
  - Docket No. 2018-0165 (IGP Docket) PUC-HECO-IR-1 and PUC-HECO-IR-2
- Forecast Assumptions Working Group Documents
  https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents

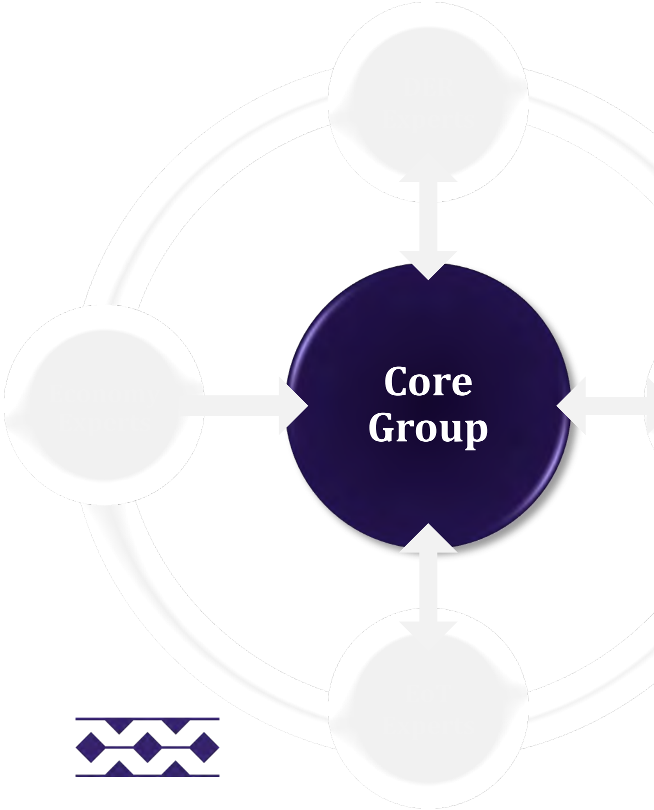
Backups

What we've done what's ahead



https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents

Meet the members of the FAWG



- **Oahu Economic Development Board** – *Pono Shim*
- **City & County of Honolulu** – *Rocky Mould*
- **Hawaii Island Economic Development Board** – *Jacqui Hoover*
- **Maui County** - *Teena Rasmussen*
- **County of Hawaii, Department of Research and Development** - *Ron Whitmore*
- **University of Hawaii Economic Research Organization (UHERO)** – *Dr. Carl Bonham*
- **Department of Business, Economic Development & Tourism (DBEDT)**– *Dr. Binsheng Li*
- **Hawaii Public Utility Commission** – *Jay Paul Lenker, Ashley Norman, Dave Parsons, Grace Relf, Clarice Schafer, Gina Yi, RMI Consultants*
- **Consumer Advocate** – *Rene Kamita*
- **Life of the Land** – *Henry Curtis*
- **Hawaii Energy** – *Ramsey Brown*
- **Electric Reliability Council of Texas (ERCOT)** - *Calvin Opheim*
- **NV Energy** - *Terry Baxter*
- **Portland General Electric** - *Amber Riter*
- **Sacramento Municipal Utility District (SMUD)** - *Patrick McCoy*
- **EPRI Understanding Electric Utility Customers** - *Omar Saddiqui*

The forecast starts with the development of the sales forecast and results in an hourly load forecast

Sales
- By island
- By rate
- By layer

Hourly load forecast
- By island
- By rate
- By layer

Peaks
- By island
- By month

A.3. INTEGRATED GRID PLANNING TECHNICAL ADVISORY PANEL REVIEW

Integrated Grid Planning
Technical Advisory Panel Review
Review Point 1 | August 2020

Overview of the Technical Advisory Panel

Objective

The Technical Advisory Panel (TAP) is a group of independent, third-party, technical experts in grid planning. It is made up of members from research institutions, utilities, and RTOs across North America. Members were specifically selected to provide a diverse background on technical topics related to variable renewable integration, distributed energy resources, transmission planning, and other key topics related to HECO's Integrated Grid Planning Efforts.

The objective of the TAP is to provide an independent technical resource for HECO to leverage to analyze, evaluate, and provide feedback to the IGP data sources, methodologies, modeling tools, and results. In addition, the TAP is intended to provide public feedback and an independent review of HECO's Review Point filings.

TAP Membership

- Richard Rocheleau (Chair), Hawaii Natural Energy Institute (HNEI)*
- Jeffrey Burke, Arizona Public Service (APS)*
- Andrew Hoke, National Renewable Energy Laboratory (NREL)*
- Julia Matevosjana, Electric Reliability Council of Texas (ERCOT)
- Kevin Schneider, Pacific Northwest National Laboratory (PNNL)*
- Robert Sheridan, National Grid*
- Aidan Tuohy, Electric Power Research Institute (EPRI)*

  *participated in 8/14/2020 web-based meeting on load forecast methodologies

TAP Reviews

The TAP may provide input to the utility via verbal or written input. In addition to TAP contributions during in-person meetings and web-meetings, the HPUC has also requested formal review at select times during the process. While these formal reviews (such as this document) are intended to provide a summary of the TAP comments and discussions on the item under review, inputs may not reflect a unanimous view of all TAP members and does not represent the views of the respective member organizations. All TAP discussions and feedback follow the Chatham House Rule and neither the identity nor the affiliation of the speaker(s) are attributed to comments and feedback presented in this report.

TAP members comments and feedback are intended to address *technical* aspects of the IGP, including assumptions, methodologies, and modeling tools. While these comments and feedback may impact policy decisions, the TAP review is not intended to support specific policy views or mediate conflicting stances from stakeholder input.

Finally, while this report presents observations and recommendations from the TAP, it does not necessarily constitute an acceptance of the IGP methods or results, nor does it validate the accuracy of the results presented.

Technical Advisory Panel Update

In the winter of 2019/2020, Hawaiian Electric Company (HECO) and the Hawaii Natural Energy Institute (HNEI) began a process to reform the TAP, including changes to both the TAP membership and TAP directive. This effort culminated in a revised work plan submitted May 27, 2020 to the HPUC by HECO. This document specified a more expanded role for the TAP with the guidance that "*through its November [2019] IGP Commission Guidance, the Commission noted that, "[f]or the stakeholder process outlined in the Workplan to effectively serve as a replacement for independent evaluation, the Technical Advisory Panel would have to take an active role in analyzing, evaluating, and providing public feedback on Working Group activities and Review Point filings.*"

With a newly reconstituted TAP, a series of meetings were conducted with HECO and independently (TAP members only) to discuss roles and responsibilities and to initiate the formal review process. A brief summary of these introductory meetings and associated exchanges follows.

- **8 June 2020 and 12 June 2020:** TAP Chair & HECO welcomed new TAP members, HECO provided an overview of the IGP process and described the expanded role of the TAP as an independent evaluator, and summarized activities specific to Review Filing Point 1 (FP1).
- **9 June 2020**: Via email, the TAP was provided with significant documentation including a draft of FP 1 and requested to initiate review. This review was to specifically consider IGP forecasts inputs and assumptions, and the associated Exhibit A, with a less specific request for feedback on Exhibits B, C, D, and E. The draft FP 1 comprises over 320 pages of documents including nearly 300 pages of power point presentation from multiple working group meetings.
- **29 June, 2020:** Chair convened a TAP only meeting to discuss updated roles, responsibilities, and status of the requested review and subsequently the methods and preferred operating process of TAP membership to ensure a more productive approach for the TAP. As part of the proposed process, HECO and HNEI started regular meetings to discuss better ways to involve the TAP, solicit feedback, and integrate TAP comments into the IGP process.
- **14 August, 2020:** Following multiple exchanges between Chair (and Chair support team) and HECO team, the TAP and HECO met to review technical content related to the IGP load, DER, energy efficiency, and electric vehicle forecast. In this meeting HECO provided a more concise summary of specific elements of Review Point Filing 1 focusing on the outputs of the Forecast Assumptions Working Group. TAP comments resulting from this meeting are summarized below.

TAP Review Report Number 1
Review of Forecast Assumptions Working Group
August 24, 2020

Scope of TAP Review Report No 1

HECO's draft Review Point 1 filing included extensive work done to date, including deliverables on Grid Services, Resiliency, Non-wire Alternatives, etc. Based on discussions between HNEI and HECO leading up to this review, it was decided to limit this first TAP meeting only to the HECO load forecast, as this is a fundamental building block of all subsequent modeling efforts, and early prioritization and feedback was requested by HECO. Thus, this report provides the TAP's observations, feedback, and recommendations related to the Company's forecasts of underlying load, energy efficiency (EE), distributed energy resources (DER), and electric vehicles (EV).

In upcoming work and meetings the TAP will review, provide feedback, and report on other Review Point 1 technical matters including the SEOWG Grid Needs Assessment & Solution Evaluation Methodology, June 2020.

Key Conclusions, Observations and Recommendations

- The TAP agreed that the layered approach for load forecasting (underlying, DER, energy efficiency, electric vehicles) used by the FAWG makes sense and captures the important levers most likely to impact HECO's load changes. It was noted that the layered approach is consistent with the process used by other utilities and allows for transparent assumptions and targeted sensitivity analysis in downstream modeling.

- TAP members generally agreed that there is a good link between the econometric models and forecasting load growth, but also noted that recent trends may have changed the relationship between economic growth and load growth. While the larger datasets are preferred, econometric modeling should ensure that recent year data do not show a significantly different economic relationship to load growth.

- The TAP expressed some concern regarding ability to accurately quantify those segments for which there is less historical record. It was noted that quantifying loads for energy efficiency, DER, and EV more than 10 years in the future is very challenging. However, there will be additional IGP cycles and opportunities to correct the long-term forecast over time.

- It was also noted that risks associated with uncertainty and accuracy may be different for different users of the forecasts. Depending on how the forecast is to be used, significant accuracy may be required, while for other use cases, it is a not-to-exceed number. It is important that adequate scenarios be analyzed to know which side of the error (positive or negative) is riskier for a given use case. For example, the risk of not procuring enough capacity could be worse than having too much. Specific concerns or comments on the individual layers are summarized in the Appendix.

- There was significant discussion concerning uncertainty and value of conducting "bookend' analyses to test the sensitivity of models and resulting portfolios against a wide range of load forecasts. The TAP recommends that bookend analyses be conducted to understand the potential high and low load forecast potential that could reasonably occur. The impact of error in any individual layer may be more impactful when it changes the daily profile.

- While not explicitly covered in the presentation, HECO and TAP were in agreement that an important component to the load forecast is a better understanding of daily load profiles. This includes uncertainty in peak demand and potential control of distributed energy resources. The pattern and timing of load, including but not limited to peak demand, is important for ensuring enough resources are available for reliability.

Specific TAP Recommendations

- HECO should consider testing the sensitivity of models and resulting portfolios by running bookend scenarios that utilize the cumulative potential high and low load forecasts for each layer.
- HECO should ensure that subsequent modeling tasks include sensitivities for time-of-use flexibility and/or random variation in the daily load profiles of DER and EV loads, rather than using a static load profile across modeling tasks.
- HECO should consider using a wider range of future energy efficiency and EV adoption rates due to the high uncertainty, especially beyond year 10. The TAP noted that proposed retirement of thermal units might be impacted by this uncertainty.

Next Steps

The following topics have been identified by HECO, HNEI and TAP members for potential subsequent TAP review:

- Grid Service Definitions and Sources
- Modeling tools and approaches

Appendix

The following captures specific TAP questions and HECO responses from the August 14 Meeting

Underlying Load Forecast

- **What was the warming trend?**
  Ans: Warming trend included, 1.5 degree increase by 2050 over the historical 20-year average, for each of the 5-islands. Historical data show a 0.5 degree increase in the past 20 years, but after input from WG, it was increased to 1.5 degrees based on IPCC and additional data in the literature.
- **Market analysis and customer service are more near-term. Econometric is more long-term. Where does trending fit in - is it used for long-term forecast?**
  Ans : Trending is used for customer count. This is based on recent history only. Tends to be pretty stable, so the trending model works well. You can draw a line from history, and it's been shown to be reasonably accurate. With DER, it no longer is considered accurate for the sales forecast.
- **Do the trending and econometric models get blended together, or do they get evaluated separately? How does customer count get translated into sales?**
  Ans : Customer count is based on trending; econometric modeling provides use per customer. You multiply the two together for the future demand. Econometric model takes into account the drivers in the economy.
- **When you look at uncertainty in future DER, EVs, and EE projections - do you take into account seasonal and time of day impacts, or just the annual total?**
  Ans : We don't just scale it, we use hourly profiles for the DER and we capture time and season.
- **What you show is generally a single forecast There are some sensitivities, but do the users of the forecast get to select which sensitivities they are going to plan for, or is the expectation that all planning uses the same scenario, or are the scenarios dependent on the use case?**
  Ans : We (HECO) come up with a reference case, but we do work with the end users (in this case Chris Lau's planning team), and get feedback from stakeholder groups.
- **The regression approaches may need scrutiny - economic trends and electricity usage trends have been separating in recent years. Can you elaborate on whether you included any change in the economic drivers?**
  Ans: Difficulty in trying to capture recent trends (i.e., Covid). - use of standard deviation to develop error bars - did this in the past but not recently.
  Ans: HECO also tests different historical periods - checks fits and elasticities - this is detailed in HECO's response to the Commissions Information Request (which historical trends were used)
  -One TAP member noted that they've found that the relationships are relatively strong - econometric model still does a very good job
  -One TAP member noted that utility(ies) are familiar with forecasts that utilize a Business As

Usual (BAU) case and then layers on EE, DER. It was noted that the underlying forecast (econometrics) still shows growth - very similar to what HECO is showing

DER Forecast

- **How did you determine the potential PV customers?**
  Ans: Residential - segment adopters (renter-occupied v. owner-occupied)
  Ans : Commercial - more is known about the customer's facilities
- **The recent DER Programs had caps on participation - Do you foresee the caps going away or have they been considered in this forecast?**
  Ans: Considered the caps in the near-term forecast CGS, CGS+, etc. as these are temporary
  Ans: Don't anticipate there being caps on future new DER programs (longer-term)
- **What assumptions are being made about how the distributed batteries will be utilized, are they being used for grid services?**
  Ans: On the forecasting side we are assuming an hourly profile, but that can be adjusted by the model itself. Some TAP members would recommend more aggressive use of distributed storage be considered in the models.
- **What is derived from the DER forecast that is used as the inputs to the subsequent modeling?**
  Ans: The DER forecast provides PV generation and battery storage load shifting profiles (shown as layers in in the overall forecast) that are passed to the modeling teams. These profiles can then be adjusted by the modelers based on system needs. There was not time for discussion of the impact on daily/hourly profiles.
- **Where do you get the prices for the input? And do they get impacted by the amount of DER deployed?**
  Ans: IHS Market is used for DER prices; electricity prices derived internally
  Ans: IHS Market factors this (broader market adoption (depreciation/economies of scale) in to the price

Energy Efficiency Forecast

- **HECO-posed question - (slide 24) - should a lower EE forecast be used? If so, does TAP have suggested ranges**
  Ans: TAP was in general agreement that EE forecast seemed aggressive and that less aggressive forecast should be considered as part of the bookend analysis.
- **Are Hawaii Energy EE estimates used to compare with AEG estimates?**
  Ans: Hawaii Energy projections do not go out farther than 3-5 years… AEG projections are out to 2050
- TAP comment re Slide 33: See a trend of 18 years of declining load, yet projection flattens and increases (even without EVs) around 2025. Concern about stacking errors - if these all happen in the same direction, there will be a big error because these (DER, EE, EV) are not necessarily linked and therefore error should be evaluated individually.

- TAP comment that BTM DER tends to be pretty steady over time while EE is driven on how big incentives are. So, it's policy-driven with some impact on sales, a little bit higher than peak. This seems a little aggressive.

EV Forecast

- **Are the amounts of EV a reasonable range?**
  Ans: TAP commented that curves at other utilities look similar… little adoption early on, and then accelerated growth. Then curves bend up in time as ICE v. EV. The longer-term trend is very challenging to forecast accurately. Other utilities share similar EV trends, where adoptions starts increasing significantly after the 2020s,with a similar shape to the growth trend. Both vehicle performance and incentives are likely to have significant impact on this behavior so may need to adjust going forward.
  Ans: – While other utilities may be showing similarly aggressive numbers in the forecast, It's important to understand which side of the error band is the riskier side for the particular location. How the forecast numbers are used is critical
  Ans: – Some TAP members thought that even the low-side (60%) is very aggressive
- **Are there any state-wide policy issues on EVs that are being planned?**
  Ans: Yes, included is a 100% county fleet conversion by 2035
  Ans: County pledges for EV transportation by 2045 are used for context, but not direct inputs to the model.
- HECO Slide 34 - Responds to bookends. Planning team will test additional sensitivities related to EV charging profiles. The base case modeling runs will assume that EVs are considered with unmanaged charging profiles. The result will determine how unmanaged EV charging would impact the system. This would illustrate and potential quantify the needs for alternative charging programs. This modeling result would then go back to the forecasting team with information on potential programs

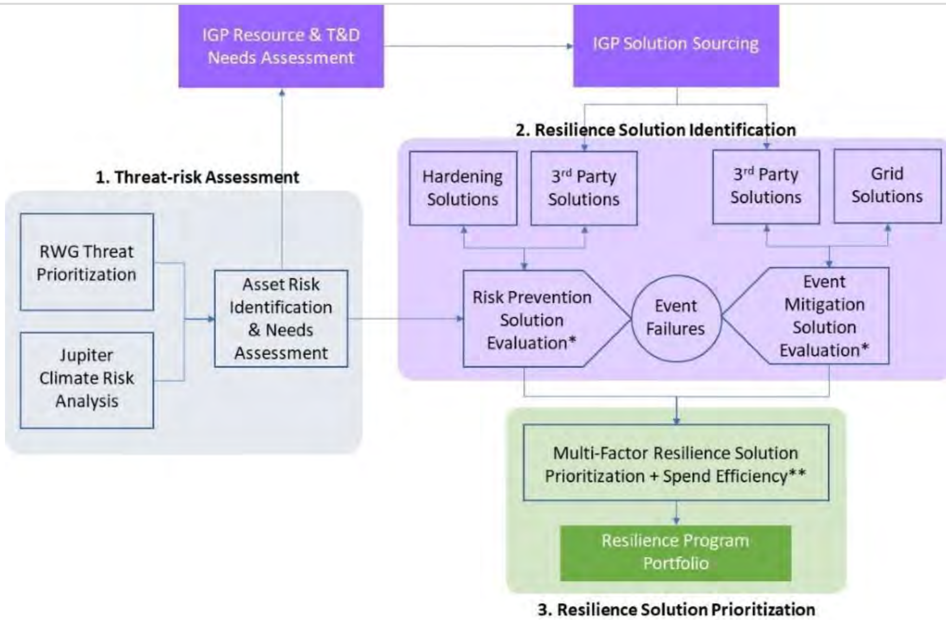
Other General TAP Comments

- States often have aspirational state goals, don't want to say that it won't occur, but somehow you have to make sure you don't blindly follow what the state policy makers are hoping for
- A lot of the uncertainty goes way up at the tail end of the forecast after 10 years, but short range in the uncertainty is likely lower, so we will have an opportunity to adjust.
- Regarding accuracy, sometimes accuracy matters for the actual number, for other use cases it is a not to exceed number. Thus, the accuracy measure is based on what you use the forecast for
- HECO's bookend analysis showing the low scenario for each of the forecast layers follows a trend seen over the past 15 years. As a result, this low bookend sensitivity may be more realistic than the reference case forecast and a valuable downside scenario to be evaluated.
- **What about the power-perspective (shapes) and not just the energy-perspective?**
  Ans (HECO): Forecasts all have associated shapes 8760 that are integrated downstream, just it was not covered today. TAP agrees this is important from a reliability and peak demand POV.

EXHIBIT B: INTEGRATED RESILIENCE PLANNING APPROACH

The Companies have been focused on power system resilience in response to the increasing threats from climate change. Resilience planning is about mitigating risks, including outages and public safety. A specific resilience planning process, based on industry best practices, is under development to integrate with IGP. This process has three distinct steps, 1) threat-risk assessment, 2) resilience solution identification, and 3) resilience solution prioritization. This resilience planning approach and linkage with IGP is illustrated in Figure B 1 below.

Figure B 1 – Resilience Planning Approach



* Resilience solution evaluation includes technical resilience performance assessment & secondarily other beneficial factors

** This customer & community-centric prioritization & cost effectiveness method can be applied to all T&D capital expenditures

The RWG reached a general agreement that all relevant costs need to be captured, which includes the costs that utilities might incur to mitigate severe outages, as well as the cost of the outage to customers and stakeholders.[64] This process attempts to address this objective in the context of a multi-factor evaluation that leads to a risk-spend efficiency prioritization adapting leading resilience planning practices in the industry.

1. <u>Threat-Risk Assessment</u>

The Companies' prior efforts with the Department of Defense and critical facilities in our communities has expanded through the work with the Resilience Working Group (RWG). The stakeholder driven threat identification and prioritization combined with customer segmentation

[64] See RWG Report at 57 https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/resilience/20200429_rwg_report.pdf

and prioritization provide a key input into the resilience planning process. The RWG final report is publicly available.[65]

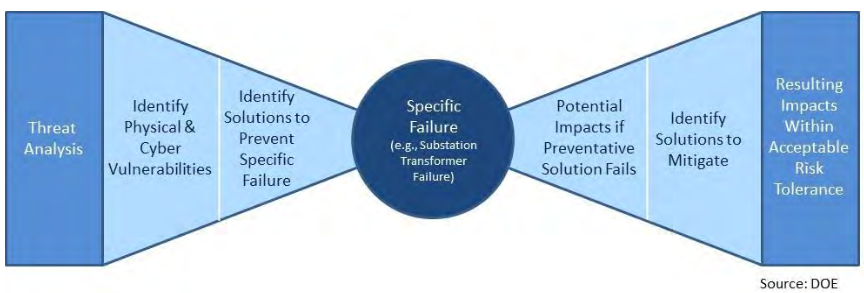
Jupiter Intelligence's high-resolution climate analytics provide asset-level resolution for short and long-term flooding and wind risk to assess physical risks over a 30-year time horizon to help the Companies address the resiliency of its generation, transmission, and distribution infrastructure. In its first phase, the Jupiter climate risk data will help the Companies prioritize geographic locations and assets that are most at risk. Subsequently, it will provide detailed area analyses of all assets.[66]

The Jupiter locational analysis combined with the RWG prioritization provides the basis for a detailed customer and community-based threat-risk assessment of the Companies' assets. This informs the need, location, and timing of investment to cost effectively provide the level of electric system resilience our customers expect. The result is a set of resilience needs in the form of specific performance requirements to prevent and mitigate event-based risks.

2. Resilience Solution Identification

The Companies are applying the "bowtie method" (Figure B 2), as increasingly used in the industry to leverage risk-threat assessments as described above into a structured solution identification process involving two aspects, event risk prevention and event consequence mitigation. This method, employed in California's wildfire mitigation planning, translates the threat-risk assessment and asset vulnerabilities in Step 1 into specific event risk prevention and mitigation analysis and solution identification. A bow-tie approach helps identify where and how solutions would have the greatest impact for customers and communities.

Figure B 2 – "Bowtie Method" Risk-Threat Assessment



This is done by implementing solutions to prevent certain events from causing system failures. Preventive solutions are shown on the left side of the bowtie. Mitigation solutions can either reduce the impact of a failure event or facilitate recovery of the failure to reduce the consequences of an event. Mitigation solutions are shown on the right side of the bowtie. Challenges involve identifying the additional risk exposure from a range of threats and the system impacts given the increasing complexity of a more distributed power system along with the potential overlapping set of grid needs identified in the IGP analyses. The Companies

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65 Resilience Working Group Report (PDF): https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/resilience/20200429_rwg_report.pdf

66 See https://view.hawaiianelectric.com/jupiter-intelligence-special-report/page/1

recognize the need to start more simply and evolve sophistication over time as with climate analysis.

The specific prevention and mitigation solutions will be identified through both utility asset options and potential third-party and customer solutions. The utility asset options involve vegetation management, hardening, undergrounding, and increasing switching flexibility, for example. Third-party solutions may involve microgrids, local energy producing resources, and load management. Customer options include back-up generation, storage, and microgrids. The third-party solution opportunities will be incorporated into the IGP sourcing process to streamline and hopefully identify solutions that achieve multiple objectives. The result is a portfolio of solutions to address the various and unique resilience needs of the power system, communities, and individual critical facilities and customers as illustrated in Figure B 3 below.

Figure B 3 – Resilience Solution Portfolio

This portfolio is developed by assessing the utility, third-party, and customer solutions against the respective prevention and mitigation performance requirements identified in Step 1. The resulting solution set will then be prioritized in Step 3.

3. Resilience Solution Prioritization

Resilience solution prioritization involves assessing the comparative customer and community risk reduction value of the solutions related to associated generation, transmission, substation, and distribution infrastructure. The Companies intend to use a risk-spend efficiency (RSE) metric to ascertain the benefit to cost ratio of resilience risk reduction solutions. The benefit is expressed in terms of the magnitude of risk reduction while the costs include solution expenditure. This process begins with assessing solution value in terms of community and customer resilience risk reduction in terms of estimated customer minutes of interruption (CMI) avoided over the planning horizon.

Locational Propensity Factor

The Locational Propensity Factor estimates the potential event risk reduction and the propensity of the event to occur during the planning horizon. Each island and area on each island have different relative levels of exposure to major climate event risk. The Companies' assets have been assessed for the propensity to experience major climate events based on the Jupiter analysis performed in Step 1. While not a predictor of future events, it is nonetheless a useful factor for prioritizing where to focus on certain efforts. The number of events is multiplied by the estimated outage risk reduction per event provided by a solution. The aggregate avoided CMI value is then considered in relation to community impact.

Community & Customer Impact Factor

Resilience events involve long outage durations which can have much larger impacts on Hawaii's national security facilities and communities than short duration outages. As such, assessing the impact on communities involves consideration of national security and community impacts to defense facilities, critical facilities, vulnerable population, and other priorities identified by the RWG stakeholders in Step 1. The RWG identified these priorities in their report and can be applied to assess aggregate community impacts. For example, identifying the defense facilities, critical facilities and number of vulnerable people and assigning weights to reflect the priority of providing electricity to these people and facilities. This would more fully assess the national security, community impacts, and individual population risk reduction from major events.

The resulting weighted community impact number is multiplied by the aggregate CMI value to create a resilience value denoted in avoided CMI.

Other Resilience Values

As in California, the monetary impact of avoided safety-related incidents (e.g., wildfire risk mitigation, wires/poles down) and can be incorporated. Likewise, damage reduction solutions can also be incorporated (e.g., targeted hardening of poles/structures that would be expensive/difficult to replace after an event due to their location, equipment on pole/structure, etc.)

Non-Resilience Values

Additionally, other desirable values provided by a solution will be considered. For example, if a resilience solution also improved the normal, blue-sky capability to integrate DER or enable electrification these values could be assessed within the IGP framework. The California Public Utility Commission provided direction to identify these types of associated benefits when evaluating resilience solutions. This may involve incorporating a second weighting based on the aggregate value from other factors to apply to the resilience value (CMI). This type of multi-factor weighted value analysis is used in several states, including Michigan. The weighted solution values identified are averaged and used to multiply the CMI value to yield a composite value number.

Risk-Spend Efficiency (RSE) Prioritization

The last step is to divide the risk reduction value by the cost of the solution (utility or third-party) to determine the risk-spend efficiency of the solution. This approach is an adaptation of the RSE used more narrowly in California for wildfire mitigation planning. This approach aligns with the RWG's recognition that all relevant impacts need to be captured, which includes the impact of a long duration outage to customers and communities as well as the cost that utilities might incur to mitigate severe outages.

The resulting RSE score is used to rank the solutions with the highest ranked solutions prioritized within budget and other financial considerations. This overall framework prioritizes/ranks solutions in respect to specific needs and within an overall portfolio that also accounts for customer-based solutions. As such, this enables the Companies to determine how many solutions of various types are needed in order achieve resilience goals or objectives as a matter of policy (e.g., total length of outage by critical facility/customer tiers).[67]

[67] RWG Report at 59-60.

EXHIBIT C: PUBLIC MEETING AND VIRTUAL OPEN HOUSE FEEDBACK

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

Public Engagement Summary

Honolulu | Kahului | Hilo | Kona

Spring 2020

Hawaiian Electric

Contents

Integrated Grid Planning Project
Broad Public Engagement Summary

March 2020

In March 2020, Hawaiian Electric launched a broad public engagement program for the Integrated Grid Planning (IGP) Project. A combination of in-person and online engagement provided customers various opportunities to connect with the IGP team.

The goal of these efforts was to proactively engage and communicate with the community/public throughout the development of IGP, including:

- Educating the public about IGP and why it is important
- Providing an update on the status/progress of IGP's development process
- Sharing progress, insights and next steps for each Working Group
- Building relationships with the community/customers
- Gathering input/comments

In-person Public Meetings

Hawaiian Electric held four in-person public meetings throughout its service territory that focused on IGP. The meetings consisted of open house stations from 5-6 p.m. followed by a panel discussion from 6-7:30 p.m.

TUESDAY Mar 03
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

TUESDAY Mar 10
Hawaii Pacific University
(Multi-Purpose Room 3)
1 Aloha Tower Drive
Honolulu, O'ahu 96813

THURSDAY Mar 05
Hilo High School (Cafeteria)
556 Waiānuenue Avenue
Hilo, Hawai'i 96720

THURSDAY Mar 12
Hawaiian Electric (Kahului Auditorium)
210 W. Kamehameha Avenue
Kahului, Maui 96732

1) Stations

The public meetings featured several stations staffed by Hawaiian Electric representatives designed to provide information and answer questions on various aspects of IGP and other Company initiatives, including:

2) Outreach

Hawaiian Electric used an array of tools and tactics to invite the community/public to the meetings.

a. Flyer

Public meeting flyers were developed and provided to Hawaiian Electric communications teams for distribution and posting. For a copy of the meeting flyers, see **Appendix A**.

b. Emails

An email invite with the flyer attached (by island) was sent to approximately 300 stakeholders between February 17 – 28, inviting them to the public meetings and announcing the online open house. For a copy of the email invite, see **Appendix A**.

c. Website

A new sub-page on the Integrated Grid Planning website (**hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning**) was developed for the broad public engagement. This page provided information on engagement opportunities including time, date, and location of each in-person meeting as well as a link to the virtual open house and community meeting materials. The webpage was updated regularly to provide timely information on the progress of IGP-related activities and on an as-needed basis with information related to promotional and engagement activities.

d. Media

Paid advertisements were placed in four print media outlets with distribution in the project area announcing the public meetings; radio ads also ran on Maui. The paid print advertisement ran for four consecutive weeks prior to the meetings. In addition, a news release was sent to area media outlets on February 21 and 24. The paid advertisement and news release are available in **Appendix B**.

e. Social Media

To further promote the meetings and engage the community/public, Facebook and Twitter were used to promote the meetings and garner input.

Facebook Live

27 people tuned into the Facebook Live on March 2, 2020 to hear about IGP, view meeting materials and hear about the upcoming engagement opportunities. The live streaming received 1,100+ views with an estimated reach of 6,624 consisting of 1,351 unique viewers and receiving 31 post engagement (reactions, comments, and shares).

Facebook Events

Individual Facebook event posts were set up two weeks prior to each in-person meeting and concluded on the day of each meeting in order to boost and target each event. Facebook event post analytics are displayed in **Table 1**.

Top Statistics

- Hilo's event post had the highest rate of RSVP's at 135
- Hilo's event post had the most engagement in clicks, comments, reactions and shares
- Oahu's after-event post had the highest reach at 70,203

Table 1: Facebook Event Posts

	Kona (2/19 - 3/3)	Hilo (2/21 - 3/5)	Honolulu (2/25 - 3/10)	Maui (2/26 - 3/10)
Spend	$270.00	$200.00	$200.00	$177.20
Event RSVP's	68	135	108	100
Cost per RSVP	$3.97	$1.48	$1.64	$2.00
Reach	8,282	7,748	9,738	7,104
Impressions	23,983	23,630	23,241	22,387
Frequency	2.9	3.05	2.39	3.15
Link Clicks	112	182	151	131

Click-Through-Rate (CTR)	0.46%	0.77%	0.65%	0.58%
Comments	9	9	3	4
Reactions	71	109	100	97
Shares	10	29	14	14

Facebook and Twitter ads were also posted on the day of the meetings as well as after the meetings to encourage the community/public to participate and comment via the online open house. Facebook and Twitter day of and after event post analytics are displayed in **Table 2** through **Table 5**.

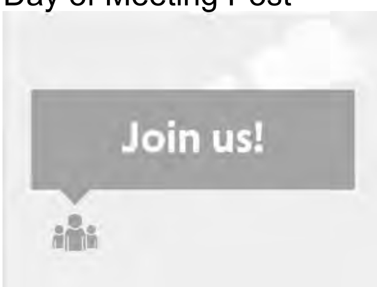
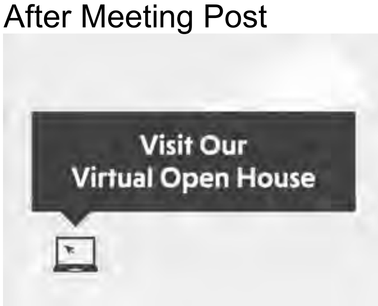
	Facebook	Twitter
Day of Meeting Post 	Join Us! We're at the [location] today hosting an open house and panel discussion on getting to 100% Renewables. Stop by, learn and provide input on Integrated Grid Planning. Learn more [website link].	Join us! We're at the [location] today talking about getting to 100% Renewables. Stop by, learn & provide input on Integrated Grid Planning. Learn more [website link].
After Meeting Post 	Missed the Getting to 100% Renewables open house yesterday? Visit Hawaiian Electric's online virtual open house [link] today to review the information presented and provide input through survey questions and a comment form. We want to hear from you!	Missed the Getting to 100% Renewables open house yesterday? Visit our online virtual open house [link] to review information and provide input. We want to hear from you!

Table 2: Facebook Day Of Posts

	Kona (March 3)	Hilo (March 5)	Honolulu (March 10)	Maui (March 12)
Spend	$75.00	$75.00	$75.00	
Reach	13,542	3,916	6,491	
Event RSVPs	-	18	15	

Cost Per 1,000 People Reached / RSVP	$5.55	$4.14	$5.00	
Impressions	14,119	5,257	7,982	
Frequency	1.04	1.34	1.23	
Link Clicks	19	30	33	
CTR	0.13%	0.57%	0.41%	
Comments	0	2	1	
Reactions	4	27	43	
Shares	3	4	6	

Table 3: Twitter Day Of Posts

	Kona (March 3)	Hilo (March 5)	Honolulu (March 10)	Maui (March 12)
Spend	$25.00	$25.00		
Clicks	13	18		
Cost Per Click	$1.92	$1.39		
Impressions	1,257	898		
Link Clicks	13	18		
CTR	1.03%	2.00%		
Comments	0	0		
Reactions	0	0		
Shares	0	0		

Table 4: Facebook After Event Posts

	Kona (March 3)	Hilo (March 5)	Honolulu (March 10)	Maui (March 12)
Spend	$100.00	$60.00	$100.00	$100.00
Reach	23,368	26,092	70,203	44,257

Cost Per 1,000 People Reached	$4.28	$2.28	$1.42	$2.26
Impressions	24,412	26,172	70,203	45,017
Frequency	1.05	1.003	1.00	1.02
Link Clicks	37	59	234	91
CTR	0.15%	0.22%	0.33%	0.20%
Comments	1	2	0	0
Reactions	3	0	0	7
Shares	0	0	0	1

Table 5: Twitter After Event Posts

	Kona (March 3)	Hilo (March 5)	Honolulu (March 10)	Maui (March 12)
Spend	$100.00	$100.00	$100.00	$100.00
Clicks	128	85	261	249
Cost Per Click	$0.78	$1.17	$0.38	$0.40
Impressions	3,998	3,059	11,331	6,427
Link Clicks	128	85	261	249
CTR	3.20%	2.78%	2.30%	3.87%
Comments	1	0	0	0
Reactions	0	0	0	0
Shares	0	0	0	0

Notes for Future Engagement

Some of the day-of campaigns failed to drive impressions on both Facebook and Twitter, which may be due to Facebook's ad review time, too concise targeting, or setup issues. Therefore, the Maui day-of Facebook post,as well as the Honolulu and Maui day-of Twitter posts did not go live. Because of the granularity of flight time (duration of ads), targeting and budget, it may be best to pivot away from single day messaging in the future or perhaps do a quick swap out of creative for the active campaigns on the day of events. Comments were limited across all posts. See **Appendix B** for copies of the social media posts**.**

f. Stakeholder Council Digital Toolkit

With input from the Stakeholder Council, a digital toolkit was created and provided to the Stakeholder Council two weeks prior to the broad public engagement to allow them to download and use as a resource, including a PowerPoint with talking points, meeting flyer and overview handout. A key responsibility of the Stakeholder Council is to be a liaison to their community and organizations to share information and collect feedback. For a copy of the digital toolkit, see **Appendix C**.

3) Open House Overview

A total of 162 people attended the series of four public meetings. **Table 6** provides a breakout of attendance by meeting day along with how attendees heard about the meeting (not everyone answered and some selected more than one option). For a copy of the sign-in sheets, see **Appendix D**.

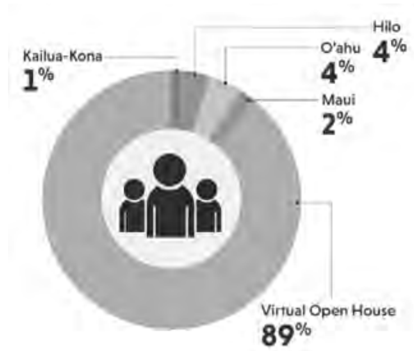


Table 6: Open House Attendance and Meeting Awareness

Date	Attendees	Facebook	News	Word of Mouth	Other
March 3, 2020 (Kona)	17	4	4	3	3
March 5, 2020 (Hilo)	52	21	6	11	15
March 10, 2020 (Honolulu)	61	10	5	17	30
March 12, 2020 (Maui)	32	4	1	10	14
Total	**162**	**39**	**16**	**41**	**62**

4) Meeting Materials

The following meeting materials can be found in **Appendix E**.

- Sign-In Sheets
- Overview Handout
- Question Card
- Comment/Survey Form
- Working Group Overview
- EV Handouts
- Display Boards
    - o Integrated Grid Planning (1)
    - o Grid Modernization (2)
    - o Renewable Energy – Grid Scale (2)

- Renewable Energy – Roof Top (2)
- Renewable Energy – Community-Based (1)
- Electrification of Transportation (2)
- Resilience (1)
- Careers at Hawaiian Electric (2)
- Engagement (1)
- Survey Input Boards (4)

5) Meeting Comments

During sign-in and throughout the meetings, attendees were given an opportunity to submit their comments via comment/survey forms, which could be turned in to the comment box during the meetings or brought home to mail, fax or email later. Those attending the virtual online meetings also had an opportunity to answer survey questions at the click of their mouse. **Table 7** identifies the total number of comment/survey forms collected during the in-person public meetings and **Table 8** identifies the total number of comments received via the virtual online meeting. For a copy of the submitted comments/surveys, see **Appendix F**.

Table 7: Comment/Survey Forms

Date	Comment/ Survey Forms
March 3, 2020 (Kona)	5
March 5, 2020 (Hilo)	7
March 10, 2020 (Honolulu)	1
March 12, 2020 (Maui)	2
Total	**15**

Table 8: Virtual Open House Surveys/Comments

Survey Type	Quantity
General (2 questions)	49
IGP Overview (7 questions)	33
Public Engagement (8 questions)	24
Open-Ended Comments	5
Total	**111**

a. Key Themes - Survey Boards

In addition to the comment/survey forms collected, attendees had an opportunity to answer survey boards using sticker dots. **Table 9** summarizes the survey board comments.

Table 9: Survey Boards Comments Summary

Question	Response
Rank the following in order of importance.	**Most Important** 1. Energy reliability 2. Helping to increase the use of renewable energy **Least Important** 3. Adopting new technologies to provide customers with more information and control of their energy usage 4. Lowering energy costs 5. Reducing greenhouse gases
How interested are you in doing the following?	**Already Have/Do** 1. Installing rooftop solar 2. Buying an electric vehicle **Not Interested** 3. Installing a grid interactive water heater 4. Using transit or carpooling regularly (most trips)
What change at your home or business do you plan to make to help Hawai`i get to 100% renewables?	**Top 3 Responses** 1. Rooftop solar 2. Electric vehicles 3. Energy-saving appliances
What type of help would you need to make renewable or energy efficient upgrades to your home or business?	**Top 5 Responses** 1. Community-based solar 2. Recommendations for PV contractors 3. Cost benefit analysis 4. Financial incentives & tax rebates 5. Advocate for legislation and permitting to more easily obtain PV & storage

b. Key Themes - Survey Responses

Table 10 summarizes the survey responses.

Table 10: Survey Responses Summary

How did you hear about this meeting?	1. Word of Mouth 2. Social Media 3. Email 4. News 5. Radio

In the future, what type of Integrated Grid Planning information would you be most interested in receiving?	**Top 5 Responses** 1. Electrification of transportation 2. Rooftop and community solar renewables 3. General 4. Grid modernization 5. Advanced meters
What would be your preferred method to receive future information on IGP?	1. Email 2. Social Media 3. IGP Website 4. Mail 5. Newspaper 6. Radio

Overall responses to "additional thoughts" were very positive on the Public Meeting format. There were a few responses that need personal attention, but does not affect the population as a whole. Examples of some of the responses were:

- Keep up the good work! Very informational presentation!
- Interest in programs to support community power generation;
- Meetings are important to our rural neighbor island communities; appreciate that community members are included; thorough team coverage; lots of information; food and professional facilitation certainly a plus;
- It's all new concept – the panelist gave a balanced perspective on IGP!
- Love this virtual open house!

c. Additional Comments

No comments were submitted to the IGP email.

6) Panel Discussion

The public meetings also included a panel discussion with local representatives from various organizations sharing different perspectives on getting to 100% renewables. Attendees had the opportunity to submit or ask questions of the panelists during the facilitated Q&A session. A total of 127 questions were submitted collectively as shown in **Table 11** below. See **Appendix F** for a matrix of the panelist questions.

Table 11: Panelist Questions

Date	Question Cards
Kona/Hilo	41
Honolulu	55

Maui	31
Total	**127**

Kona and Hilo

- Blue Zones Hawaii | Carol Ignacio, Community Program Manager
- County of Hawai'i | Riley Saito, Deputy Director, Research & Development
- Geometrician Associates | Ron Terry, Principal
- Hawaiian Electric | Colton Ching, Senior Vice President, Planning & Technology
- Hawaiian Electric | Kevin Waltjen, Director, Hawai'i Island
- Hawaiian Electric | Lisa Dangelmaier, Director, System Operations, Hawai'i & Maui

Honolulu

- Community | Cynthia Rezentes, Nanakuli Neighborhood Board Chair
- City & County of Honolulu | Josh Stanbro, Chief Resilience Officer & Executive Director, Office of Climate Change, Sustainability & Resiliency
- Hawai'i Farm Bureau | Brian Miyamoto, Executive Director
- Hawaiian Electric | Colton Ching, Sr. Vice President, Planning & Technology
- O'ahu Economic Development Board | Pono Shim, President & CEO
- Ulupono Initiative | Murray Clay, President

Maui

- Alliance for Maui Community Associations | Dick Mayer, Coordinator
- County of Maui | Michele McLean, Director, Department of Planning
- Hawaiian Electric | Colton Ching, Sr. Vice President, Planning & Technology
- Hawaiian Electric | Rebecca Dayhuff Matsushima, Director, Renewable Acquisitions
- Waiwai Ola Waterkeepers Hawaiian Islands | Rhiannon Chandler-'Iao, Executive Director

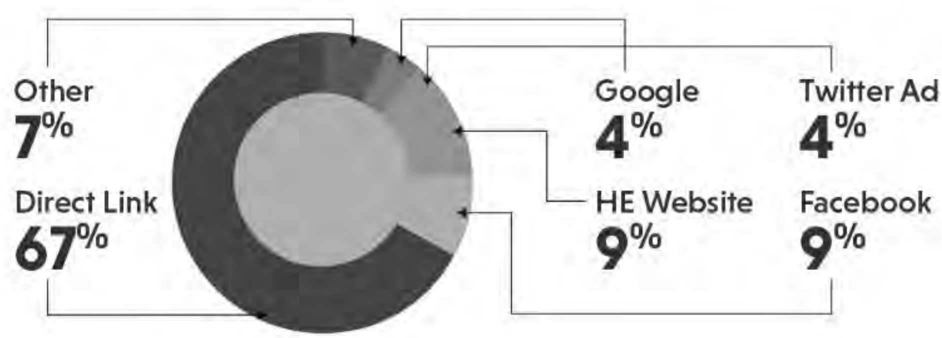
Following are links to the panel discussion videos that were posted to Hawaiian Electric's YouTube page and linked on the IGP website:

- Oahu: https://youtu.be/ZtrPrFOre50
- Maui: https://youtu.be/244Qex3LRWg
- Hilo: https://youtu.be/MioInqQOcNo

Virtual Open House

In addition to the four in-person public meetings, a virtual open house was available online for those who were unable to attend the in-person meetings. The virtual meeting was available from March 2 to March 31, 2020 (extended past March 20 through the end of the month) at hawaiianelectric.com/igp and allowed customers/public to review materials available at the open house, provide survey input, watch a recording of the panel discussion and leave comments for Hawaiian Electric to review and consider—all while using their computer or personal device and at their own pace.

The virtual meeting received 1,260 unique visitors from 31 different sources, with the top six sources collectively shown below.



Appendix G includes screen shots of the online open house and complete analytics.

Appendices

Appendix A: Meeting Invite

Appendix B: Media/Social Media

Appendix C: Stakeholder Council Digital Toolkit

Appendix D: Sign-In Sheets

Appendix E: Meeting Materials

Appendix F: Meeting Comments

Appendix G: Virtual Open House

P.O. Box 2750
Honolulu, Hawaii 96840
igp@hawaiianelectric.com

Appendix A
Meeting Invite

Hawaiian Electric

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

Getting to 100% Renewables

Join Us At Our Public Meetings

See back for details.

5:00 pm–7:30 pm

Learn how we use **Integrated Grid Planning** (IGP) to plan for our renewable future together.

CAN'T JOIN US?

Visit our Online Open House available March 2–20, 2020
www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning

Public Meeting Agenda

PART 1 **Open House**
5:00 pm-6:00 pm

PART 2 **Panel Discussion**
6:00 pm-7:30 pm

Dates & Locations

TUESDAY **Mar 03**
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, HI 96740

THURSDAY **Mar 05**
Hilo High School (Cafeteria)
556 Waianuenue Avenue
Hilo, HI 96720

TUESDAY **Mar 10**
Hawaii Pacific University
(Multi-Purpose Room 2)
1 Aloha Tower Drive
Honolulu, HI 96813

THURSDAY **Mar 12**
Maui Electric (Auditorium)
210 W Kamehameha Avenue
Kahului, Maui 96732

- Pupus will be provided
- Free parking with validation

Email: **IGP@hawaiianelectric.com**
Website: **www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning**

facebook.com/HawaiianElectric
twitter.com/hwnelectric
instagram.com/hawaiianelectric

Getting to 100% Renewables

Join Us At Our Public Meetings

5 – 7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

Agenda

PART 1 Open House
5 – 6 pm

PART 2 Panel Discussion
6 – 7:30 pm

Dates & Locations

TUESDAY Mar 03
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

TUESDAY Mar 10
Hawaii Pacific University*
(Multi-Purpose Room 3)
1 Aloha Tower Drive
Honolulu, O'ahu 96813
**Free parking with validation*

THURSDAY Mar 05
Hilo High School (Cafeteria)
556 Waiānuenue Avenue
Hilo, Hawai'i 96720

THURSDAY Mar 12
Hawaiian Electric (Kahului Auditorium)
210 W. Kamehameha Avenue
Kahului, Maui 96732

- Pupus will be provided
- Check out our careers station

VIRTUAL OPEN HOUSE

Can't join us? Then visit our Virtual Open House between **March 2–20, 2020 at www.hawaiianelectric.com/igp**

WE WANT **TO HEAR** FROM YOU

We welcome your input! Here are the many ways to stay connected with us.

Email:
IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Hawaiʻi's Renewable Energy Future Series

Getting to 100% Renewables

Join Us At Our Community Meeting
5–7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

TUESDAY Mar 03
Kealakehe High School *(Cafeteria)*
74-5000 Puohulihuli Street
Kailua-Kona, Hawaiʻi 96740

THURSDAY Mar 05
Hilo High School *(Cafeteria)*
556 Waiānuenue Avenue
Hilo, Hawaiʻi 96720

Pupus will be provided at both community meetings

PART 1 Open House Stations
5–6 pm

Eight (8) informational stations to browse and ask questions:

1. Integrated Grid Planning (IGP)
2. Grid Modernization
3. Grid Scale Renewables
4. Rooftop Renewable Energy
5. Community-Based Renewable Energy
6. Resilience
7. Electrification of Transportation
8. Careers at Hawaiian Electric

PART 2 Panel Discussion
6–7:30 pm

Panel Participants

- **Hawaiian Electric** | Colton Ching, Sr. Vice President, Planning and Technology
- **Hawaiian Electric** | Kevin Waltjen, Director, Hawaiʻi Island
- **Hawaiian Electric** | Lisa Dangelmaier, Director, System Operations, Hawaiʻi and Maui
- **County of Hawaiʻi** | Riley Saito, Deputy Director, Research and Development
- **Geometrician Associates** | Ron Terry, Principal
- **Community** | Carol Ignacio

VIRTUAL OPEN HOUSE

Can't join us? Check out our Virtual Open House between **March 2–20, 2020 at www.hawaiianelectric.com/igp**

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IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Getting to 100% Renewables

Join Us At Our Public Meetings

5 – 7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

TUESDAY **Mar 10**

Hawaii Pacific University* *(Multi-Purpose Room 3)*
1 Aloha Tower Drive, Honolulu, Oʻahu 96813
**Free parking with validation*
Pupus will be provided

PART 1 Open House Stations
5 – 6 pm

Eight (8) informational stations to browse and ask questions:

1. Integrated Grid Planning (IGP)
2. Grid Modernization
3. Grid Scale Renewables
4. Rooftop Renewable Energy
5. Community-Based Renewable Energy
6. Resilience
7. Electrification of Transportation
8. Careers at Hawaiian Electric

PART 2 Panel Discussion
6 – 7:30 pm

Panel Participants

- **Community | Cynthia Rezentes,** Nanakuli Neighborhood Board Chair
- **Ulupono Initiative** | Murray Clay, President
- **Oʻahu Economic Development Board** | Pono Shim, President & CEO
- **City & County of Honolulu** | Josh Stanbro, Chief Resilience Officer & Executive Director, Office of Climate Change, Sustainability & Resiliency
- **Hawaiʻi Farm Bureau** | Brian Miyamoto, Executive Director
- **Hawaiian Electric** | Colton Ching, Sr. Vice President, Planning and Technology

VIRTUAL OPEN HOUSE

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WE WANT **TO HEAR** FROM YOU

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IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Maui's Renewable Energy Future Series

Getting to 100% Renewables

Join Us At Our Community Meeting

5–7:30 pm

>>> Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

THURSDAY **Mar 12**

Hawaiian Electric *(Kahului Auditorium)*
210 W. Kamehameha Avenue
Light refreshments will be provided

PART 1 Open House Stations
5–6 pm

Eight (8) informational stations to browse and ask questions:

1. Integrated Grid Planning (IGP)
2. Grid Modernization
3. Grid Scale Renewables
4. Rooftop Renewable Energy
5. Community-Based Renewable Energy
6. Resilience
7. Electrification of Transportation
8. Careers at Hawaiian Electric

PART 2 Panel Discussion
6–7:30 pm

Panel Participants

- **Rhiannon Chandler-ʻIao**, Executive Director, Waiwai Ola Waterkeepers Hawaiian Islands
- **Colton Ching**, Senior Vice President, Planning and Technology, Hawaiian Electric
- **Rebecca Dayhuff Matsushima**, Director, Renewable Acquisitions, Hawaiian Electric
- **Dick Mayer**, Coordinator, Alliance for Maui Community Associations
- **Michele McLean**, Director, Department of Planning, County of Maui

VIRTUAL OPEN HOUSE

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Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Appendix B
Media/Social Media

Hawaiʻi's Renewable Energy Future Series
Getting to 100% Renewables

Join Us At Our Community Meeting
5 –7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

TUESDAY **Mar 03**
Kealakehe High School *(Cafeteria)*
74-5000 Puohulihuli Street
Kailua-Kona, Hawaiʻi 96740

THURSDAY **Mar 05**
Hilo High School *(Cafeteria)*
556 Waiānuenue Avenue
Hilo, Hawaiʻi 96720

Pupus will be provided at both community meetings

PART 1

Open House Stations | 5 – 6 pm

- 8 Informational Stations to browse and ask questions

PART 2

Panel Discussion | 6 – 7:30 pm

- **Hawaiian Electric** | Colton Ching, Sr. V.P., Planning & Technology
- **Hawaiian Electric** | Kevin Waltjen, Director, Hawaiʻi Island
- **Hawaiian Electric** | Lisa Dangelmaier, Director, System Operations, Hawaiʻi and Maui
- **County of Hawaiʻi** | Riley Saito, Deputy Director, Research & Development
- **Geometrician Associates** | Ron Terry, Principal
- **Community** | Carol Ignacio

VIRTUAL OPEN HOUSE

Can't join us? Check out our Virtual Open House between March 2–20, 2020 at www.hawaiianelectric.com/igp

WE WANT **TO HEAR** FROM YOU
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IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Hawai‘i's Renewable Energy Future Series

Getting to 100% Renewables

Join Us At Our Community Meeting
5 –7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

TUESDAY **Mar 10**

Hawaii Pacific University
(Multi-Purpose Room 3)
1 Aloha Tower Drive
Honolulu 96813

- *Free parking with validation*
- *Pupus will be provided*

PART 1 **Open House Stations** | 5 – 6 pm

- 8 Informational Stations to browse and ask questions

PART 2 **Panel Discussion** | 6 – 7:30 pm

- **Community** | Cynthia Rezentes, Nanakuli Neighborhood Board Chair
- **Ulupono Initiative** | Murray Clay, President
- **O‘ahu Economic Development Board** | Pono Shim, President & CEO
- **City & County of Honolulu** | Josh Stanbro, Chief Resilience Officer & Executive Director, Office of Climate Change, Sustainability & Resiliency
- **Hawai‘i Farm Bureau** | Brian Miyamoto, Executive Director
- **Hawaiian Electric** | Colton Ching, Sr. Vice President, Planning and Technology

VIRTUAL OPEN HOUSE

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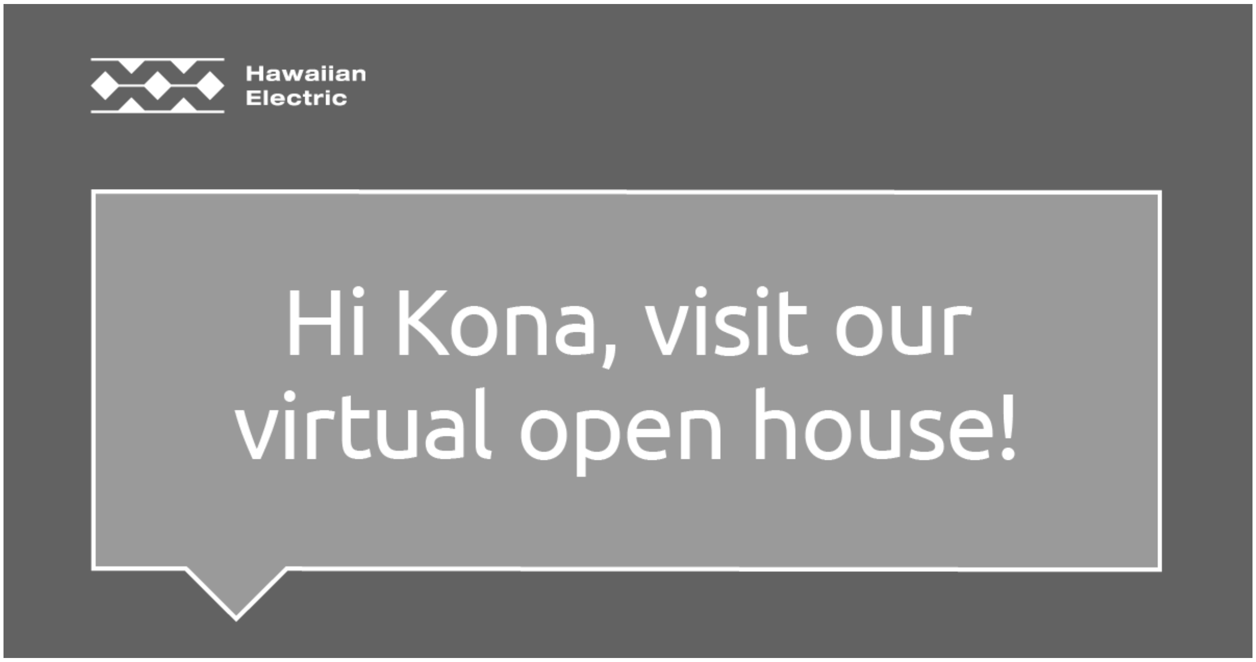
Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Event Post (February 19 to March 3, 2020)

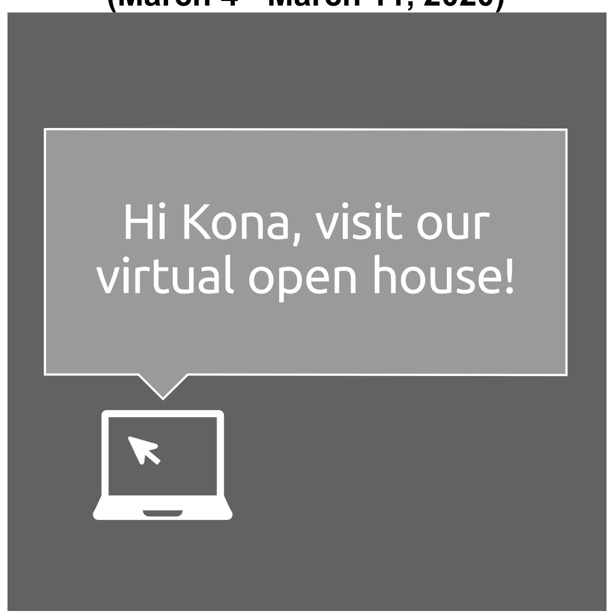
Facebook Day of Post (March 3, 2020)

Facebook After Event Post (March 4 to March 11, 2020)



Twitter Day of Post (March 3, 2020)

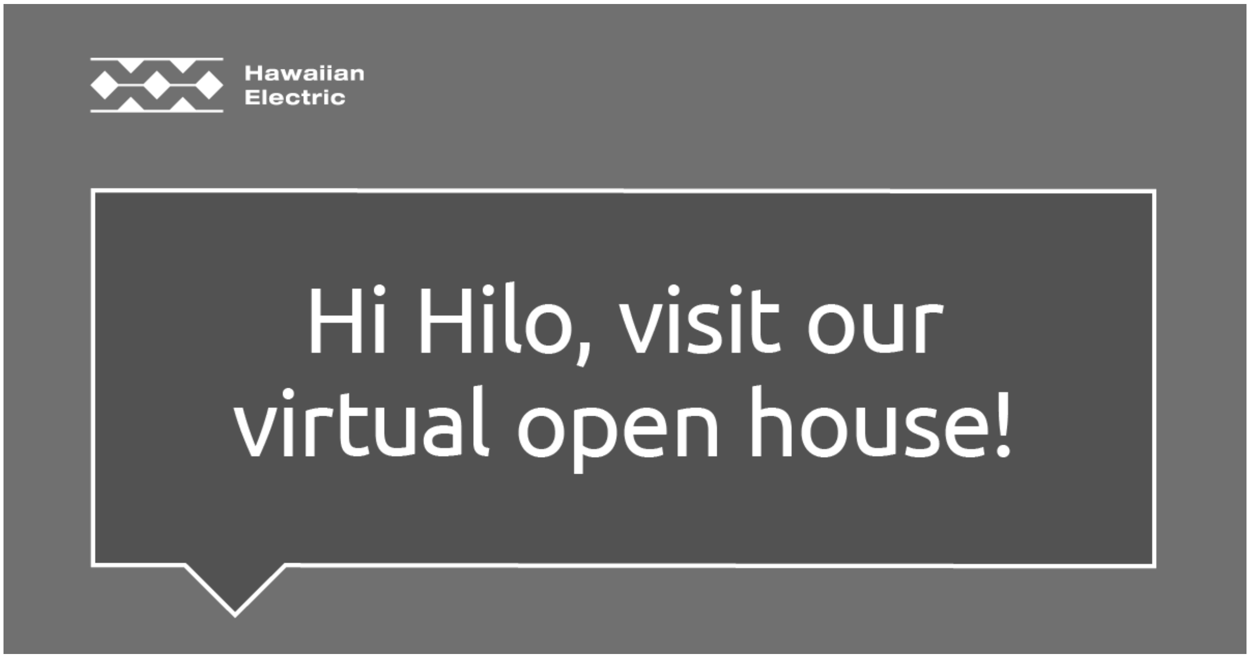
Twitter After Event Post (March 4 - March 11, 2020)



Event Post (February 21 to March 5, 2020)

Facebook Day of Post (March 5, 2020)

Facebook After Event Post (March 6 to March 19, 2020)



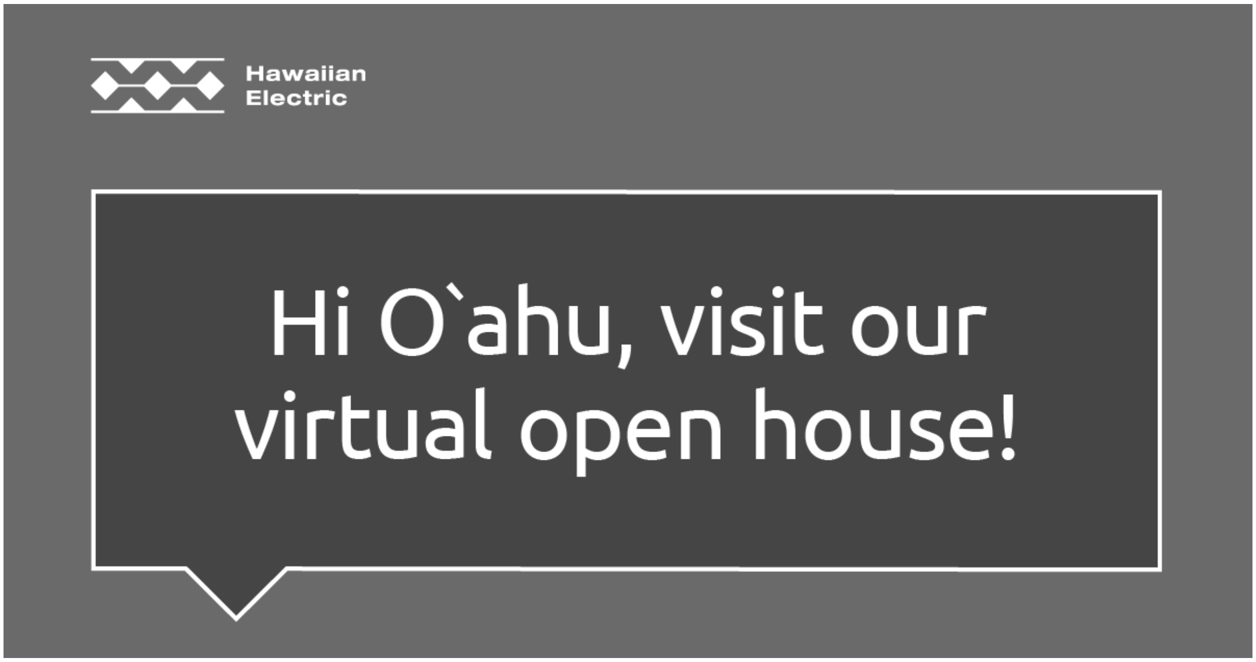
Twitter Day of Post
(March 5, 2020)

Twitter After Event Post
(March 6 - March 19, 2020)

Event Post (February 25 to March 10, 2020)

Facebook Day of Post (March 10, 2020)

Facebook After Event Post (March 11 to March 19, 2020)



Twitter Day of Post
(this post did not go live)

Twitter After Event Post
(March 11 - March 19, 2020)

Event Post (February 26 to March 10, 2020)

Facebook Day of Post ***(this post did not go live)***

Facebook After Event Post (March 13 to March 19, 2020)

Twitter Day of Post
(this post did not go live)

Twitter After Event Post
(March 12 - March 19, 2020)

Appendix C
Stakeholder Council Digital Toolkit

Getting to 100% Renewables

Join Us At Our Public Meetings

5 – 7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

Agenda

PART 1 Open House 5 – 6 pm

PART 2 Panel Discussion 6 – 7:30 pm

Dates & Locations

TUESDAY Mar 03
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

TUESDAY Mar 10
Hawaii Pacific University*
(Multi-Purpose Room 3)
1 Aloha Tower Drive
Honolulu, O'ahu 96813
*Free parking with validation

THURSDAY Mar 05
Hilo High School (Cafeteria)
556 Waiānuenue Avenue
Hilo, Hawai'i 96720

THURSDAY Mar 12
Hawaiian Electric (Kahului Auditorium)
210 W. Kamehameha Avenue
Kahului, Maui 96732

- Pupus will be provided
- Check out our careers station

VIRTUAL OPEN HOUSE

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Website:
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Hawaiian Electric

Hawai'i's Renewable Energy Future Series

Getting to 100% Renewables

Join Us At Our Community Meeting
5–7:30 pm

>>> Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

TUESDAY Mar 03 — **Kealakehe High School** *(Cafeteria)*
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

THURSDAY Mar 05 — **Hilo High School** *(Cafeteria)*
556 Waiānuenue Avenue
Hilo, Hawai'i 96720

Pupus will be provided at both community meetings

PART 1 Open House Stations
5–6 pm

Eight (8) informational stations to browse and ask questions:

1. Integrated Grid Planning (IGP)
2. Grid Modernization
3. Grid Scale Renewables
4. Rooftop Renewable Energy
5. Community-Based Renewable Energy
6. Resilience
7. Electrification of Transportation
8. Careers at Hawaiian Electric

PART 2 Panel Discussion
6–7:30 pm

Panel Participants

- **Hawaiian Electric** | Colton Ching, Sr. Vice President, Planning and Technology
- **Hawaiian Electric** | Kevin Waltjen, Director, Hawai'i Island
- **Hawaiian Electric** | Lisa Dangelmaier, Director, System Operations, Hawai'i and Maui
- **County of Hawai'i** | Riley Saito, Deputy Director, Research and Development
- **Geometrician Associates** | Ron Terry, Principal
- **Community** | Carol Ignacio

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Hawaiian Electric

Getting to 100% Renewables

Join Us At Our Public Meetings

5–7:30 pm

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

TUESDAY **Mar 10**

Hawaii Pacific University* *(Multi-Purpose Room 3)*
1 Aloha Tower Drive, Honolulu, Oʻahu 96813
**Free parking with validation*
Pupus will be provided

PART 1 Open House Stations
5–6 pm

Eight (8) informational stations to browse and ask questions:

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7. Electrification of Transportation
8. Careers at Hawaiian Electric

PART 2 Panel Discussion
6–7:30 pm

Panel Participants

- **Community | Cynthia Rezentes,** Nanakuli Neighborhood Board Chair
- **Ulupono Initiative** | Murray Clay, President
- **Oʻahu Economic Development Board** | Pono Shim, President & CEO
- **City & County of Honolulu** | Josh Stanbro, Chief Resilience Officer & Executive Director, Office of Climate Change, Sustainability & Resiliency
- **Hawaiʻi Farm Bureau** | Brian Miyamoto, Executive Director
- **Hawaiian Electric** | Colton Ching, Sr. Vice President, Planning and Technology

VIRTUAL OPEN HOUSE

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WE WANT **TO HEAR** FROM YOU

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IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

Hawaiian Electric

Maui's Renewable Energy Future Series
Getting to 100% Renewables

Join Us At Our Community Meeting
5–7:30 pm

>>> Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

THURSDAY **Mar 12**

Hawaiian Electric *(Kahului Auditorium)*
210 W. Kamehameha Avenue
Light refreshments will be provided

PART 1 Open House Stations
5–6 pm

Eight (8) informational stations to browse and ask questions:

1. Integrated Grid Planning (IGP)
2. Grid Modernization
3. Grid Scale Renewables
4. Rooftop Renewable Energy
5. Community-Based Renewable Energy
6. Resilience
7. Electrification of Transportation
8. Careers at Hawaiian Electric

PART 2 Panel Discussion
6–7:30 pm

Panel Participants

- **Rhiannon Chandler-'Iao**, Executive Director, Waiwai Ola Waterkeepers Hawaiian Islands
- **Colton Ching**, Senior Vice President, Planning and Technology, Hawaiian Electric
- **Rebecca Dayhuff Matsushima**, Director, Renewable Acquisitions, Hawaiian Electric
- **Dick Mayer**, Coordinator, Alliance for Maui Community Associations
- **Michele McLean**, Director, Department of Planning, County of Maui

VIRTUAL OPEN HOUSE

Can't join us? Check out our Virtual Open House between **March 2–20, 2020 at www.hawaiianelectric.com/igp**

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Hawaiian Electric

Customer Priorities

We're Listening

In response to engagement, surveys, and focus groups, we were told affordability, reliability, and energy choices are most important to customers.

Affordability
Lower energy bills

Reliability
Fewer outages

Energy Choices
More control over energy generation and use

Is this true for you?

Let us know if you have different opinions. We're using this information to help make smart future energy decisions for customers.

5 Ways Customers Can Help Hawai'i Reach 100% Renewables

1. Reduce energy use at home and work
2. Upgrade to energy smart appliances
3. Upgrade to an advanced meter
4. Buy an electric vehicle
5. Participate in customer energy options

Visit **hawaiianelectric.com/products-and-services/** to learn more ways you can help

WE WANT **TO HEAR** FROM YOU

We welcome your input! Here are the many ways to stay connected with us.

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IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

HawaiianElectric
hwnelectric
hawaiianelectric

Hawaiian Electric

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

What is IGP?

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

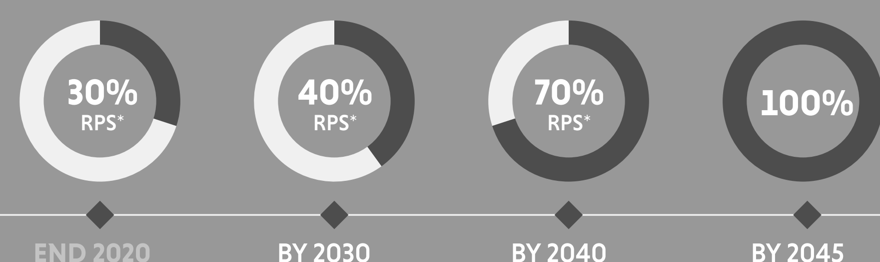
Our Energy Future

Achieve Energy Independence
Reduce oil dependency and volatile fuel costs by increasing renewables

Climate Change Considerations
Add more renewables to reduce greenhouse gas emissions and build a resilient grid

Modernize Our Island Grids
Integrate new technologies to facilitate 100% renewable energy

Our Goal for the Future:
100% Renewables by 2045



*RPS = Renewable Portfolio Standard

How Does This Benefit Our Customers?

- More options to control and lower bills
- Time-of-Use rates to save money and lower fuel and maintenance costs
- Financial incentives for purchasing an electric vehicle
- Benefits of solar energy by offsetting bills without installing PV panels on their property
- Integrate higher levels of renewables into the modern grid
- Faster power outage restoration with greater convenience
- Improved efficiencies and integration of renewables

What Do We Need to Consider?

Integrated Grid Planning looks into the best technology options for all aspects of our energy system and identifies energy needs and behaviors of future customers taking into consideration key factors.

- **Future customer needs**
- **Community impact**
- **Cost to design and build large projects**
- **Future resource costs**
- **New technologies**
- **Number of electric vehicles**
- **New businesses and industries**
- **Number of residents installing rooftop solar**
- **Preparing for extreme events**

Participating in the Process

As part of the IGP process, we are collecting your input and considering all our options in planning for our renewable future. Here are the participants Hawaiian Electric is collaborating with:

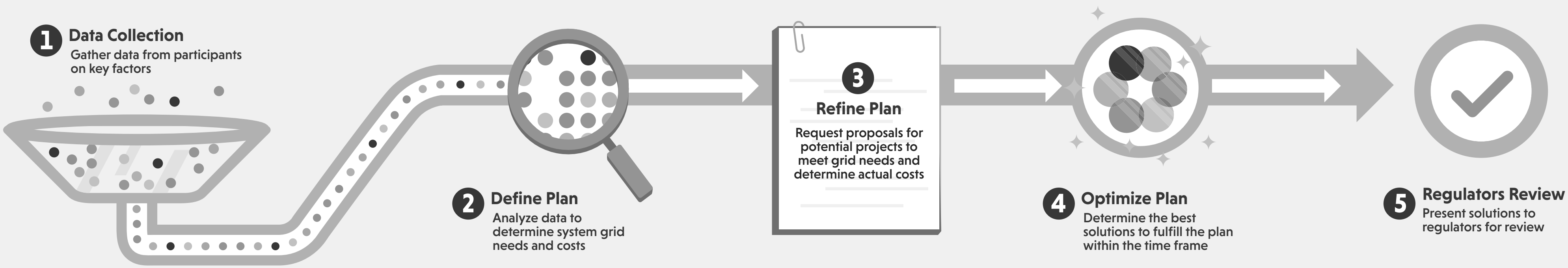
Working Groups
Address specific topics in an advisory capacity and not as a decision-making group

Stakeholder Council
Represents customers and broad stakeholders to review work and provide guidance and insights

The Public
Communication with customers

Technical Advisory Panel
Provides independent evaluation and feedback on the working group activities and review point filings

How Do We Get There? Integrated Grid Planning



Hawaiian Electric

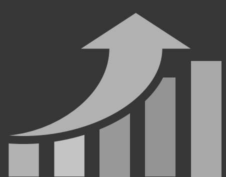
Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

What is IGP?

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

Our Energy Future



Achieve Energy Independence

Reduce oil dependency and volatile fuel costs by increasing renewables

Climate Change Considerations

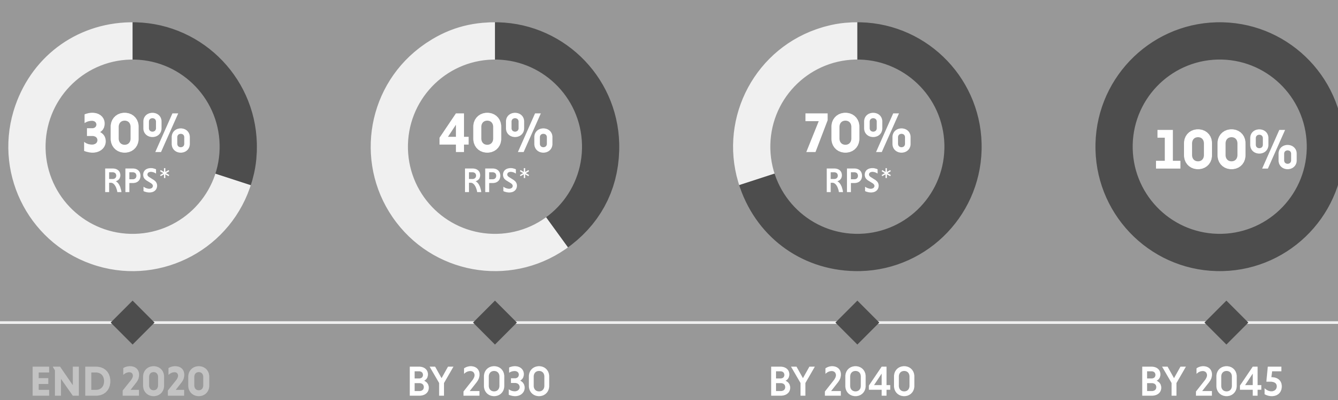
Add more renewables to reduce greenhouse gas emissions and build a resilient grid

Modernize Our Island Grids

Integrate new technologies to facilitate 100% renewable energy

Our Goal for the Future:

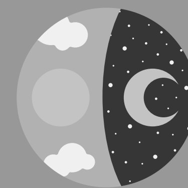
100% Renewables by 2045



*RPS = Renewable Portfolio Standard

How Does This Benefit Our Customers?

More options to control and lower bills



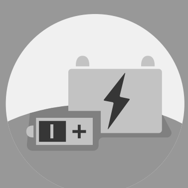
Time-of-Use rates to save money and lower fuel and maintenance costs

Financial incentives for purchasing an electric vehicle

Benefits of solar energy by offsetting bills without installing PV panels on their property

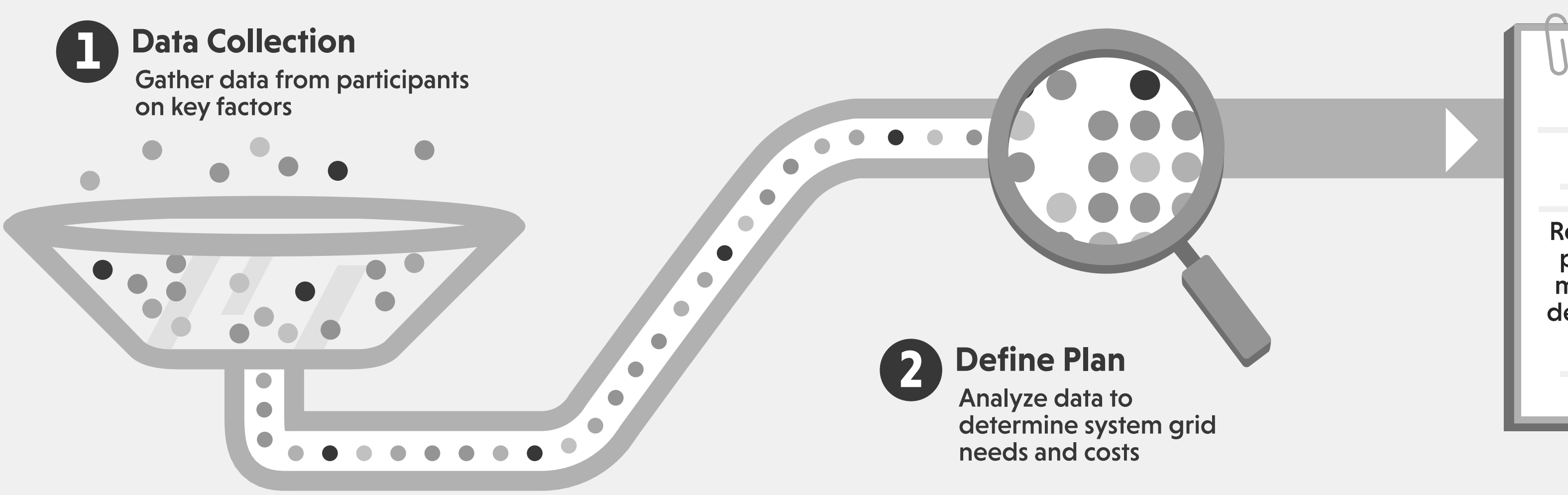
Integrate higher levels of renewables into the modern grid

Faster power outage restoration with greater convenience



Improved efficiencies and integration of renewables

How Do We Get There? Integrated Grid Planning



What Do We Need to Consider?

Integrated Grid Planning looks into the best technology options for all aspects of our energy system and identifies energy needs and behaviors of future customers taking into consideration key factors.

- **Future customer needs**
- **Community impact**
- **Cost to design and build large projects**
- **Future resource costs**
- **New technologies**
- **Number of electric vehicles**
- **New businesses and industries**
- **Number of residents installing rooftop solar**
- **Preparing for extreme events**

Participating in the Process

As part of the IGP process, we are collecting your input and considering all our options in planning for our renewable future. Here are the participants Hawaiian Electric is collaborating with:

Working Groups

Address specific topics in an advisory capacity and not as a decision-making group

Stakeholder Council

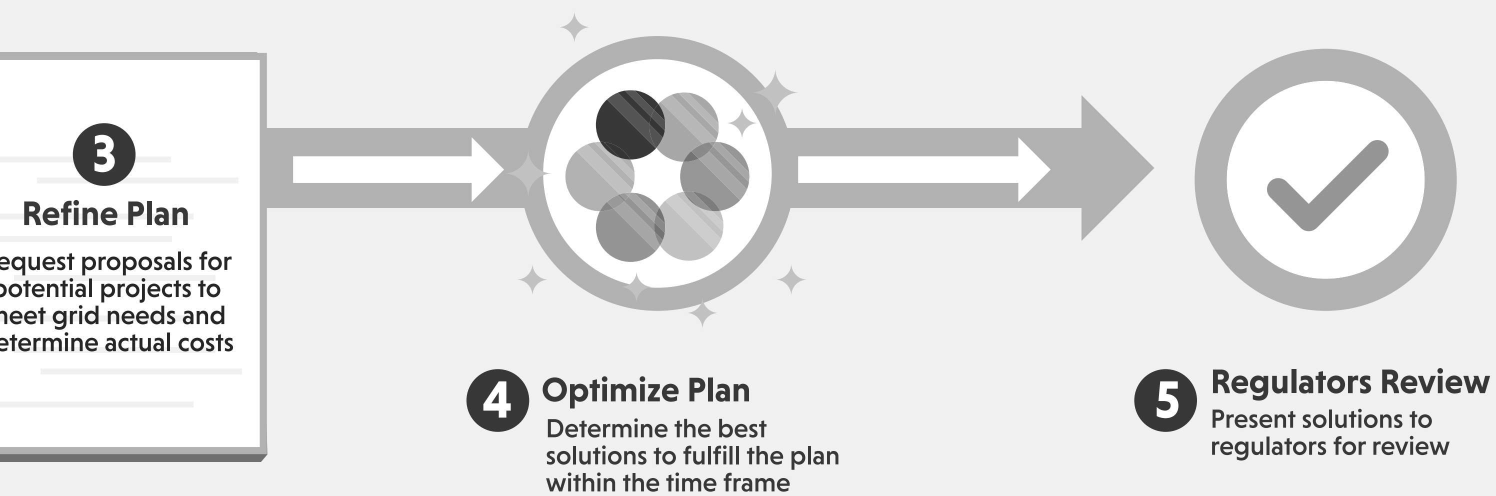
Represents customers and broad stakeholders to review work and provide guidance and insights

The Public

Communication with customers

Technical Advisory Panel

Provides independent evaluation and feedback on the working group activities and review point filings



Customer Priorities

We're Listening

In response to engagement, surveys, and focus groups, we were told affordability, reliability, and energy choices are most important to customers.

Affordability

Lower energy bills

Reliability

Fewer outages

Energy Choices

More control over energy generation and use

Is this true for you?

Let us know if you have different opinions. We're using this information to help make smart future energy decisions for customers.

5 Ways Customers Can Help Hawai'i Reach 100% Renewables

1. Reduce energy use at home and work
2. Upgrade to energy smart appliances
3. Upgrade to an advanced meter
4. Buy an electric vehicle
5. Participate in customer energy options

Visit **hawaiianelectric.com/products-and-services/** to learn more ways you can help

WE WANT **TO HEAR** FROM YOU

We welcome your input! Here are the many ways to stay connected with us.

Email:
IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

HawaiianElectric

hwnelectric

hawaiianelectric

Hawaiian Electric

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

What is IGP?

Be part of the **Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

Our Energy Future

Achieve Energy Independence

Reduce oil dependency and volatile fuel costs by increasing renewables

Climate Change Considerations

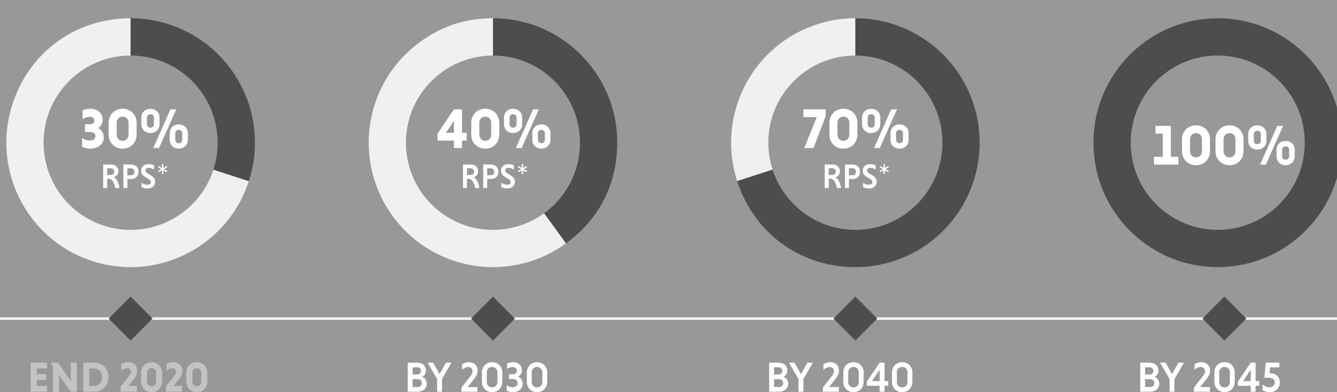
Add more renewables to reduce greenhouse gas emissions and build a resilient grid

Modernize Our Island Grids

Integrate new technologies to facilitate 100% renewable energy

Our Goal for the Future:

100% Renewables by 2045



*RPS = Renewable Portfolio Standard

How Does This Benefit Our Customers?

- More options to control and lower bills
- Time-of-Use rates to save money and lower fuel and maintenance costs
- Financial incentives for purchasing an electric vehicle
- Benefits of solar energy by offsetting bills without installing PV panels on their property
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- Faster power outage restoration with greater convenience
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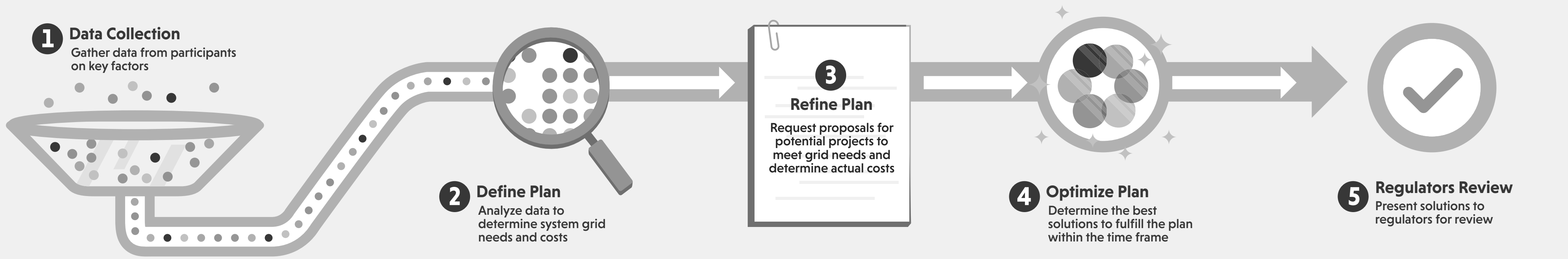
How Do We Get There? Integrated Grid Planning



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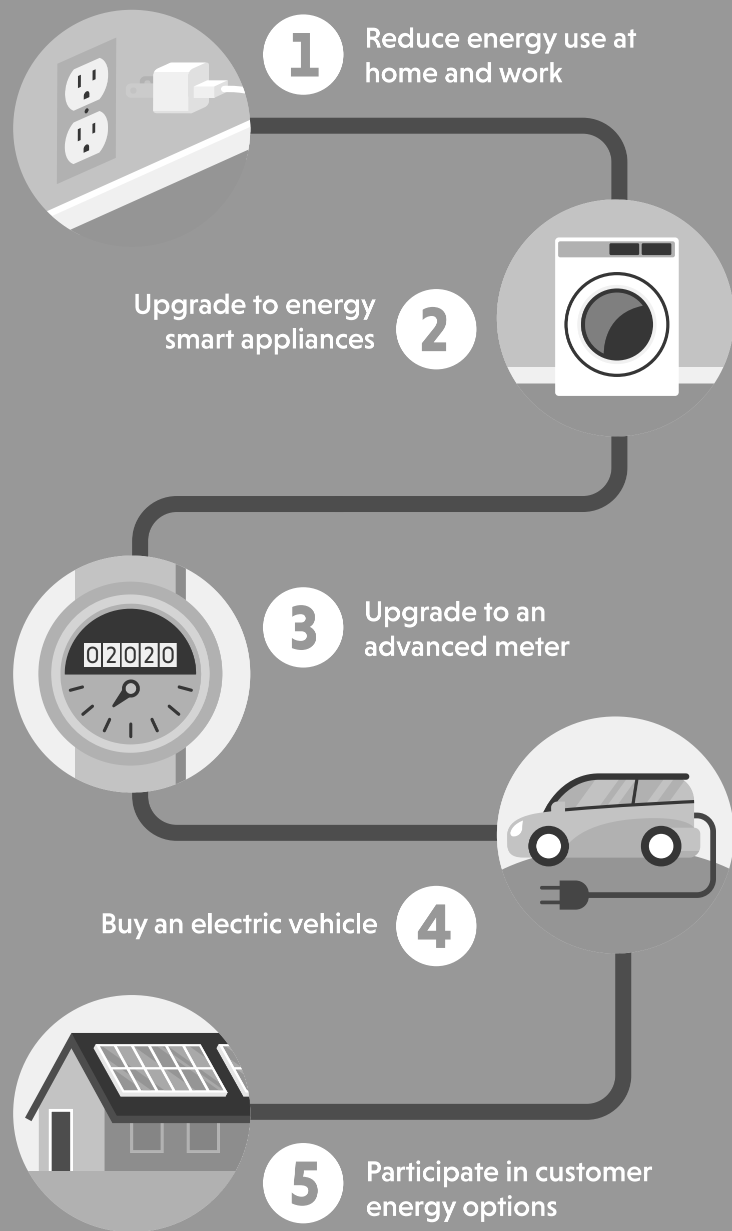

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Website:
www.hawaiianelectric.com/igp

HawaiianElectric

hwnelectric

hawaiianelectric

Hawaiian Electric

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

Printing **Instructions**

IGP Overview Handout

Below are the print settings for the three (3) IGP Overview Handout versions.

1. **IGP_Overview_Handout_17x11.pdf** (preferred version)
   In the print settings >
   - Select 17" x 11" (tabloid)
   - 2-sided printing
   - Flip on the short side

2. **IGP_Overview_Handout_8.5x11.pdf** (use only when printing on tabloid is unavailable)
   In the print settings >
   - Select 8.5" x 11" (letter)
   - 2-sided printing
   - Flip on the long side

3. **IGP_Overview_Handout_For_Viewing.pdf** (use for viewing only)

Hawaiian Electric

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

Getting to 100% Renewables

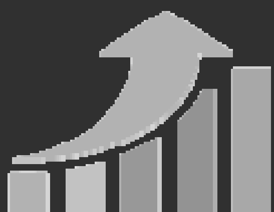
Our Goal for the Future:
100% Renewables by 2045

END 2020 | BY 2030 | BY 2040 | BY 2045

*RPS = Renewable Portfolio Standard

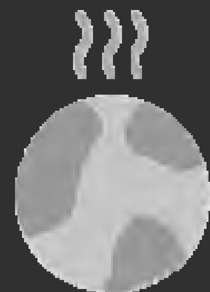
Hawaiian Electric

Our Energy Future



Achieve Energy Independence

Reduce oil dependency and volatile fuel costs by increasing renewables



Climate Change Considerations

Add more renewables to reduce greenhouse gas emissions and build a resilient grid

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Hawaiian Electric

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Hawaiian Electric

What is IGP?

Integrated Grid Planning (IGP) is an **energy planning process** to identify the best options for our customers to move Hawai‘i toward a clean energy future.

How Does This Benefit Our Customers?

More options to control and lower bills

Financial incentives for purchasing an electric vehicle

Integrate higher levels of renewables into the modern grid

Improved efficiencies and integration of renewables

Time-of-Use rates to save money and lower fuel and maintenance costs

Benefits of solar energy by offsetting bills without installing PV panels on their property

Faster power outage restoration with greater convenience

Hawaiian Electric

Factors to Consider in Planning **for our Clean Energy Future**

Future customer needs

Community Impact

Cost to design and build large projects

Future resource costs

New technologies

Number of electric vehicles

New businesses and industries

Number of residents installing rooftop solar

Preparing for extreme events

Hawaiian Electric

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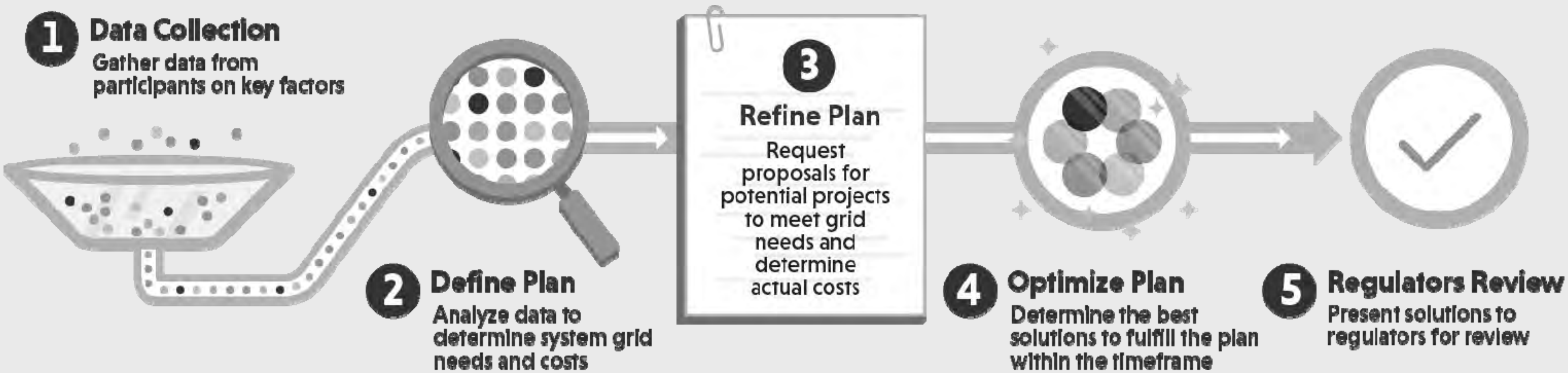
IGP Process


1 Data Collection
Gather data from participants on key factors
2 Define Plan
Analyze data to determine system grid needs and costs
3 Refine Plan
Request proposals for potential projects to meet grid needs and determine actual costs
4 Optimize Plan
Determine the best solutions to fulfill the plan within the timeframe
5 Regulators Review
Present solutions to regulators for review

What is the **Outcome of IGP?**

Filed applications for projects & strategies used for long-term decision making

Working Groups

- **Standardized Contracts (SCWG)**
  Procurement of services through a contracting mechanism between Hawaiian Electric (utility) market operators and third party providers of grid and other ancillary services.
- **Competitive Procurement (CPWG)**
  Procurement of resources in alignment with Hawaiian Electric's grid plans as identified through the IGP process.
- **Forecasts and Assumptions (FAWG)**
  Support development of forecast assumptions and sensitivities as part of pre-IGP planning cycle activity, and provide strategic inputs and feedback on assumptions and methodologies used for load forecast development and results.
- **Distribution Planning (DPWG)**
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  Support the development of resilience planning.
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  Identify needed grid services and review and make recommendations regarding the transparent evaluation and optimization method.

Hawaiian Electric

Join us at our Public Meetings
5–7:30 pm

Be part of **the Integrated Grid Planning (IGP)** conversation
to shape our renewable energy future together.

Agenda

PART 1 — **Open House**
5 – 6 pm

PART 2 — **Panel Discussion**
6 – 7:30 pm

Dates & Locations

TUESDAY Mar 03

Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai‘i 96740

TUESDAY Mar 10

Hawaii Pacific University*
(Multi-Purpose Room 3)
1 Aloha Tower Drive
Honolulu, O‘ahu 96813
**Free parking with validation*

THURSDAY Mar 05

Hilo High School (Cafeteria)
556 Waiānuenue Avenue
Hilo, Hawai‘i 96720

THURSDAY Mar 12

Hawaiian Electric (Maui Auditorium)
210 W Kamehameha Avenue
Kahului, Maui 96732

Open House Stations

There will be eight (8 stations)

Integrated
Grid Planning

Grid
Modernization

Grid-scale
Renewables

Rooftop Renewable
Energy

Community-Based
Renewable Energy

Electrification of
Transportation

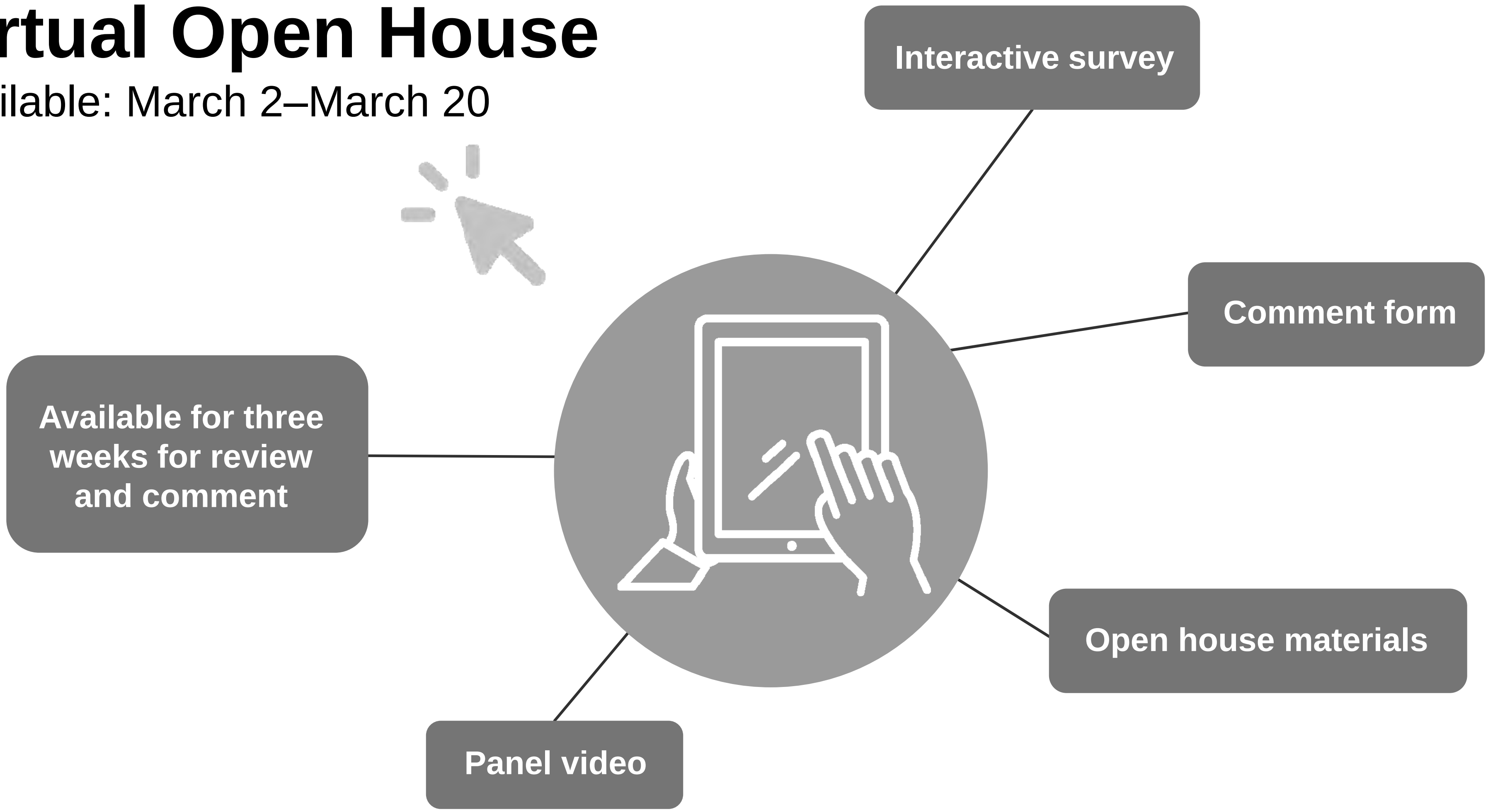
Resilience

Careers at
Hawaiian Electric

Hawaiian Electric

Virtual Open House

Available: March 2–March 20



We Want to Hear From You

We welcome your input! Here are the many ways to stay connected with us.

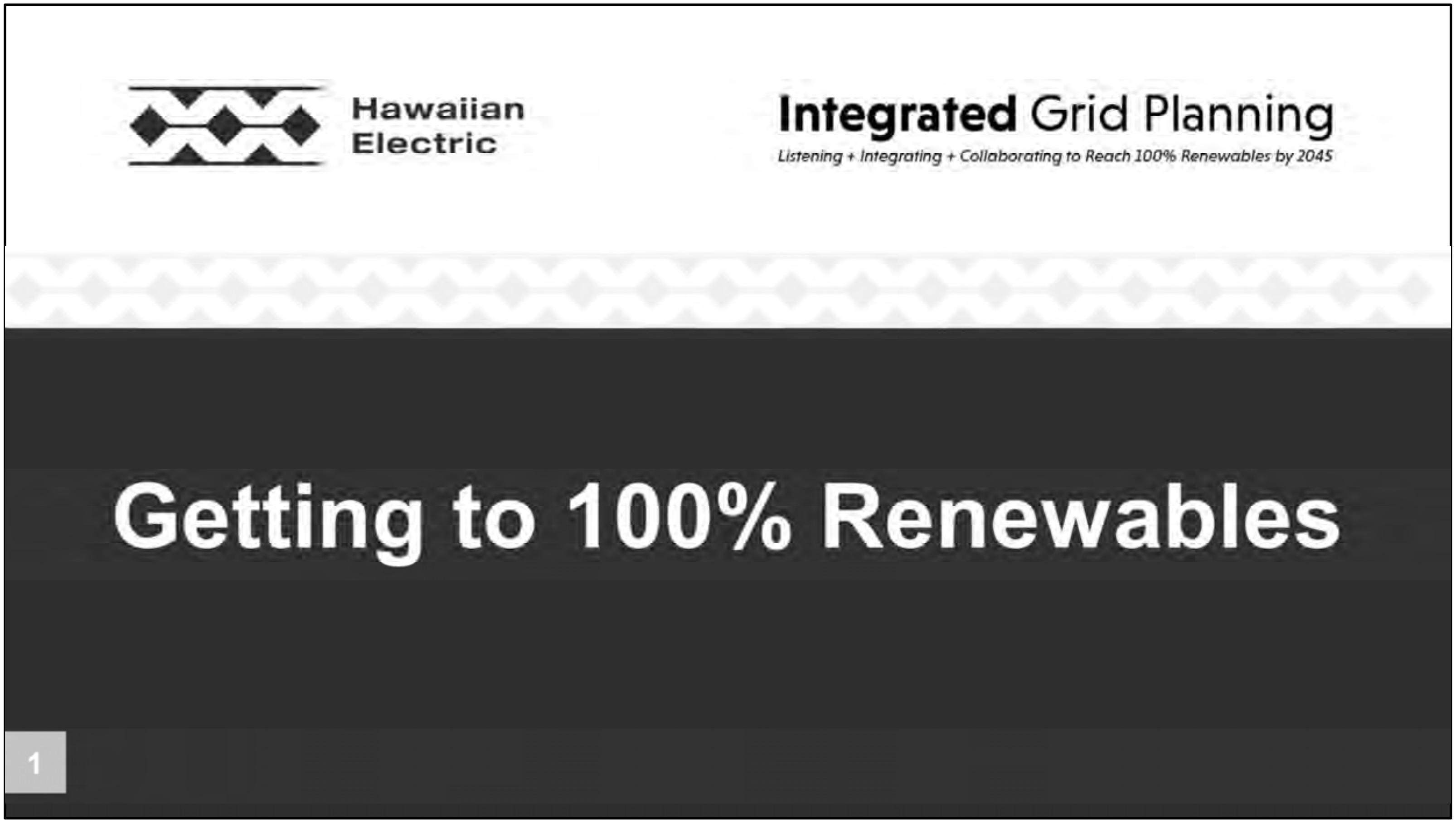
Email: **IGP@hawaiianelectric.com**

Website: **www.hawaiianelectric.com/igp**

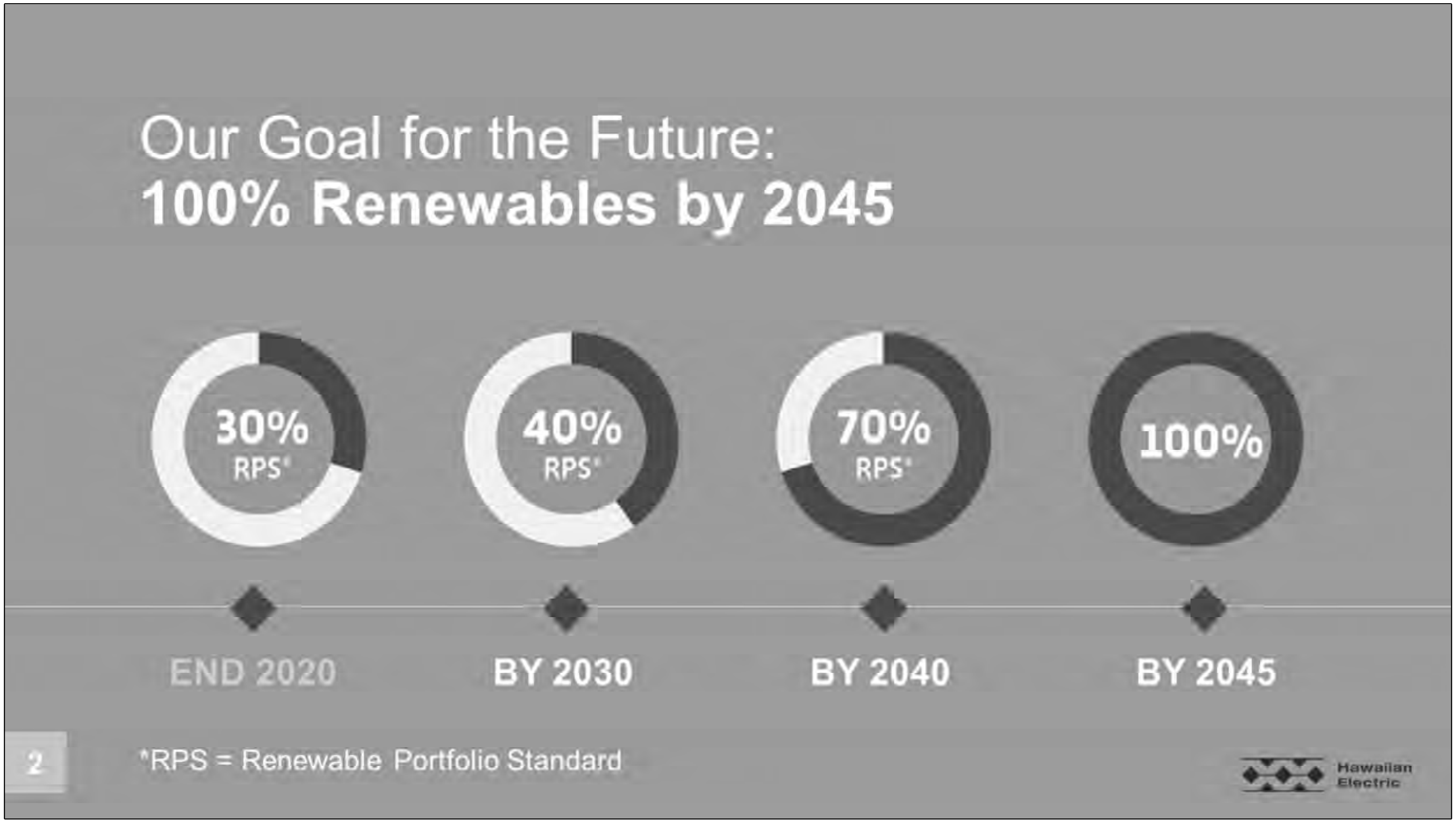
facebook.com/HawaiianElectric

twitter.com/hwnelectric

instagram.com/hawaiianelectric

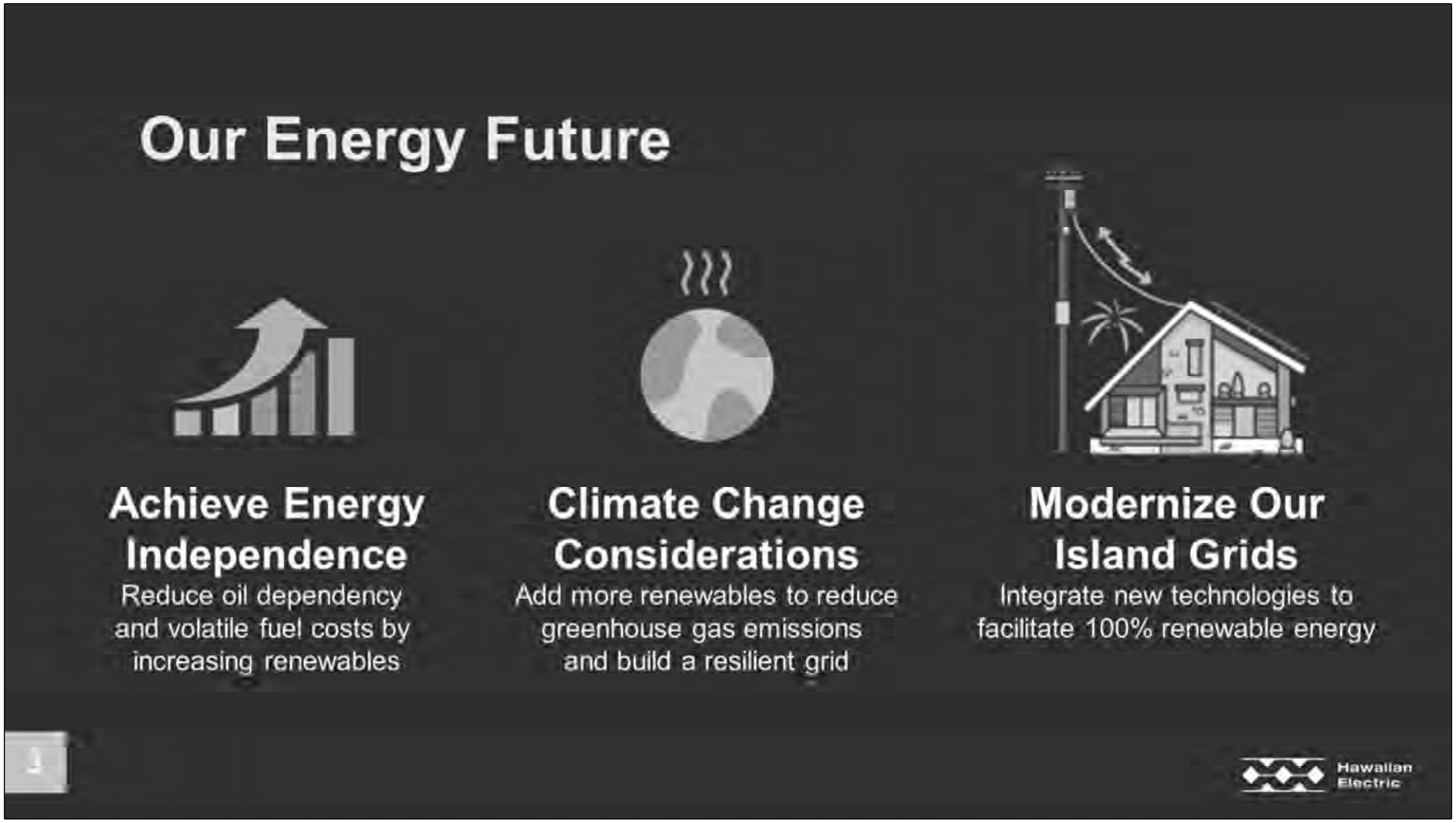


This presentation covers information on Hawaiian Electric's Integrated Grid Planning with a focus on how the process plays a role in helping us reach our 100% renewable energy goal



In 2015, our state made a commitment to our clean energy future of getting to 100% renewables by 2045.

As you can see by this chart – we, collectively, have significant changes to make in order to achieve this goal. It will take a collaborative and integrated process for the state of Hawaii to completely transform the way we generate, transfer and use energy across our state. We need to make changes today and incrementally over the next 25 years to reach our goal.



Each of us has a unique vision of our energy future. As Hawaiian Electric looks toward the future – they are looking at three key areas:

- First, achieving energy independence by reducing our dependency on oil and volatile fuel costs by increasing renewables.
- Second, making sure that we're considering climate change by adding more community and large-scale renewables to our energy grid and building a stronger, more resilient grid.

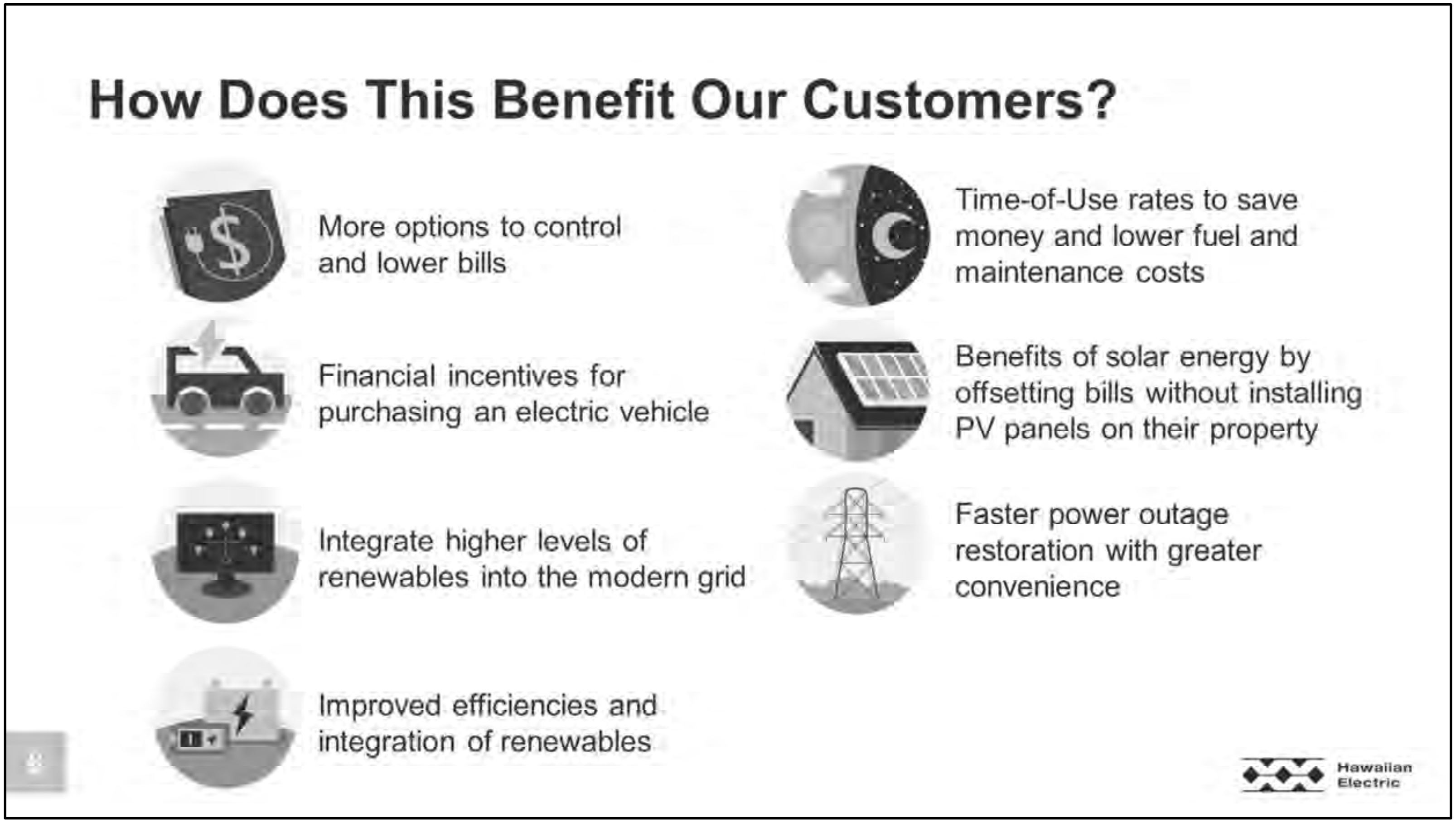
-Third, modernizing our grid. We need to build a smart energy system using new technologies that enable us to transform how we generate, deliver and use our energy. These upgrades will create a smarter and more flexible energy grid allowing us to increase renewables.

We <u>each</u> play a role in meeting Hawaii's energy goals. It is important for us to think about the energy we produce and use, everyday, as a complete energy system.

Here are five steps – large and small – that will help customers conserve energy, monitor energy use, and generate renewable energy. Visit hawaiianelectric.com/products-and-services/ to learn more ways you can help.

So what is IGP?

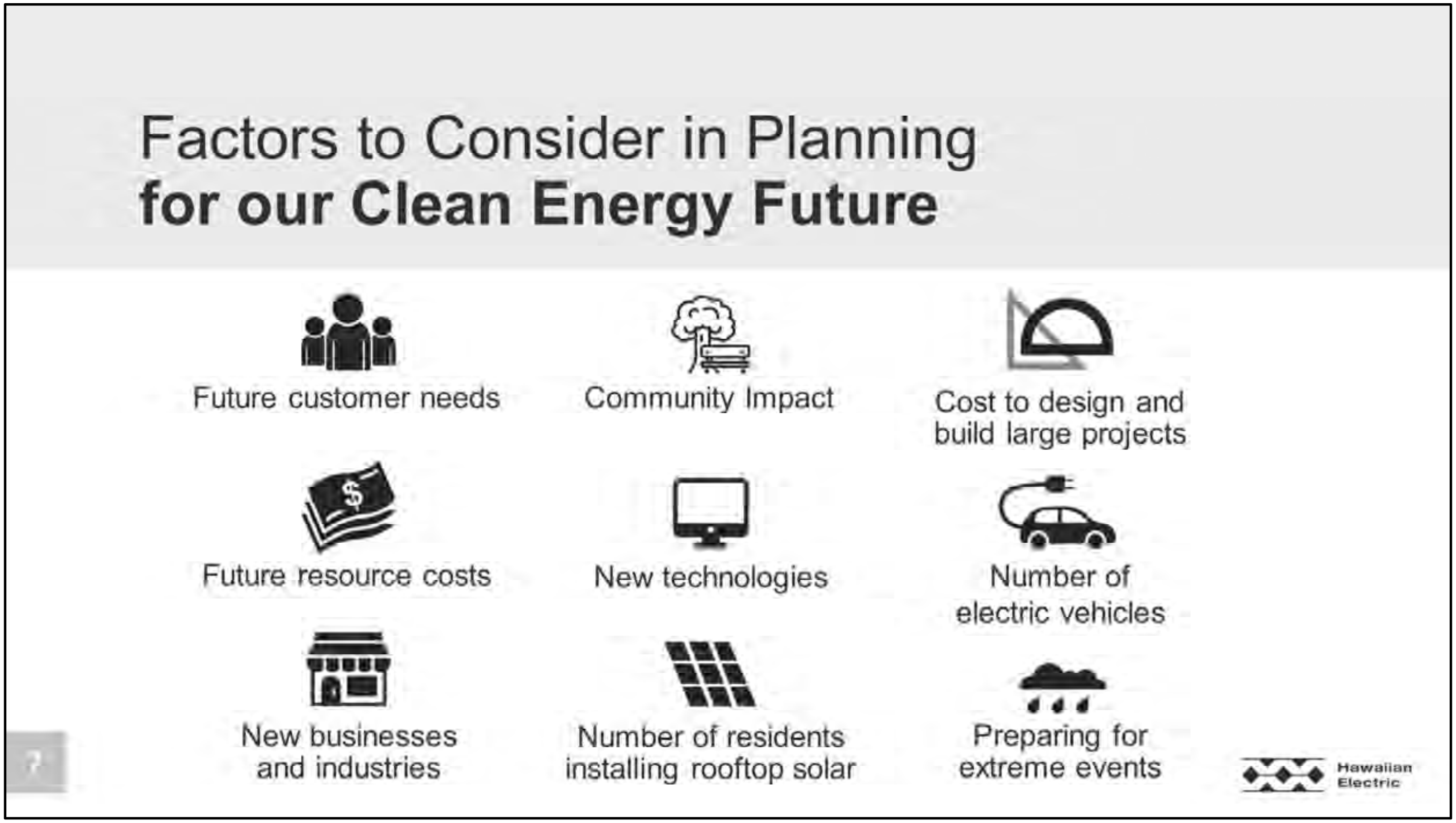
It's an energy planning process. Similar to a business strategic planning process, Hawaiian Electric gathers data and develops a plan to provide insights and directions for the future of the utility to meet customer needs, regulatory requirements and clean energy goals.



You may be asking – how does this benefit me/customers?

Hawaiian Electric is continually working ways to improve the customer experience including:
- Developing ways to modernize our grid
- Integrating time of use programs to conserve energy and save money
- Installing and integrating more rooftop and community solar
- Supporting the electrification of transportation system
- Identify opportunities and technologies to store energy

They are doing all of this while keeping customer's electric bills and service reliability in mind.



Several factors drive and impact the right solutions as we plan for our clean energy future.

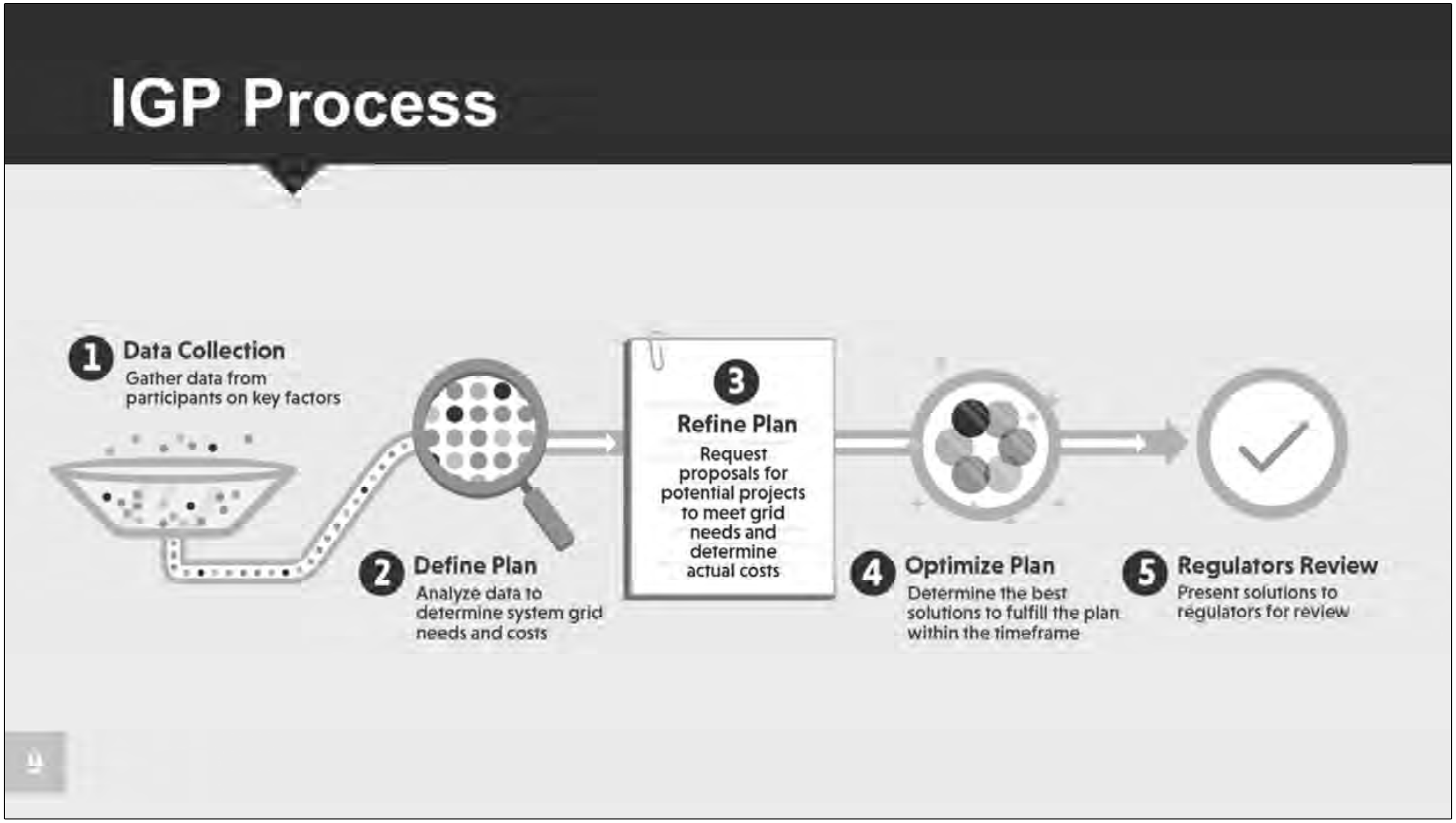
The eight factors listed provide a snapshot of the type of information Hawaiian Electric gathers and considers during the planning process to help identify challenges and opportunities. Future costs for materials and fuel, the number of electric vehicles purchased, and the impact of natural disasters, all garner different solutions for Hawaiian Electric to consider.

Today, data and models are used to help forecast what these different factors may actually be in the next 5 or 25 years.

An aspect of Integrated Grid Planning is working with several stakeholder groups to collect input and consider various options in planning for Hawaii's renewable future. Here are the participants Hawaiian Electric is collaborating with:

- Working Groups
- The Stakeholder Council
- The public
- A Technical Advisory Panel

Representatives from across Hawaii, Oahu and Maui County participate in meetings, workshops, and review data, methodologies and reports. Participation includes representatives from various groups and organizations bringing different ideas and perspectives to the conversation.



Integrated Grid Planning has five major steps.

This is a two year planning process. Hawaiian Electric collects data from experts and stakeholders, including the public, on the various key factors shown earlier.

Data collected is analyzed and used to determine what the grid needs and may cost.

Then a plan is refined based on proposals for potential projects gathered which include actual costs. For instance, if you were remodeling your kitchen, you may have an idea in mind of what you want and about how much it will cost, but you won't have actual costs until you have a bid put together by a contractor. This is a similar process Hawaiian Electric will undergo in order to gather potential projects and their actual costs.

What is the **Outcome of IGP?**

Filed applications for projects & strategies used for long-term decision making

Hawaiian Electric

In the Integrated Grid Planning process, Hawaiian Electric will develop a long term plan that will be submitted to the PUC for review. This plan will provide insights into long term decisions made for resources (generation), transmission (how power is transferred to customers) and distribution (how customers receive their energy). Hawaiian Electric will use the findings and identified solutions in the long term plan to inform procurements. The projects that emerge from the procurements will also be submitted to the PUC for review and used to update the long term plan.

Working Groups

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  Support the development of resilience planning.
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  Identify needed grid services and review and make recommendations regarding the transparent evaluation and optimization method.

Hawaiian Electric

There are 7 working groups collaborating on various aspects of the planning process. More information on each of these working groups can be found on the IGP website including upcoming scheduled meetings.

Join us at our Public Meetings
5–7:30 pm

Be part of **the Integrated Grid Planning (IGP)** conversation to shape our renewable energy future together.

Agenda

PART 1 **Open House**
5 – 6 pm

PART 2 **Panel Discussion**
6 – 7:30 pm

Hawaiian Electric

Upcoming public meetings will be held in March 2020.

The public meetings will have two parts:

1) The open house will have eight stations to talk with Hawaiian Electric staff
2) The panel will include speakers with various perspectives on getting to 100% renewables. Audience members will have an opportunity to submit or ask questions of the panel members during the facilitated Q&A session.

Dates & Locations

TUESDAY Mar 03
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

TUESDAY Mar 10
Hawaii Pacific University*
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1 Aloha Tower Drive
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**Free parking with validation*

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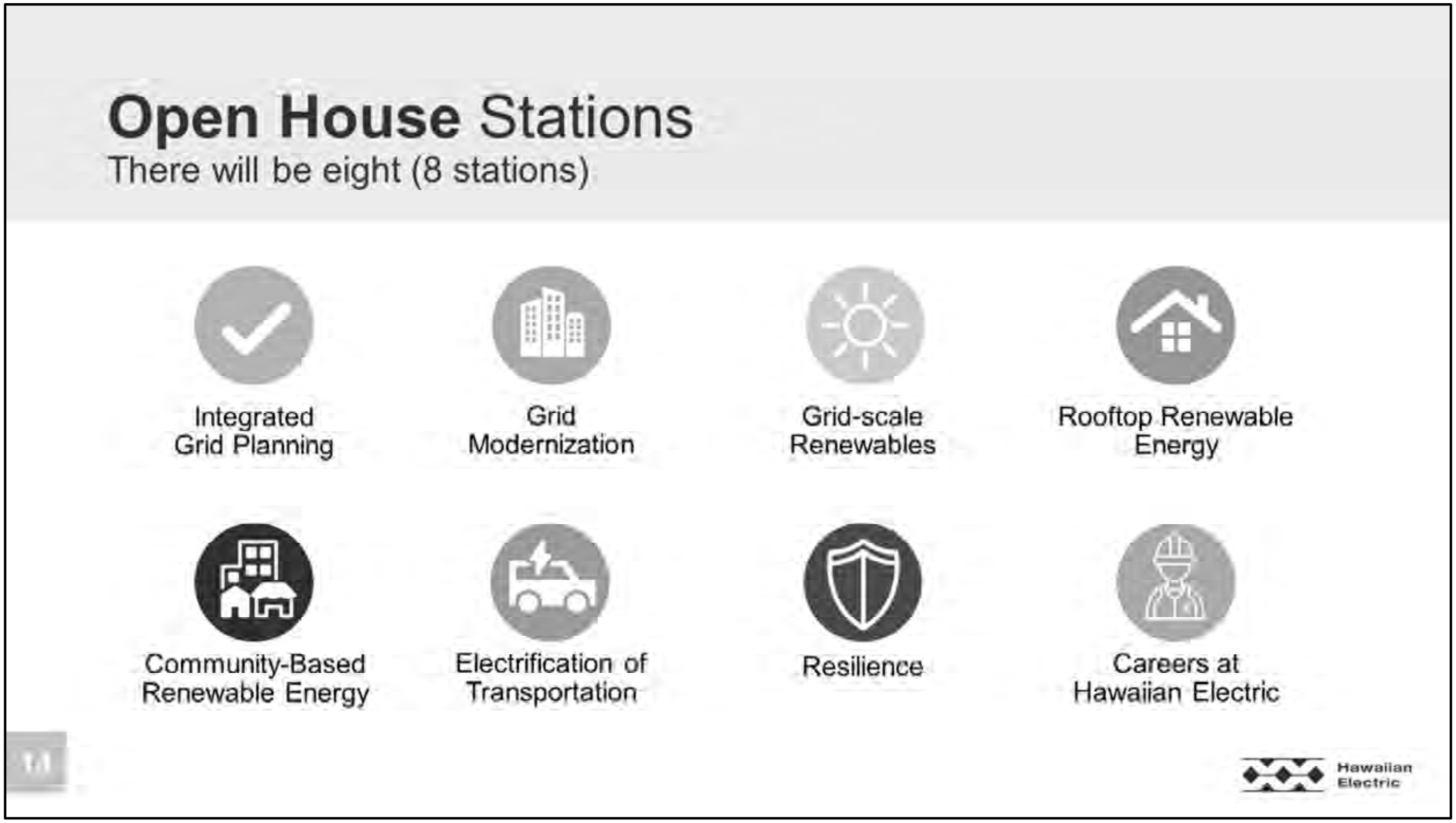
Hilo, Hawai'i 96720

THURSDAY Mar 12
Hawaiian Electric (Maui Auditorium)
210 W Kamehameha Avenue
Kahului, Maui 96732

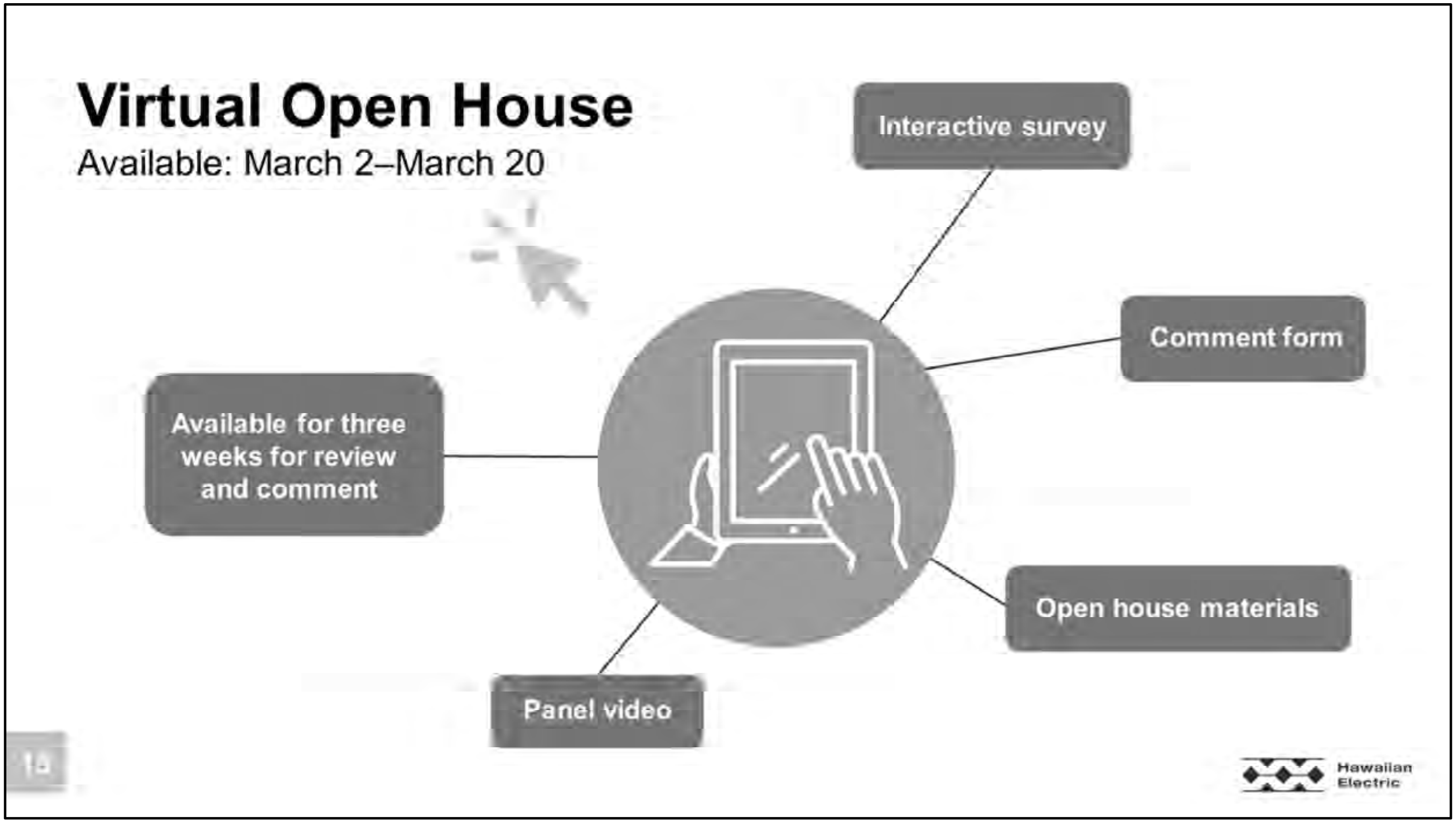
A series of four public meetings will be held on three islands.

We encourage each of your to share information with your networks about the upcoming meetings. It's important for customers to participate in this process for Hawaiian Electric to listen to customer questions or concerns and educate customers on Integrated Grid Planning.



In addition to information on IGP, Hawaiian Electric staff will be available to talk about career opportunities and address questions about advanced meters and customer energy options.

Some of the stations will include survey input opportunities to help verify forecasted data and shape future engagement efforts.



In addition to the four in-person public meetings, a virtual open house will be available with the same information that is presented at each open house station. A panel discussion will be filmed and also available to watch. Visitors will have the opportunity to view materials, answer survey questions, and complete a comment form. The virtual open house will be made available through the IGP website and open March 2 – 20.

Hawaiian Electric's Integrated Grid Planning team is open to input and feedback. Feel free to send the team an email at IGP@hawaiianelectric.com and be sure to visit the IGP website for more information and links to documents, meeting notes and upcoming meetings and engagement opportunities. IGP information is also shared on Hawaiian Electric's social channels.

Appendix E
Meeting Materials

Hawaiian Electric

Integrated Grid Planning

Tuesday, March 3, 2020 | 5-7:30 p.m.
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

First & Last Name (Please Print)	Email	Would you like to receive project updates?	How did you hear about the open house?
1.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
2.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
3.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
4.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
5.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
6.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
7.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
8.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
9.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
10.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
11.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
12.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other

Hawaiian Electric

Integrated Grid Planning

Thursday, March 5, 2020 | 5-7:30 p.m.
Hilo High School (Cafeteria)
556 Waianuenue Avenue
Hilo, HI 96720

First & Last Name (Please Print)	Email	Would you like to receive project updates?	How did you hear about the open house?
1.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
2.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
3.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
4.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
5.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
6.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
7.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
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9.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
10.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
11.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
12.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other

Hawaiian Electric

Integrated Grid Planning

Tuesday, March 10, 2020 | 5-7:30 p.m.
Hawaii Pacific University (MPR 3)
1 Aloha Tower Drive
Honolulu, HI 96813

First & Last Name (Please Print)	Email	Would you like to receive project updates?	How did you hear about the open house?
1.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
2.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
3.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
4.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
5.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
6.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
7.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
8.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
9.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
10.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
11.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
12.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other

Hawaiian Electric

Integrated Grid Planning

Thursday, March 12, 2020 | 5-7:30 p.m.
Maui Electric (Auditorium)
210 W Kamehameha Avenue
Kahului, Maui 96732

First & Last Name (Please Print)	Email	Would you like to receive project updates?	How did you hear about the open house?
1.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
2.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
3.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
4.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
5.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
6.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
7.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
8.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
9.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
10.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
11.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other
12.		☐ Yes ☐ No	☐ Facebook ☐ News ☐ Word of Mouth ☐ Other

Hawaiian Electric

Integrated Grid Planning

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

What is IGP?

An energy planning process to identify the best options for customers to move Hawai'i toward a clean energy future.

Our Energy Future

Achieve Energy Independence

Reduce oil dependency and volatile fuel costs by increasing renewables

Address Climate Change

Add more customer-sited and grid-scale renewables to reduce greenhouse gas emissions

Modernize Our Island Grids

Integrate new technologies to facilitate 100% renewable energy

Our Goal for the Future:

100% Renewables by 2045

30%	40%	70%	100%
TODAY	BY 2030	BY 2040	BY 2045

What We Need to Consider?

Integrated Grid Planning looks into the best technology options for all aspects of our energy system and identifies energy needs and behaviors of future customers.

- Future customer needs
- New technologies
- Cost to design and build large projects
- Future resource costs
- Number of residents installing rooftop solar
- Number of electric vehicles
- New businesses and industries
- Preparing for extreme events

Who is Part of the Process?

As part of the IGP process, we are collecting your input and considering all our options in planning for our renewable future. Here are the groups Hawaiian Electric is collaborating with:

Working Groups
Address specific topics in an advisory capacity and not as a decision-making group

Stakeholder Council
Represents customers and broad stakeholders to review work and provide guidance and insights

The Public
Communication with customers

Technical Advisory Panel
Provides independent evaluation and feedback on the working group activities and review point filings

How Does This Benefit Our Customers?

- More options to control and lower bills
- Time-of-Use rates to save money and Lower fuel and maintenace costs
- Financial incentives for purchasing an electric vehicle
- Benefits of solar energy by offsetting bills without installing PV panels on their property
- Integrate higher levels of renewables into the modern grid
- Faster power outage restoration with greater convenience
- Improved efficiencies and integration of renewables

How We Get There? Integrated Grid Planning

Sustainability
Economic Development
Reliability
Renewable Energy
Stability
Resilience
Affordability

1 Data Collection
Gather data from experts in these 7 key areas

2 Review
Analyze data to determine system needs

3 Define and Refine Plan
Gather information from providers through Request for Information (RFI) to better define plan. Then, procure preliminary Request for Proposals (RFP) to provide a more realistic cost.

4 Optimize Plan
Determine the best solution to fulfill the plan within the timeframe

5 Regulators Review
Present final 5-year Action Plan to regulators for review

YEAR 1 — YEAR 2

Customer Priorities

We're Listening

In response to engagement, surveys, and focus groups, we were told affordability, reliability, and energy choices are most important to customers.

Affordability

Short description that goes above Affordability.

Reliability

Short description that goes below Reliability.

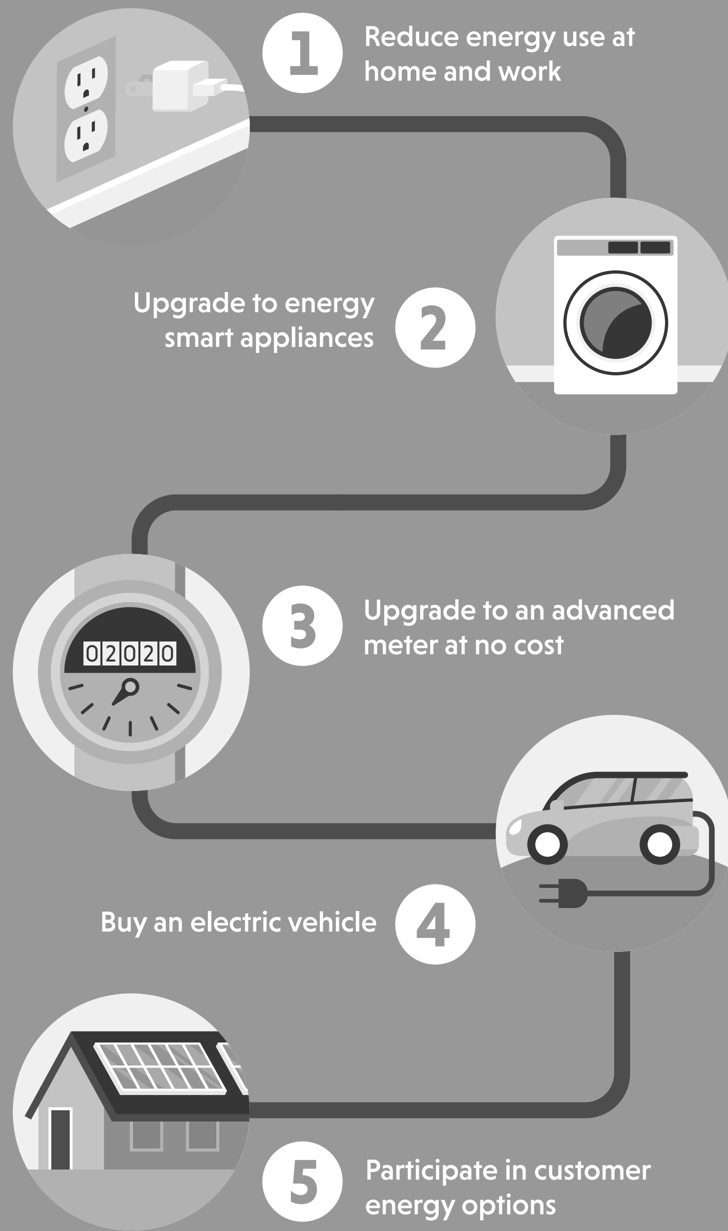
Energy Choices

Short description that goes below Energy Choices.

Is this true for you?

Let us know if you have different opinions. We're using this information to help make smart future energy decisions for customers.

5 Ways Customers Can Help Hawai'i Reach 100% Renewables



Visit **hawaiianelectric.com/products-and-services/** to learn more ways you can help

WE WANT **TO HEAR** FROM YOU

We welcome your input! Here are the many ways to stay connected with us.

Email:
IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

HawaiianElectric

hwnelectric

hawaiianelectric

Integrated Grid Planning

Survey Questions and Input Form

Your input will help us improve future customer communications

How did you hear about this meeting?

- ◯ *Social media*
- ◯ *Newspaper*
- ◯ *Radio*
- ◯ *Flyer/banner*
- ◯ *IGP Website*
- ◯ *Word of Mouth*
- ◯ *Other* ______________________

In the future, what type of Integrated Grid Planning information would you be most interested in receiving? ***(Select up to 3)***

- ◯ *General updates*
- ◯ *Input opportunities*
- ◯ *Resilience*
- ◯ *Utility scale renewable projects*
- ◯ *Electrification of transportation*
- ◯ *Incentive programs*
- ◯ *Advanced meters*
- ◯ *Employment opportunities*
- ◯ *Rooftop and community solar renewables*
- ◯ *Grid modernization*
- ◯ *Other* ______________________

What would be your preferred method to receive future information on Integrated Grid Planning? ***(Select up to 2)***

- ◯ *Social media*
- ◯ *Newspaper*
- ◯ *Radio*
- ◯ *Email*
- ◯ *IGP Website*
- ◯ *Mail*
- ◯ *Other* ______________________

Share any additional thoughts. ***We are listening!***

____

____

____

____

____

____

____

Demographic Questions (Optional)

Where is your home or business located?

- ◯ *Moloka'i*
- ◯ *Lāna'i*
- ◯ *O'ahu*
- ◯ *Maui*
- ◯ *Hawai'i (Big Island)*

What is your age?

Do you make the purchasing decisions for your home or business?

- ◯ *Yes*
- ◯ *No*

What is your ownership of your home or business location?

- ◯ *Own*
- ◯ *Rent*

Want a response to your comment?

Name ______________________

Email ______________________

Phone ______________________

Please fold, fasten, and mail - No envelope necessary

PLACE
POSTAGE
HERE

Hawaiian Electric
Integrated Grid Planning Team
PO Box 2750
Honolulu, HI 96840

Working Groups

Standardized Contracts (SCWG)

Procurement of services through a contracting mechanism between Hawaiian Electric (utility) market operators and third party providers of grid and other ancillary services.

Competitive Procurement (CPWG)

Procurement of resources in alignment with Hawaiian Electric's grid plans as identified through the IGP process.

Forecasts and Assumptions (FAWG)

Support development of forecast assumptions and sensitivities as part or pre-IGP planning cycle activity, and provide strategic inputs and feedback on assumptions and methodologies used for load forecast development and results.

Distribution Planning (DPWG)

Enhancement to the methods and tools for distribution planning and the integration with resource and transmission planning.

Grid Services (GSWG)

Identify and define additional energy, capacity, ancillary and T&D non-wires alternative services.

Resilience (RWG)

Support the development of resilience planning.

Solution Evaluation and Optimization (SEOWG)

Identify needed grid services and review and make recommendations regarding the transparent evaluation and optimization method.

	CPWG	DPWG	FAWG	RWG	SEOWG
Blue Planet Foundation					
City and County of Honolulu					
County of Maui					
Department of Business, Economic Development and Tourism, State Energy Office					
Department of Commerce and Consumer Affairs, Division of Consumer Advocacy					
Department of Defense					
Hawaiʻi Island Economic Development Board					
Hawaiʻi Energy					
Life of the Land					
Oʻahu Economic Development Board					
Public Utilities Commission					
Hawaiʻi Energy Connection					
Ulupono Initiative					
Organizations (82 total):	**23**	**40**	**17**	**29**	**13**
Individuals (171 total):	**40**	**73**	**24**	**65**	**29**

Working Group Participants

#	174 Power Global Inc.
A	Advanced Microgrid Solutions
	Applied Energy Group
	Arizona Public Service Electric Company
	Australian Energy Market Operator
B	Black & Veach
	Blue Planet Foundation
C	Chamber of Commerce
	City and County of Honolulu
	Community Delegate - Maui
	Community Delegate - Moloka'i
	Community Delegrate - Lana'i
	County of Hawai'i
	County of Maui
D	Demand Response
	Department of Business, Economic Development and Tourism, State Energy Office
	Department of Commerce and Consumer Affairs, Division of Consumer Advocacy
	Department of Defense
	Department of Transportation
E	E3
	Electric Power Research Institute
	Electric Reliability Council of Texas
	Enel X
	Energy Efficiency
	Energy Freedom Coalition of America
	Energy Island
	EnerNex
	Enphase Energy
H	Half Moon Power
	Hawai'i Energy
	Hawaii Energy Strategists
	Hawai'i Island Economic Development Board
	Hawai'i Natural Energy Institute
	Hawai'i Pacific Solar
	Hawaii PV Coalition
	Hawai'i Society of Healthcare Engineers
	Hawai'i Solar Energy Association
	Hawaiian Electric - Lead of CPWG
	Hawaiian Electric - Lead of DPWG
	Hawaiian Electric - Lead of FAWG (load forecasting)
	Hawaiian Electric - Lead of FAWG (non-load forecasting assumptions)
	Hawaiian Electric - Lead of RWG
	Hawaiian Electric - Lead of SEOWG
	Hawaiian Telcom
	Holu Hou Energy LLC
	Honolulu Board of Water Supply
I	ICF
	Independent Power Producer
L	Large Commerical and Industrial Customer
	Life of the Land
	Local Government - Hawai'i
M	Maui County Community
	National Renewable Energy Laboratory
	Nevada Energy
	Newport Consulting Group - Facilitator
O	O'ahu Economic Development Board
	Office of State Planning
	Open Access Technology International
P	Par Hawai'i
	Portland General
	Progression HI Offshore Wind
	Public Utilities Commission
	Puget Sound Energy
Q	Quanta Technology
R	Renewable Energy Action Coallition of Hawai'i
	Rocky Mountain Institute (Public Utilities Commission consultant)
S	S&C Electric Company
	Sacramento Municipal Utility District
	Shifted Energy
	Siemens
	Small Solar and Storage
	Small Solar and Storage, Hawai'i Energy Connection
	SolarEdge
	Southern California Edison
	Steckley Power Systems
	Strategies 360 - Facilitator
	Student at Duke University studying Energy Policy
	SunRun
	Sustainability Advocate - National
	Switched Source
U	Ulupono Initiative
	United States Coast Guard
	United States Department of Commerce, National Oceanic and Atmospheric Administration
	United States Department of Energy, Office of Electricity
	United States Department of Homeland Security, Federal Emergency Management Agency
	University of Hawai'i Economic Research Organization
V	Verizon Wireless
W	Where Talk Works - Facilitator
	WZ Engineering
X	X-elio

Integrated Grid Planning

An energy planning process to identify the best options for customers to move Hawai'i toward a clean energy future.

Planning Hawai'i's Grid for **Future Generations**

With a renewed focus on comprehensive energy planning, Hawaiian Electric proposed an Integrated Grid Planning ("IGP") process that we believe will benefit customers by identifying the best options to affordably move Hawai'i toward a reliable, resilient clean energy future with minimal risk. In addition, we believe the State will benefit from expanded market opportunities for resource, grid services, and non-wires alternatives for transmission and distribution ("T&D"), which can foster innovative solutions for a new energy economy.

Our Goal for the Future: **100% Renewables by 2045**

The **Renewable Portfolio Standard (RPS)** percentage estimates the percent of sales that is represented by renewable energy. This is how we are measured in achieving compliance.

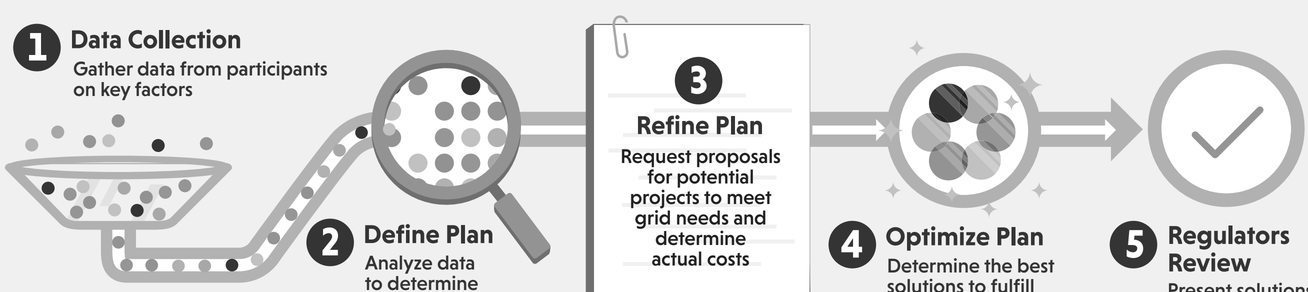
END 2020 | BY 2030 | BY 2040 | BY 2045

What is our Progress?

This is where we are at in comparison to our goal above.

9% RPS 2010 > **28%** RPS TODAY > **30+%** RPS END 2020 > **60+%** RPS 2030

How Do We Get There?



1 Data Collection
Gather data from participants on key factors

2 Define Plan
Analyze data to determine system grid needs and costs

3 Refine Plan
Request proposals for potential projects to meet grid needs and determine actual costs

4 Optimize Plan
Determine the best solutions to fulfill the plan within the time frame

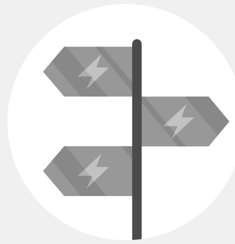
5 Regulators Review
Present solutions to regulators for review

Grid Modernization

Grid modernization is transforming our energy grid to be a dynamic, two way stream of power, shifting back and forth between customers and Hawaiian Electric

What's in it for the Customer?

More information for customers to manage electric bills



More customer choices

Faster outage restoration

Minimal bill impact

Greater integration of renewable energy

More efficient power production and delivery

Protecting Your Privacy

- **We PROTECT** information and assets from all unauthorized access
- **We MONITOR** networks 24/7 at our Security Operations Center

Grid Modernization | **Advanced Meters**

Advanced meters are an important part of our Grid Modernization Strategy. Along with the other Grid Modernization technologies, advanced meters enable customers to:

- View your daily energy usage from your phone or computer
- Manage your energy use to reduce your bill
- Help to improve restoration times during power outages
- Help Hawai'i reach a 100% clean energy future

For more information visit www.hawaiianelectric.com/advancedmeters

Grid Modernization

Grid modernization is transforming our energy grid to be a dynamic, two way stream of power, shifting back and forth between customers and Hawaiian Electric

How does Grid Modernization Technology Work?

Customers' resources are an important part of the grid. Reliability is critical as more and more customers provide resources to the grid. Learn about the new technology as we move toward changing yesterday's grid to tomorrow's grid.

Line Sensors
Provides data on amount of energy generated by rooftop solar and enables more efficient grid operations.

Remote Intelligent Switch
Utility pole-mounted automated switch enabling faster outage restoration.

Remote Fault Indicators
Provides precise location of faults, enabling faster outage restoration.

Substation Automation
Provides remote control of circuit breakers and access to data enabling more efficient operation and faster outage restoration.

Battery Storage
Stores excess electricity and discharges as needed to enable continued growth of rooftop solar and large renewables.

Wireless Neighborhood Area Network
Enables integration of existing devices with smart meters, intelligent switches, line sensors, fault indicators and secondary var controllers. Supports automatic information gathering and monitoring of the grid for faster fault location, recovery and restoration.

Advanced Inverters
Responds to changes in rooftop solar output to reduce impacts on neighbors' service quality.

Secondary Var Controllers (SVC)
Provides additional support beyond inverters' capability to maintain customer service quality. Enables the addition of more customer resources to the grid.

Advanced Meters
Provides measurement of customer's electric use, production, and service quality along with remote service connection switch. Allows customers to make informed energy choices.

www.hawaiianelectric.com/gridmod

Grid-scale Renewables

Process for selecting, evaluating, and contracting new renewable projects.

1. Regulatory Approval process for RFP ★
2. Final RFP Issued
3. Developers Submit Proposals
4. Eligibility and Threshold Evaluation
5. Initial Evaluation
6. Select Priority List
7. Best and Final Offer Submission
8. Detailed Evaluation
9. Selection of Final Award(s)
10. Contract Negotiations / Public Meeting ★
11. Regulatory Approval Process for PPAs ★

★ Public Comment Opportunity

Opportunities for Public Engagement

RFP Development

- PUC Status Conference
- Written comments to PUC

Prior to signing agreement

- Required public meeting by selected developer
- Ability to submit written comments which will also be provided to PUC

PUC Approval Process

- Written comments to PUC

Post PUC Approval Process

- Permitting approval processes requiring public comments



	O'AHU	HAWAI'I ISLAND	MAUI
Stage 2 Renewable RFP	1,300,000 MWh + 200 MW Storage 50 MW Contingency Storage	70,000–444,000 MWh + 18 MW Contingency Storage	295,000 MWh + 40 MW Storage
Acres	**3,000** (equivalent to 29 Aloha Stadiums)	**160–1,000** (equivalent to 2– 10 Aloha Stadiums)	**700** (equivalent to 7 Aloha Stadiums)

Hawai'i has many factors which must be considered when selecting renewable projects

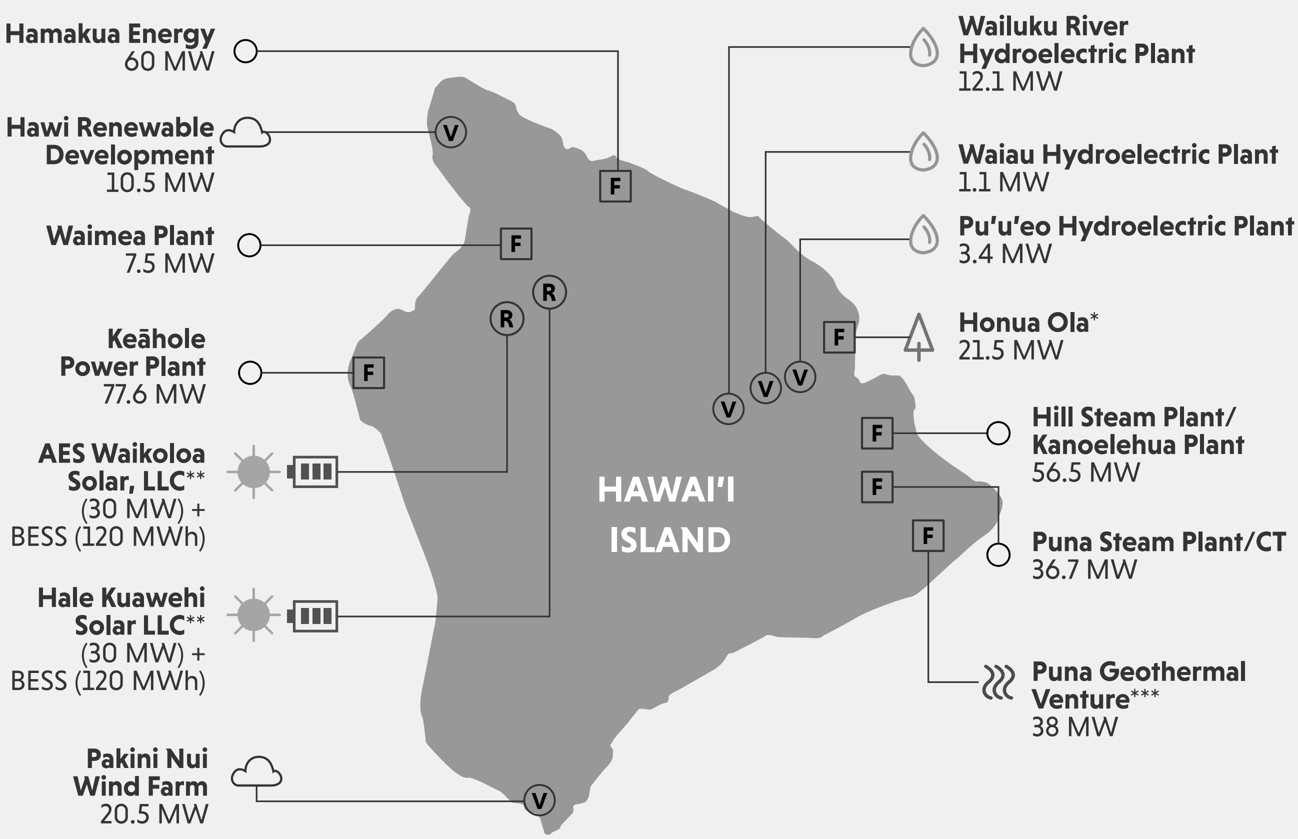
- Land Availability
- Endangered Species
- Community Interest
- Availability of Materials
- Resilience

Grid-scale Renewables

Existing and planned generating facilities in our service area and the maximum potential power in megawatts (MW) they can produce.

BIOMASS **HYDRO** **STORAGE** **OIL**

GEOTHERMAL **GRID-SCALE SOLAR** **WIND**



* AWAITING CONSTRUCTION; PUC APPROVAL ON APPEAL

** AWAITING CONSTRUCTION

*** OFFLINE SINCE MAY 2018 DUE TO VOLCANIC ACTIVITY IN LOWER PUNA / AMENDED PPA AWAITING PUC APPROVAL

F **FIRM GENERATION:** Energy available on demand, which can be adjusted as needed.

V **VARIABLE GENERATION:** Energy that may not always be available or controllable.

R **RENEWABLE DISPATCHABLE GENERATION**

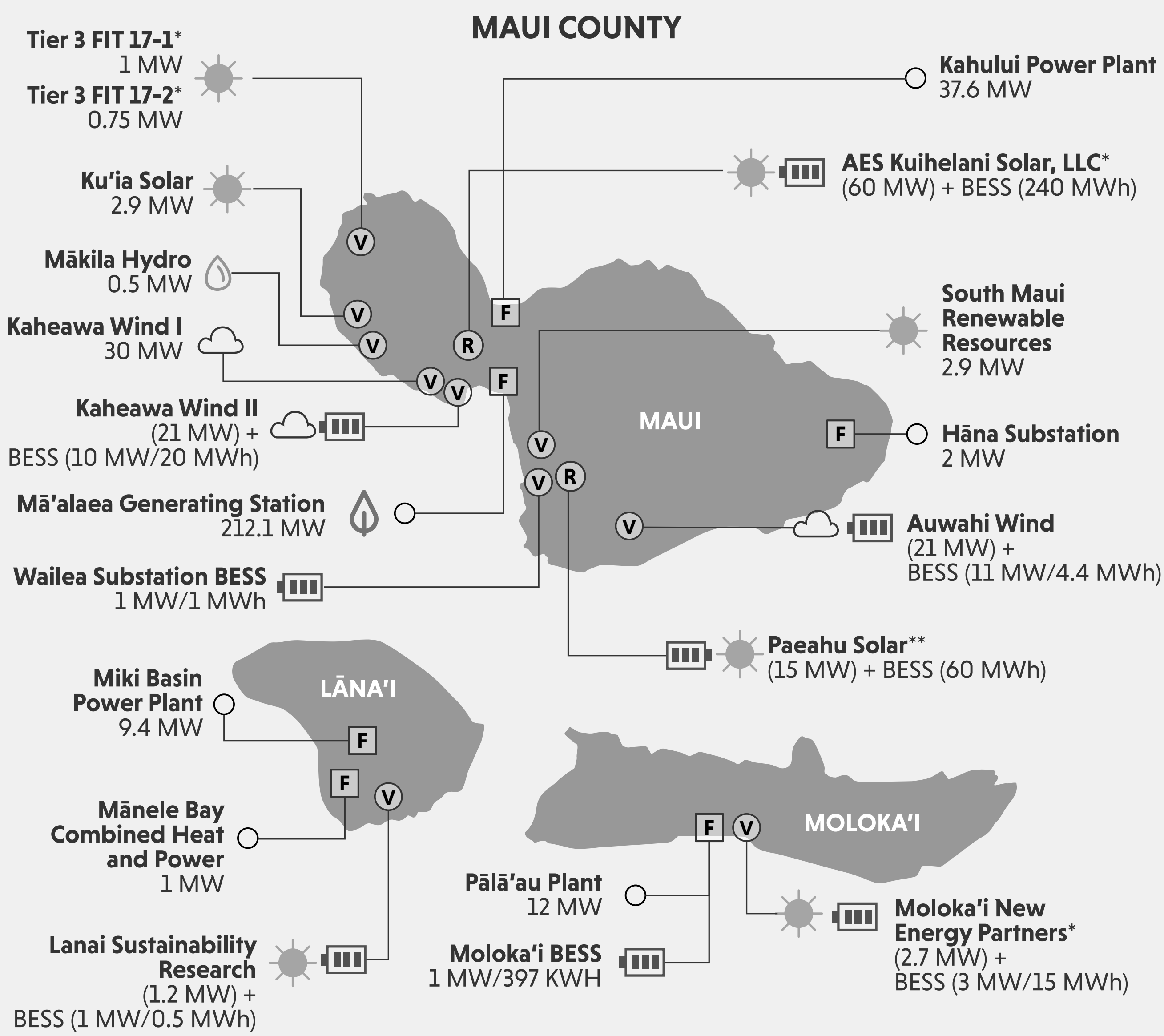
BESS: Battery Energy Storage System

To see the current progress of each of our grid scale renewable projects, visit:
www.hawaiianelectric.com/clean-energy-hawaii/our-clean-energy-portfolio/renewable-project-status-board

Grid-scale Renewables

Existing and planned generating facilities in our service area and the maximum potential power in megawatts (MW) they can produce.

BIOFUELS **HYDRO** **GRID-SCALE SOLAR** **STORAGE** **OIL** **WIND**



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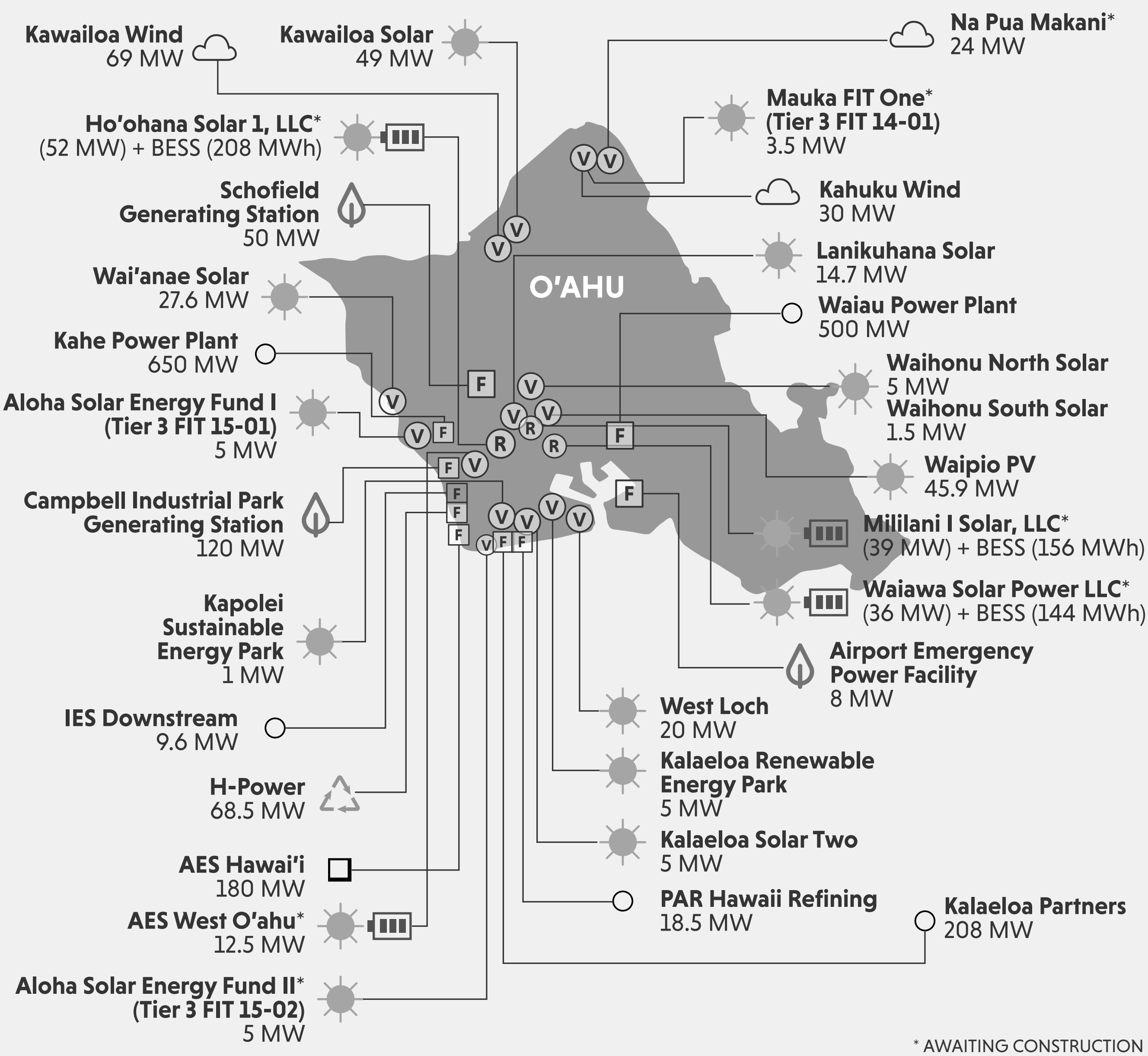
Grid-scale Renewables

Existing and planned generating facilities in our service area and the maximum potential power in megawatts (MW) they can produce.

BIOFUELS | COAL | GRID-SCALE SOLAR | STORAGE | OIL | WIND | WASTE TO ENERGY



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BESS: Battery Energy Storage System

To see the current progress of each of our grid scale renewable projects, visit:
www.hawaiianelectric.com/clean-energy-hawaii/our-clean-energy-portfolio/renewable-project-status-board

Rooftop Renewable Energy

For residential and small business customers who want to reduce their bills by installing solar systems that meet specific program requirements.

Rooftop Solar Options

Many customers already have rooftop solar on homes and businesses. And there are still opportunities and many options for residential and small-business customers to reduce their electric bills and help Hawai'i reach a clean energy future.

Customer Self-Supply (CSS)

Rooftop solar system, with battery optional, designed not to export energy to grid and thus receive no bill credit. Customer pays retail rate for electricity received from grid.

Smart Export

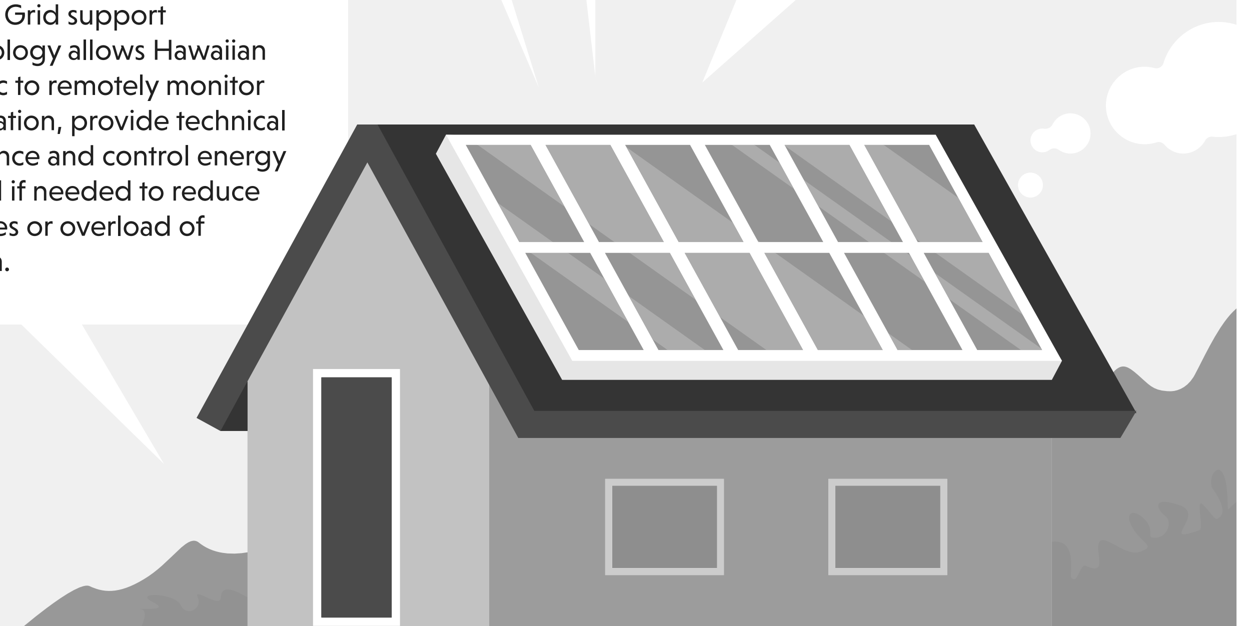
Rooftop solar system with battery storage desirable and option to export energy to grid only 4pm to 9pm. Grid support technology is required.

Customer Grid-Supply (CGS)

Rooftop solar system allowed to send energy to grid for bill credit. Customer pays retail rate for electricity received from grid.

Customer Grid-Supply Plus (CGS Plus)

Rooftop system allowed to send energy to grid for bill credit. Grid support technology allows Hawaiian Electric to remotely monitor generation, provide technical assistance and control energy to grid if needed to reduce outages or overload of system.



Rooftop Renewable Energy

For residential and small business customers who want to reduce their bills by installing solar systems that meet specific program requirements.

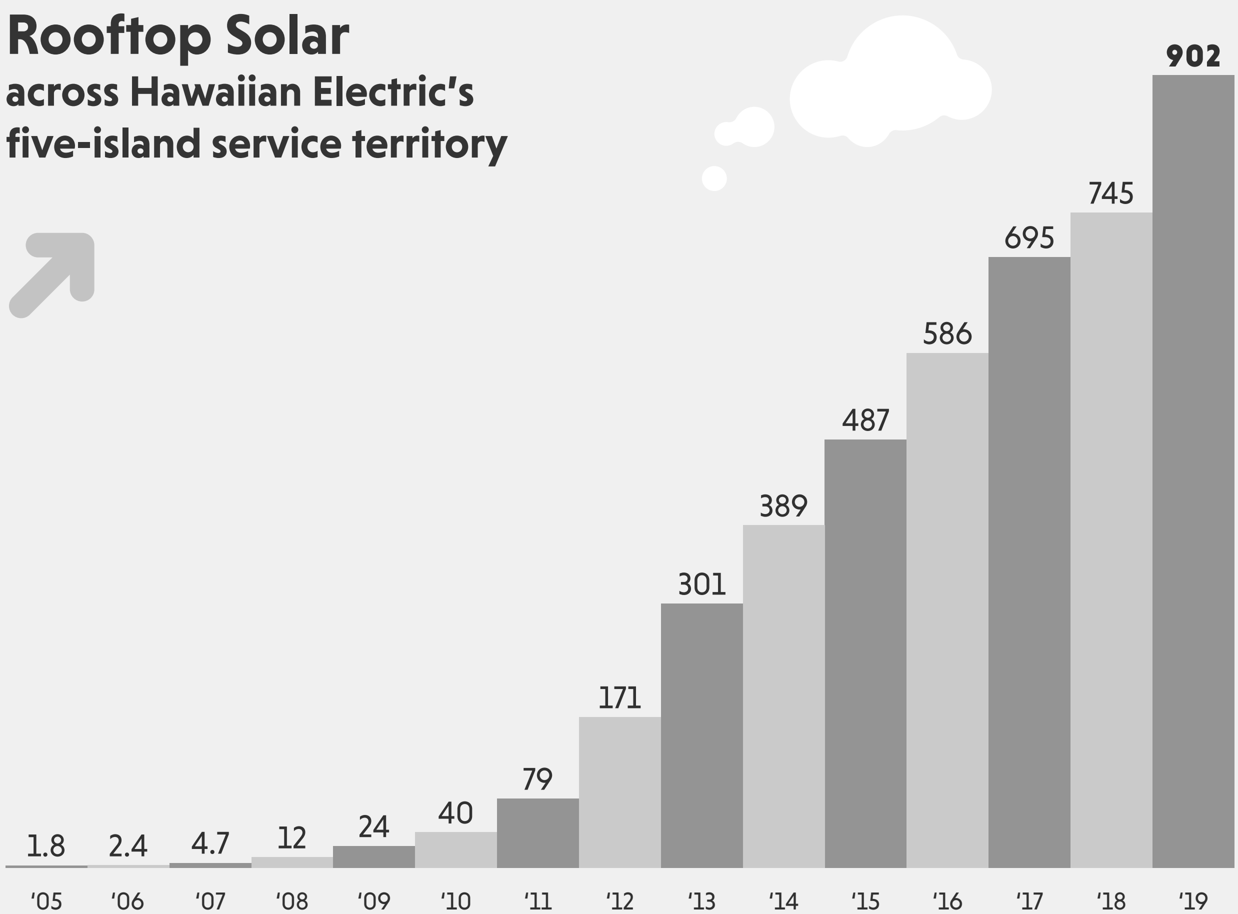
Leading in Rooftop Solar

Thanks to customers, Hawai'i leads the nation in rooftop solar per capita. It's on 20% of houses statewide; 33% on O'ahu. Rooftop solar plays an enormous part in achieving a 28% Renewable Portfolio Standard in 2019.

	Rooftop Solar Systems			Capacity in Megawatts		
	Number	% Residential	% Commercial	Capacity	% Residential	% Commercial
O'ahu	55,353	96%	4%	674	45%	55%
Hawai'i	13,410	94%	6%	103	66%	34%
Maui	13,020	92%	8%	125	57%	43%
Total	81,783			**902**		

Rooftop Solar

across Hawaiian Electric's five-island service territory



Community-Based Renewable Energy

Community-Based Renewable Energy, or community solar, provides a way for participating subscribers without privately-owned rooftop solar to benefit from electricity generated by a renewable energy facility located in their community.

The Next Phase: **'Solar without a Roof'**

Customers who don't own a roof can still save money on their monthly electric bills by joining community solar. Community solar is a hybrid: owned or leased by customers who don't or can't have solar, often because they are renters or live in apartment buildings, but sized and sited like a grid-scale solar facility.

Important Roles

Subscriber

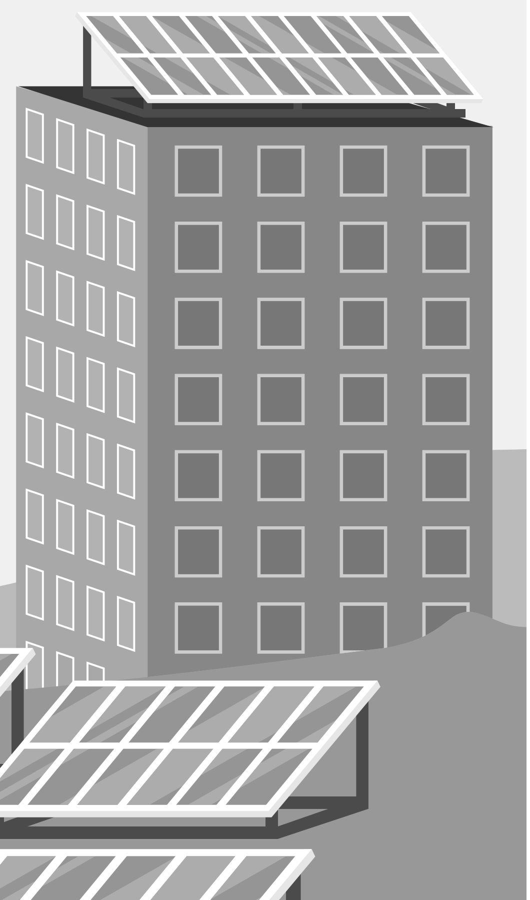
A residential or commercial electric customer who participates, by lease or purchase, in a community solar project and gets monthly bill credits to offset their electricity use.

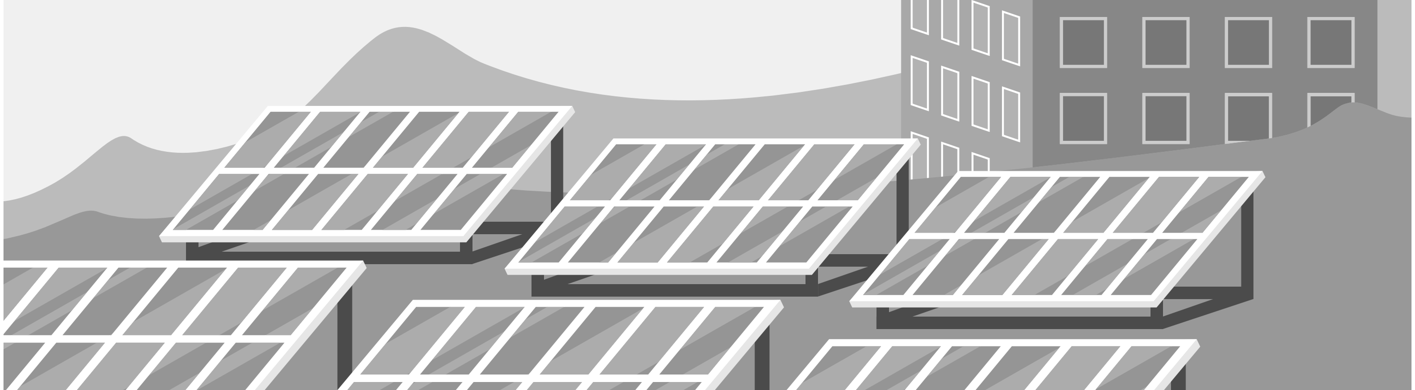
Subscriber Organization

Company, organization or group of people who own, develop or operate a community solar project.

Administration

Hawaiian Electric administers community solar on O'ahu, Moloka'i, Maui, Lāna'i, and Hawai'i Island, supervised by the Public Utilities Commission.





Electrification of **Transportation**

Why Driving an Electric Vehicle (EV) is Good for our Community and All Customers

- Promotes a clean energy future for Hawai'i as clean, renewable energy is increasingly added to the grid
- Reduces need for imported oil
- Reduces fossil fuel emissions and noise pollution

Customer Benefits of Adding More EV

Lower Cost per mile
Save with less maintenance and fueling with electricity

Federal Tax Incentive
Qualify for a credit up to $7,500

Free Parking
At state/municipal garages and metered stalls

High Occupancy Vehicles/ Zipper Lane Access
Use while driving solo

Clean Air
Produce fewer emissions, charge with renewables

Customer Cost Savings
Helps align grid needs, mainly during the day

Incentives for Customers

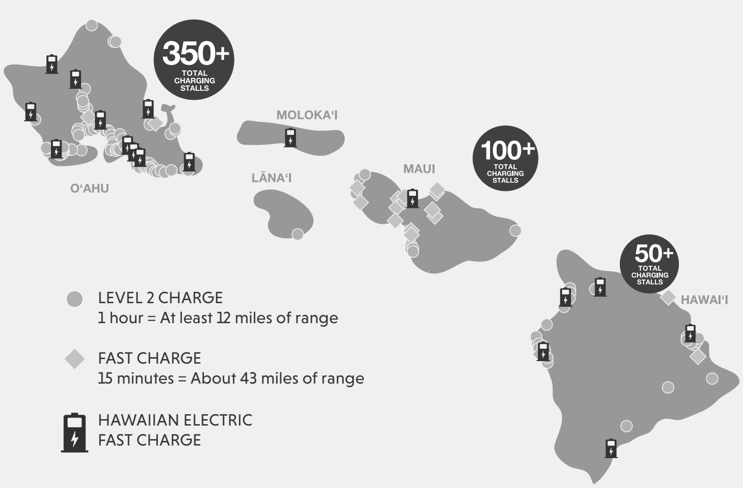
Nissan LEAF Rebate
Show your utility bill and save on a new Nissan LEAF

EV Charging Station Rebate
Offset costs for the commercial installation of charge stations with the state rebate administered by Hawai'i Energy.

How EVs will Affect Your Electric Bill

- Customers charging EVs at home may stay on their current residential rate or may qualify for a time-of-use rate which provides an opportunity to save by using energy during certain times of day when solar power is most abundant.
- Commercial customers may qualify for a time-of-use rate for one or more charging stations on their own electric service.
- Over time, all customer will save money as more EVs charge on the grid, and have the opportunity to save more as drivers participate in Smart Charging programs that incentivize EV charging to align with grid needs.

EV Charging Locations

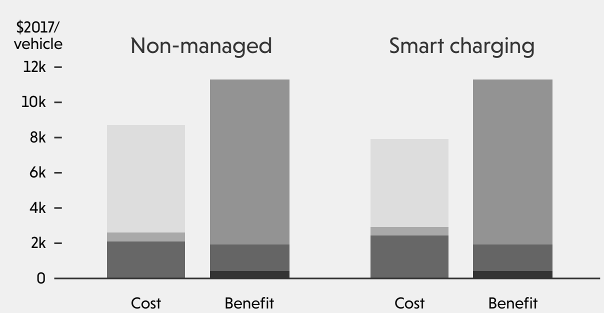


LEVEL 2 CHARGE
1 hour = At least 12 miles of range

FAST CHARGE
15 minutes = About 43 miles of range

HAWAIIAN ELECTRIC
FAST CHARGE

Savings

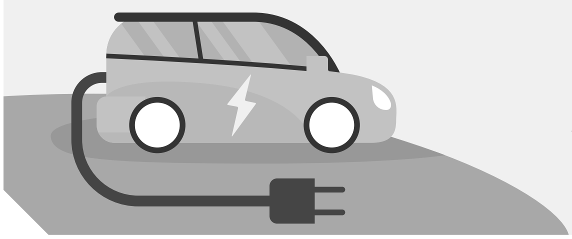


EV Electricity Supply Cost
Upfront Incremental EV Cost
Charging Infrastructure Cost
Avoided Vehicle Gas
Vehicle O&M Savings
Federal EV Tax Credit

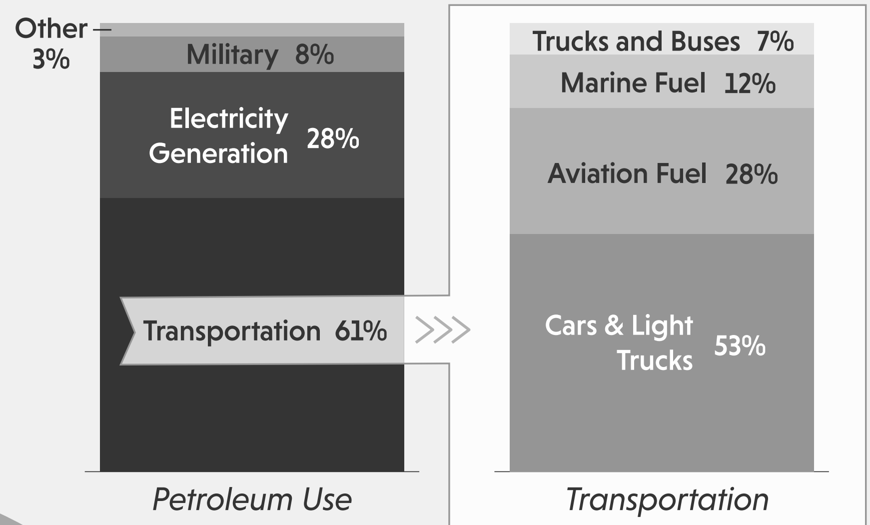
Electrification of **Transportation**

Electrification of Transportation (EoT) plays a key role in allowing us to integrate more renewable energy generation.

Here in Hawaiʻi, we are uniquely positioned to be a leader in the clean transportation revolution. Hawaiian Electric's **Electrification of Transportation Strategic Roadmap** outlines key initiatives to pave the way and achieve a clean energy future.

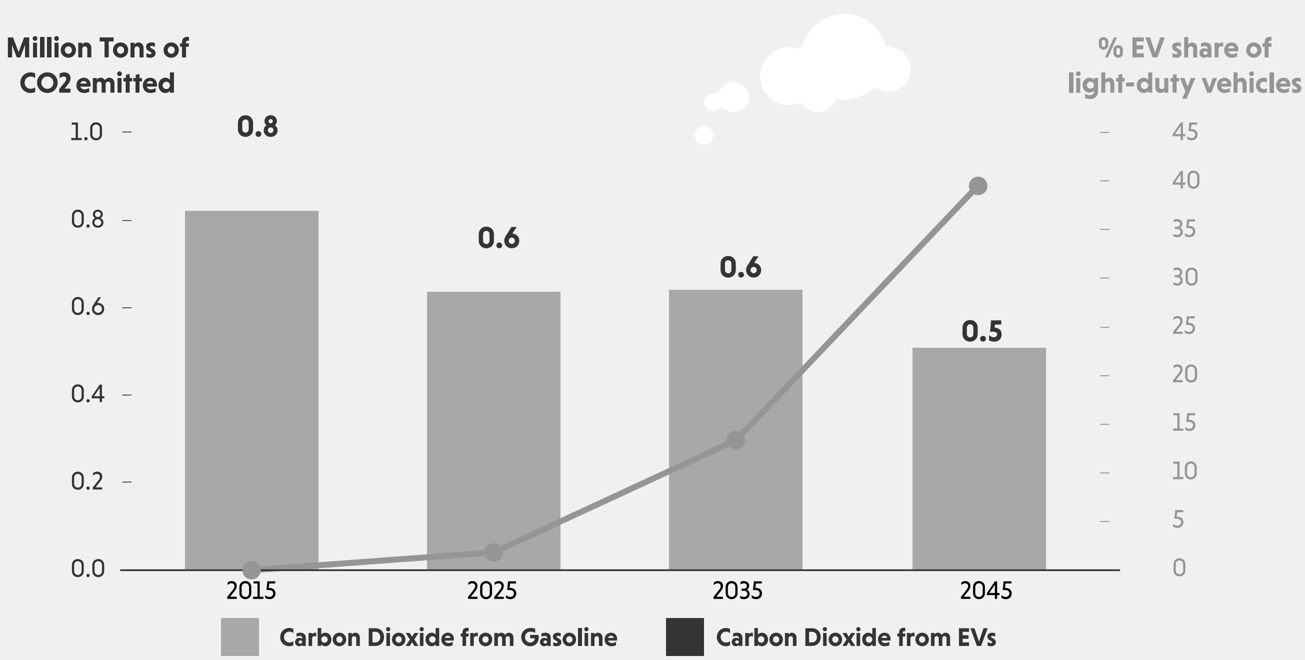


Hawaiʻi fossil fuel consumption by sector 2015



Reducing CO2 Emissions with Electric Vehicles

Forecasts show roughly 40% of all light-duty vehicles will be electric by 2045 on Hawaiʻi. This reduces CO2 emissions as the state reaches the 100% Renewable Portfolio Standard goal.



What This Means

- The state s emission of CO2 from gasoline will be reduced as EV adoption increases and there are less gasoline cars on the road.
- As more EVs are on the road and as the state transitions to meet the 100% RPS goal by 2045, CO2 contribution from EVs will decrease over time.
- Benefits not only include decreasing CO2 emissions, but also fossil fuel and noise reduction.

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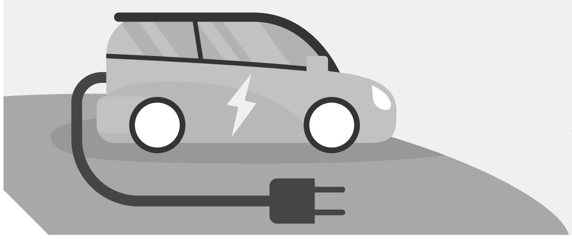
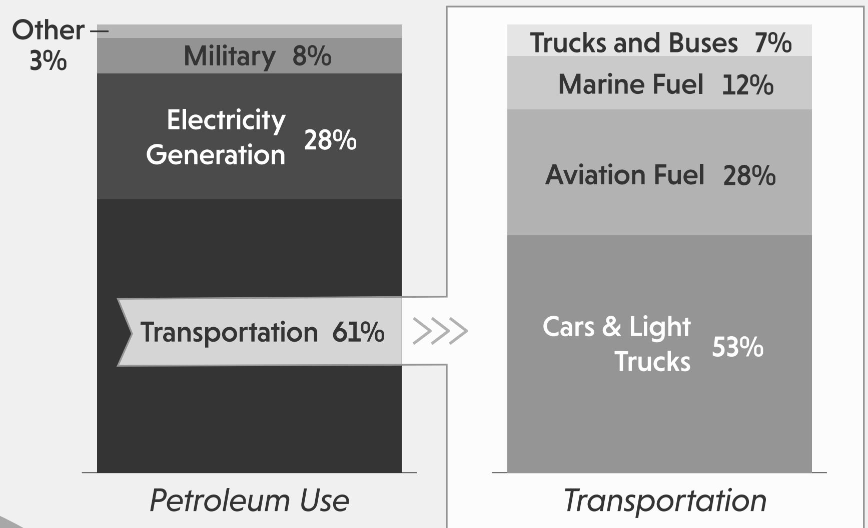
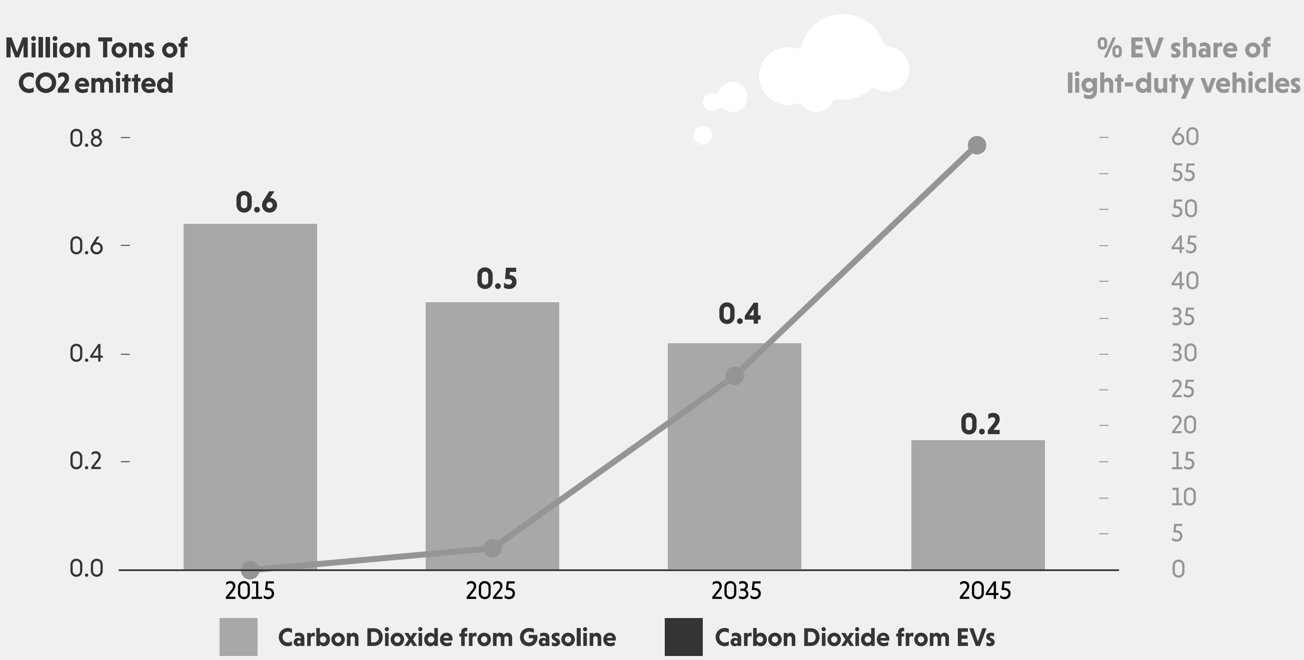


Hawai'i fossil fuel consumption by sector 2015



Reducing CO2 Emissions with Electric Vehicles

Forecasts show nearly 60% of all light-duty vehicles will be electric by 2045 on Maui. This reduces CO2 emissions as the state reaches the 100% Renewable Portfolio Standard goal.



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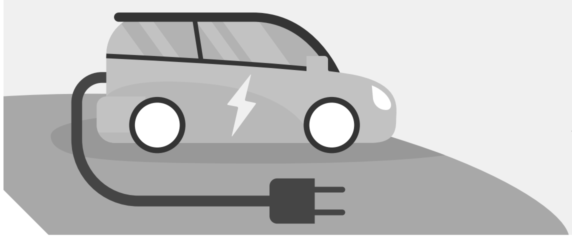
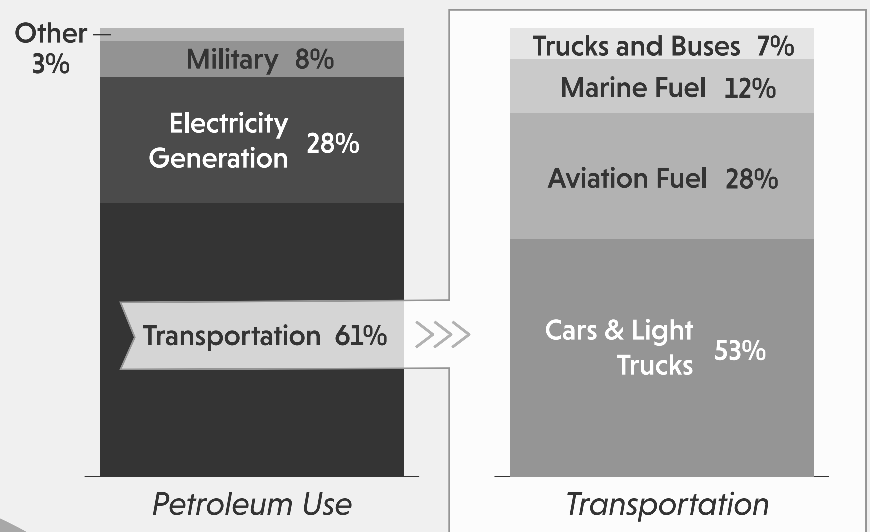
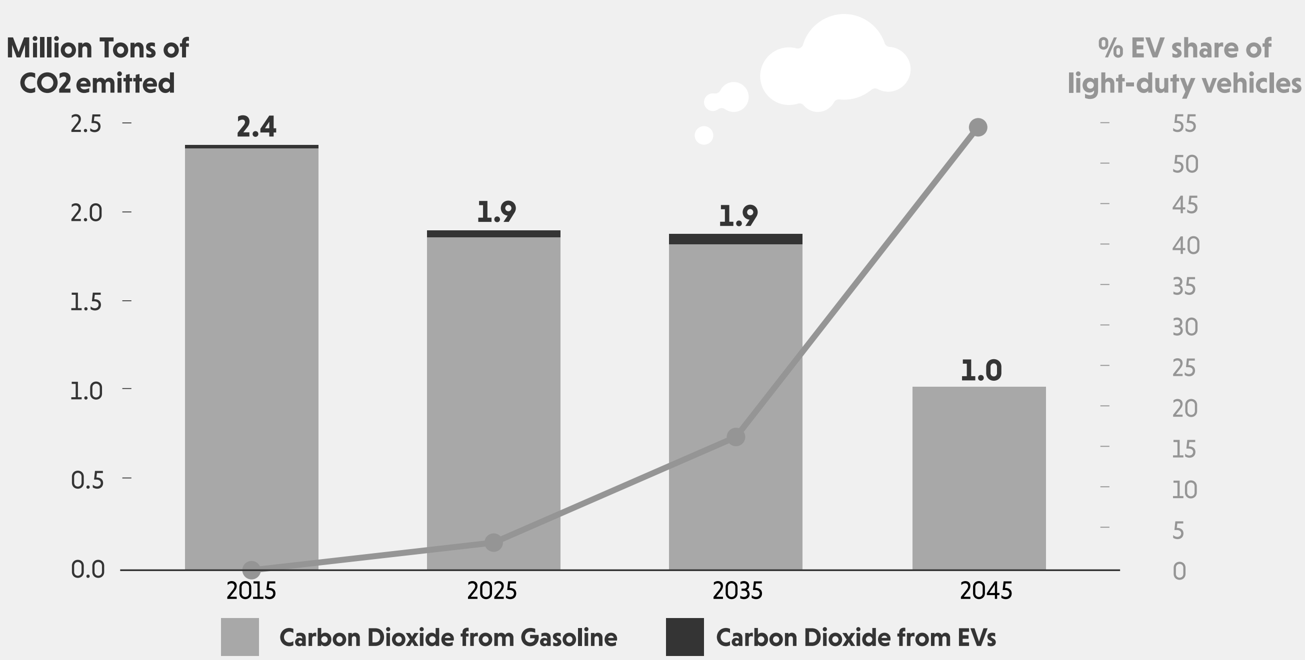


Hawai'i fossil fuel consumption by sector 2015



Reducing CO2 Emissions with Electric Vehicles

Forecasts show 55% of all light-duty vehicles will be electric by 2045 on O'ahu. This reduces CO2 emissions as the state reaches the 100% Renewable Portfolio Standard goal.



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Resilience

"Resilience is the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions." – *Public Utilities Commission Staff*

Making our Grid More Resilient

Besides strengthening our existing infrastructure and being better prepared for disasters, we must also consider the future as the grid evolves and new technology emerges. As Hawaiʻi moves toward 100% clean energy, we must ensure that the decisions we make will make the grid even more resilient than it is today.

Kīlauea Volcano Eruption

Key Planning Elements

» Minimize impacts of severe events
» Sustain mission critical functions under severe conditions
» Rapidly recover from a severe event
» Learn from severe events and continuously adapt

Threat Scenarios

Hurricane

Tsunami/Earthquake

Physical/Cyber Attack

Volcano

Solution Options

Here are some examples of how we can make our grid even more resilient in the future:

» Increased emergency resources
» Microgrids
» Structure hardening
» Targeted undergrounding
» Renewable generation diversity
» Distributed resources
» Customer programs

www.hawaiianelectric.com/about-us/our-vision-and-commitment/resilience

Looking for a New Challenge?

A career at Hawaiian Electric is a chance to make a positive impact in Hawaiʻi while building a career in a fast-moving industry.

Emerging Markets

Cultivate new market opportunities in areas from electric vehicles to cutting edge renewable technologies.

New Concepts

The circular economy (an economic system aimed at continual use of resources), grid modernization, artificial intelligence (intelligence demonstrated by machines), machine learning (communication between computers and humans), and blockchain (encrypted data) are being implemented at Hawaiian Electric to meet the energy needs of our customers.

Innovative Solutions

Help generate unique solutions and use innovation to adapt to changing climate conditions and maintain reliable service for our islands.

JOIN THE TEAM

Hawaiian Electric

Career Information

hawaiianelectric.com/careers

linkedin.com/company/hawaiianelectric

facebook.com/HawaiianElectric

twitter.com/hwnelectric

instagram.com/hawaiianelectric

Together, We Build a Better Hawai'i

Since 1891, we have been entrusted to power these islands and empower its citizens — a responsibility that has been both our mission and our honor.

Community Engagement

Our connection to customers and commitment to build a better future for Hawai'i is what drives our community service initiatives. Each year, we aim to strengthen our ties with the community through increased outreach activities and partnerships.

Educational programs

Hawaiian Electric partners with government and community organizations to reach children of all ages on topics related to energy, renewable energy, technology, engineering, math, science, emergency preparedness, electrical safety, the environment and more.

Generous Benefits

We invest in our employees by providing opportunities for rewarding careers, apprenticeship training and job advancements. We offer a competitive compensation and benefits package that includes a robust wellness program.

We Want to **Hear From You**

We welcome your input! Here are the many ways to stay connected with us.

Email:
IGP@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

HawaiianElectric

hwnelectric

hawaiianelectric

Listening + Integrating + Collaborating to Reach 100% Renewables by 2045

Integrated Grid Planning

Rank the following in order of importance, where 5 is the most important to you.

	Least important 1	2	3	4	*Most important* 5
Lowering energy costs					
Helping to increase the use of renewable energy					
Adopting new technologies to provide customers with more information and control of their energy usage					
Energy reliability					
Reducing greenhouse gases					

Integrated Grid Planning

What change at your home or business do you plan to make to help Hawaii get to 100% renewables

Purchase an energy saver appliance

Install an advanced meter

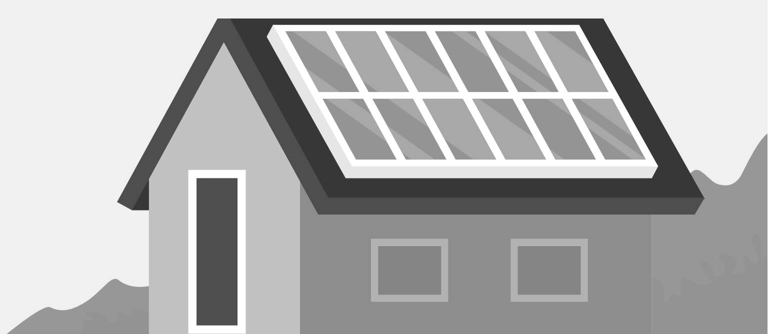
Use LED lights

Integrated Grid Planning

How interested are you in doing the following?	Already have/do	Actively pursuing 1–2 years	Waiting 3–5 years	Interested need more info	Not interested
Installing rooftop solar					
Installing an advanced meter					
Installing a battery storage system					
Buying an electric vehicle					
Using transit or carpooling regularly (most trips)					
Installing a grid interactive water heater					

Integrated Grid Planning

What type of help would you need to make renewable or energy efficient upgrades to your home or business?



Meetings Comments/Questions

Hawaiian Electric's responses to comments and questions submitted from virtual and in-person public meetings held in Honolulu, Hilo, Kona, and Maui.

SUBJECT	ISLAND	QUESTION	RESPONSE
Agriculture	Oahu	It seems that we can strike a good balance for land use by having solar farms with vertical farming? What's your position on vert farming	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.
Agriculture	Oahu	since renewables aren't allowed on Class A ag lands, is there really a tension with farming?	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.
Agriculture	Oahu	the vast majority of B and C lands are not used. Is there really a tension with energy?	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.
Agriculture	Oahu	How can you put ag second to renewables-all panelists	Ground-based solar photovoltaic facilities and agricultural production compete for land -- especially on Oahu where the land available for larger projects is diminishing. Typically land use decisions are in the hands of landowners. However, regulations, such as zoning rules and environmental restrictions, can limit land use options and we, like others, must abide by them. Panelists representing agriculture were invited by Hawaiian Electric to have the discussion regarding land usage priorities, generate public awareness, and solicit input regarding appropriate land use issues because we believe that informed land use decisions and public policy that balance energy AND agriculture need to be made considering the interests of both.
Agriculture	Oahu	in most of the US renewables supplement farming income. Why not in Hawaii?	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.
Agriculture	Oahu	What type of "pollinators" or food crops would grow well beneath a PV array / farm? (Panelist from Farm Bureau)	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.
Agriculture	Oahu	What type of plants that would attract pollinators would grow well under PV?	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.
Agriculture	Oahu	why should we prefer GMO seed farming over solar?	Hawaiian Electric does not claim to have expertise in agriculture or farming As such, the Company is not able to provide a response to this question.

SUBJECT	ISLAND	QUESTION	RESPONSE
Avoided energy	Maui	How are avoided energy costs calculated?	"Hawaiian Electric interprets ""avoided energy costs"" in this question to refer to the value of grid services. The value of grid services is determined by calculating the future costs that could be avoided by implementing a solution. For more information on the methodology used, please refer to presentation slides from the Solution Evaluation and Optimization Working Group's April 20, 2020 meeting, available on the Company's website here: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200420_wg_seo_meeting_presentation_materials.pdf.
Biomass	Hilo/Kona	Is biomass generation planning/working with the county on using bio-waste (IE; paper, cardboard, garbage)? If not, why not?	Hawaiian Electric is not aware of biomass generation planning in Hawai`i county and therefore is not able to provide a response to this question.
Biomass	Hilo/Kona	Will biomass plant have filtered smokestacks?	According Hu Honua's air permit the biomass plant will have Boiler Electrostatic Precipitator (ESP), Baghouse, and Nalco Rotating Mix (ROTAMIX) Urea Injection System or equivalent (SNCR) for their air emission control.
Biomass	Hilo/Kona	Please explain how clean biomass burning is. What materials will be burned?	Fuel for the Facility shall be biomass, primary fuel for the boiler will be initially eucalyptus or other wood chips from local plantations, with a plan to introduce leucaena or other wood chips from trees sourced by Seller.
Biomass	Hilo/Kona	My question is about the biomass. Burning trees release carbon into the atmosphere. Is there anything being done to reduce the amount of carbon being released back into the environment? I worked at a coal power energy plant and they installed 'scrubbers.' Is there anything like that for biomass?	According Hu Honua's air permit the biomass plant will have Boiler Electrostatic Precipitator (ESP), Baghouse, and Nalco Rotating Mix (ROTAMIX) Urea Injection System or equivalent (SNCR) for their air emission control.
Biomass		One response to mitigating climate chaos is to plan trees. Ho Honua burning of trees is opposite of what needs to be done. Misuse of term "renewable".	Per Hu Honua, for every 100 trees that are burned by the facility, Hu Honua will replant 105 trees to make it carbon neutral.
Building permits	Maui	What's County doing to reduce steps to get bldg permits and incentivize construction companies committed to meet 100% renewal energy goals?	Hawaiian Electric is not able to provide a response to this question. This question would better be answered by the appropriate county permitting agencies.

SUBJECT	ISLAND	QUESTION	RESPONSE
CBRE	Hilo/Kona	With tax credits being greatly reduced, how do we plan on contributing to make going solar affordable for residents? What are the alternative options in place for those residents If they are unable to get solar – IE; renters, old roofs, old bad main panels or wiring?	The Public Utilities Commission recently approved a new round of community solar, a program specifically designed so those who cannot or choose not to put solar on a single-family home roof can participate in the solar movement and save money. The new round will include more and larger projects which we are designing to appeal to more residential customers, including those with limited incomes who may not be able to make a large down payment. We hope to see this new round opening to residential subscribers later this year. We have developed a portal that you can preview through our website that should be available in June that will show what projects are available on your island so you can shop for a subscriber organization to belong to.
CBRE	Hilo/Kona	"Please update status of community solar projects. When will customers have an opportunity to buy in? (2) subscriber organizations on Hawaii Island, not yet built o Very dependent on installer's timeline to build and be in service o PUC gave 1 MW capacity on HI Island, fully allocated to developers (phase 1) o We asked PUC for 263 MW for HI island to create more opportunity (phase 2) o Portal will be available in June to see what projects are available on your island, shop for subscriber organization"	The Public Utilities Commission recently approved a new round of community solar, a program specifically designed so those who cannot or choose not to put solar on a single-family home roof can participate in the solar movement and save money. The new round will include more and larger projects which we are designing to appeal to more residential customers, including those with limited incomes who may not be able to make a large down payment. We hope to see this new round opening to residential subscribers later this year. We have developed a portal that you can preview through our website that should be available in June that will show what projects are available on your island so you can shop for a subscriber organization to belong to.
CBRE	Maui	What's the status of community solar in Hawaii?	The Public Utilities Commission recently approved a new round of community solar, a program specifically designed so those who cannot or choose not to put solar on a single-family home roof can participate in the solar movement and save money. The new round will include more and larger projects which we are designing to appeal to more residential customers, including those with limited incomes who may not be able to make a large down payment. We hope to see this new round opening to residential subscribers later this year. We have developed a portal that you can preview through our website that should be available in June that will show what projects are available on your island so you can shop for a subscriber organization to belong to.
CBRE	Oahu	Have there been or will there be community solar projects as part of the smart grid?	Yes, present and future community solar projects, as well as new renewable energy projects being chosen through the grid-scale project procurement process are all part of integrated grid planning and are part of the "smart grid" as they can be "seen" by system operators. Even some newer rooftop solar systems can be seen and controlled by system operators when necessary. Also, through demand response – programs that incentivize customers to shift or reduce their energy use – customers are playing a larger partnership role – what's sometimes called a "prosumer" role in managing the smart grid of the future.
Comment	Hilo/Kona	Thank you for Ron Terry's analysis- very much appreciated!	No response required

SUBJECT	ISLAND	QUESTION	RESPONSE
Comment	Oahu	Can you bring back the survey? Didn't get get vote in	No response required
Community impacts	Hilo/Kona	How are we enforcing environmental & social justice as we address our goals? (Submitted by Noel Morin)	In regards to renewable energy development, communities want transparency, the opportunity to engage in meaningful dialogue with developers, and to participate in the process. Hawaiian Electric is continuing to update its renewable energy procurement processes to strengthen community engagement requirements and to have community concerns addressed through careful listening, thoughtful responsiveness, and a commitment to respect the environmental and cultural values of Hawai'i.
Community impacts	Maui	What is your advice for addressing NIMBYism?	Demonstrating transparency and a willingness to engage in early and frequent communication with Hawaii's communities is critical. When proposing projects, developers (including Hawaiian Electric) must share information and work with communities to address concerns through careful listening, thoughtful responsiveness, and a commitment to respect the environmental and cultural values of Hawai'i.
Community impacts	Oahu	are communities justified in asking why smaller scale infrastructure is not prioritized over "siting" larger scale projects?	Hawaii needs both smaller scale and larger scale resources to achieve our 100% renewable goals. We are already very close to having reached the 2045 goal on Hawaii, Maui, Lanai and Molokai. On Oahu, we expect that smaller scale renewable projects will become the primary means of achieving our goals as the land available for larger projects is diminishing. In summary, achieving the 100% renewable portfolio standard goal by 2045 will require a combination of utility resources and customer owned distributed resources.
Community impacts	Oahu	will HE decline RE PPAs that are not in favor with commmnity (Kahuku/ AES)?	Each potential site has both a zoning and permitting process which includes opportunities for the community to make their concerns known. We encourage the community to provide input during the zoning and permitting processes in order for the decision-makers to consider all viewpoints when deciding on land use issues. In the end, the important interests of one community must be balanced and weighed against the equally important broader state community interests.
Community impacts	Oahu	Native Hawaiians have a right to access undeveloped land, we must consider alternatives to greenfield development. What r they?	Cynthia Rezentes - I am not sure what you mean by greenfield development but there is some right of access that needs to be determined. Does that mean Native Hawaiians should have a right to access "undeveloped land" for any purpose or traditional purposes? Does a greenfield development mean we should erode or remove undeveloped land which has resources utilized by practitioners of traditional cultural purposes. Does it have to be one or the other? Why can't there be an open discussion over how there should be a sharing of resources so all parties have at least a semblance of respect to provide for their families in a traditional manner versus those that chose differently?
Community impacts	Oahu	how do you fell abt social justice for the impacted communities. On Oahu projects are sent to the poorer and rural areas	The projects often migrate towards areas where the accessible land is available which often results in more rural sites. The panel discussion on this topic was intended to make customers aware of the issue and solicit input from the community. We encourage the community to provide input during the zoning and permitting processes in order for the decision-makers to consider all viewpoints when deciding on land use issues.

SUBJECT	ISLAND	QUESTION	RESPONSE
Community impacts	Oahu	what if accelerating large renewables forces unwanted projects on communities? Do you think 100% RE justifies any project?	Ideally, there would be a robust community process before the project is approved by the PUC to address this concern. The reality is that renewable energy projects are sometimes seen as being “disruptive” because they are high-profile or new to the community. But, this is only relative to how “unseen” legacy energy plants are in those communities. For example, if asked whether they’d prefer living next to a coal or diesel plant, versus a solar farm or turbine, the answer may change. We often don’t see what has been there for decades. This is true for the decades-long impact that coal or diesel plants have had on the broader community and natural environment, while the benefits of renewables (e.g., cleaner air, lower prices over time, etc.) can seem intangible and somewhere in the future. Likewise, we should acknowledge the very real impacts other communities continue to shoulder while hosting existing coal and diesel plants or other infrastructure. In response to the second part of the question, no. Economic impacts to customers should also be considered, such as whether the renewable energy project will increase or decrease customer bills and over what duration/period of time. It should also be considered that new renewable energy will allow for the eventual shutdown of fossil fuel plants with much larger impacts on the community. In addition, it may be possible for energy generated from a project to directly power the community in which it is located or adjacent. There are some potential inefficiencies to consider if we chose not to have 100% of the generated electricity go to the island grid; however, those may be worth it if it cultivates community acceptance by drawing a more direct link between the project and benefit to the community in the form of “home-grown” electricity.
Community impacts	Oahu	For Cynthia. Do other parts of Oahu owe Nankuli a historical debt, for hosting energy infrastructure since the 60s How can we pay it?	I do not believe that anyone "owes" Nanakuli for hosting energy infrastructure since the 60s (although I am sure other believe that debt is owed). I believe that other communities need to acknowledge that debt and work to not increase that debt by continuing to pursue and support projects which add to that debt and additional health concerns. When we say enough is enough, we mean it. You have never had to pass Waimanalo Gulch Sanitary Landfill in the 90's when to do so meant either putting up all the windows in your car or holding your breath until you passed the area because of the stench coming off the landfill at that time. Without fighting that landfill and essentially forcing the CCH and Waste Mgmt to get their act together and better manage and take care how the trash should be handled, we would probably still be experiencing those issues.
Community impacts	Oahu	what if communities could identify sites and technologies that are acceptable, to inform long range plans and RFPs	I believe all communities should figure out their own role in how to identify how they will take on their own responsibility to provide needed energy development for themselves. One example is all of the high-rise buildings in Kakaako should be developed with solar panels on their roofs or other environmentally friendly and energy reducing activities, perhaps a roof top garden which would allow for watering of the garden leading to a cooler roof and reducing some energy, doing roof top solar water heating rather than the requirement to heat water for unit use, etc. ANYTHING that would contribute to the solution rather than just take more away from those not able to afford those monstrosities.
Community impacts	Oahu	does OEDB supporting the Molokai Half Moon project heal or hurt the community?	I believe that a project doesn't heal a community. It seemed at the night of the community meeting the foundational takeaway is that earning trust and confidence heals and reduces hurt. It's up to a community if they want the project.

SUBJECT	ISLAND	QUESTION	RESPONSE
Community impacts	Oahu	what if people don't want a project in their community even after discussing options?	Likewise, we should acknowledge the very real impacts other communities continue to shoulder while hosting existing coal and diesel plants or other infrastructure.
Community impacts	Oahu	some communities view RE as a negative impact and some as a benefit. How to measure this?	Murray Clay - This is often because existing facilities, such as legacy coal and diesel plants, often go "unseen" because they have been in place for decades – with the community somewhat desensitized to their impact. For example, if asked whether they'd prefer living next to a coal or diesel plant, versus a solar farm or wind turbine, the answer may change. Also, we should not dismiss the larger impact that other communities have been dealing with for decades because of their proximity to coal or diesel plants. The community in Hawaii seems very much against the effects of climate change – drought, more frequent and severe storms, coastal homes and beaches eroding into the sea. The desire to avoid climate change aligns directly with the desire for more renewable energy. Cynthia Rezentes - I think renewable energy is not good or bad in it's own right. It really is a matter of how it impacts the surrounding community. E.g. a large solar farm in the middle of the island means farm land taken out of production or at least the potential of production and meaning more goods to continue to be received from elsewhere to feed our people. View planes are affected depending on where it is located. How about putting solar panels on the side of Diamond Head? Good angle...good access to unimpeded sunshine, close to Honolulu needing less transmission lines, gets rid of the homeless on the slopes, nice beacon for anyone looking from the ocean, etc. For me it would be a benefit (no more in my community) but perhaps a negative impact for those who live on the "gold coast" near there. I think if asked, most folks in Honolulu would consider renewable energy a benefit since they don't have to look at it and are deluded into thinking it will reduce their energy costs. But if you ask someone who has to live near it or see it on a regular basis when they are used to seeing vegetation or open areas, not so much. Who's right...depends on your view. Another way to look at this is the age-old question of where to put landfills. We are tired of hosting the landfills for the entire island... but if proposing other locations, those communities, of course, say that that selection is not a good area for a new site (I recommended Koko Crater once and had to make sure to duck when the virtual daggers came my way). A lot is a matter of perspective without consulting the entire community to figure out a balance or how to accommodate all the infrastructure required for today's economy. Again, Honolulu Harbor hosts the larger maritime port for the island (don't forget Kalaeloa though, it is not insignificant either), while the Westside hosts the oil refineries, landfills, Trash-to-power plant, etc. Who owes what to whom? Should there be discussions to decide who hosts what and how everyone can contribute to the entire plus side of the equation instead of various projects/agencies pitting communities against one another by the decisions they make. Is it a tough ask and process? Hell yes! but what is the alternative? Forcing things down communities throats?

SUBJECT	ISLAND	QUESTION	RESPONSE
Community impacts	Oahu	residents of urban Honolulu host, for example, the harbor. But rural residents benefit. Should we balance that with hosting RE	We have a harbor also on our side. If that one is not available Honolulu harbor would be even more hard pressed to provide some of the amenities that we all enjoy. Should that balance the need to provide renewable energy????? How many acres are involved and how do we control the where of renewable energy as Honolulu Harbor is contained not spread out over the entire landscape. Can we do solar for all within the same amount of space that Honolulu Harbor takes up and where, on our farmlands to further reduce produce production and more reliability on imported goods? I think a robust discussion is in order to figure out who, what, where things are located for "sharing" the burden of today's living concerns.
Community impacts	Oahu	how to assess the importance of community impacts that are inconsistent with the science - eg EMF sensitivity	Hawaiian Electric understands that some customers may have concerns regarding electric and magnetic fields (EMFs). Safety is our top responsibility, not only for our employees but for our customers and the general public. As a result, Hawaiian Electric continues to monitor the latest research on EMF and provide information to customers at the following link: https://www.hawaiianelectric.com/clean-energy-hawaii/grid-modernization-technologies/understanding-electric-and-magnetic-fields.
Company generation	Hilo/Kona	Since all fuels have impacts, what is HELCO doing to become more energy efficient?	Hawaiian Electric believes the best way to keep our generators operating efficiently is to monitor and maintain our generation facilities to industry standards. Current regulation by the Hawaii PUC have provisions that incentivizes the utility to run its generation system as efficiently as possible. It includes a reward and penalty provision, depending upon performance.
Competing priorities	Oahu	does it help or hurt transpo. decarbonization to frame electrification as a "Tesla" movement?	Who framed the transportation decarbonization as a "Tesla" movement? I recall that my words were an observation that some Tesla Drivers are some of the biggest jerk drivers and this was a statement to bring awareness that we can drive initiatives and simply think that the goal is what our Community needs rather than civility, kindness, and caring. We could get to our 100% goals and be a community so divisive because the goals forgot to address our behaviors with each other.
Competing priorities	Oahu	So we get that there are competing priorities. What is the forum where we equitably come up with a fair plan in an urgent timeframe?	As part of Integrated Grid Planning, Hawaiian Electric is evaluating and implementing new ways to connect with stakeholders and communities to engage in dialogue that enables participants to provide informed input in the planning process. Utilizing tools like virtual open houses and convening panel discussions with different perspectives to provide a holistic view of the challenges, opportunities, and tradeoffs necessary to reach our clean energy goals.
Decarbonization	Maui	You talk about 100% renewable energy. Do you also mean 100% carbon free? If not, why not?	Hawaiian Electric plans to meet the renewable portfolio standard (RPS) requirements as mandated by State law. However, some renewable projects are not 100% carbon free or carbon neutral especially when considering emissions generated over their entire lifecycle. The current state law and policies are focused on renewable energy additions and Hawaiian Electric must comply with current laws as it develops plans to achieve them.

SUBJECT	ISLAND	QUESTION	RESPONSE
Decarbonization	Oahu	where's IGP, RPS, PBR etc. for The Gas Co.?	This has been actively discussed by legislators in recent years, and we are hopeful it will be worked out to the greatest community benefit over time. But right now, we are focused on larger utilities for the greatest impact and benefit in alignment with state energy goals. We are encouraged by recent progress. On April 29, the PUC surprised many within the industry by issuing an order that demonstrates how serious commissioners are about moving away from the traditional "Cost of Service Regulation" toward the more forward-thinking PBR, a regulatory framework that is more focused on the utility's performance and achievement of public policy goals. Renewable energy advocates celebrated this decision, as it establishes a key element of PBR allowing for cleaner, more sustainable forms of energy generation in alignment with our state's energy goals, and will aid in Hawaii's economic recovery and long-term energy resilience.
Decarbonization	Oahu	Some states are adopting decarbonization policy as opposed to an RPS. Decarbonization provides more flexibility to balance needs. Agree?	A decarbonization policy may provide more flexibility in how the state and the Company reduces its reliance on fossil fuels; however, proven technologies and methods by which to reduce and capture carbon need to be available within the State of Hawaii for a decarbonization policy to provide flexibility.
Decarbonization	Oahu	Comment - disagree that decarbonization policies are more flexible. I have read every state'a policy. All constrain eligible resources	A decarbonization policy may provide more flexibility in how the state and the Company reduces its reliance on fossil fuels; however, proven technologies and methods by which to reduce and capture carbon need to be available within the State of Hawaii for a decarbonization policy to provide flexibility.
Demand response	Oahu	if competition is a good thing, why not have open grid access for DR?	If there is unlimited interconnection of DG, then there could be grid reliability/safety issues with backwards power flows from the distribution lines to the substations. Also, if "open access" refers to net energy metering (NEM), then solar exporters essentially could pay nothing for transmission and distribution and would be using the grid for backup (especially at night) without contributing to the costs of running the system (if they were net exporters). This is why NEM was a benefit for early adopters but could not be maintained in perpetuity.
Disposal	Maui	We must start with the end in mind. How, who, and where will the inoperable systems be disposed of? Are there systems that are reuseable?	Our contracts with third parties that build, own, and operate powerplants and sell power to us contain a provision requiring the Seller to remove the interconnection facilities once the contract is no longer valid. In addition, there is a requirement for the development of a program to recycle or otherwise properly dispose of the removed infrastructure. Depending on the technology and individual configuration, there may be portions of the facilities that are reusable. Developers are responsible for working with the land owner where non-interconnection equipment is sited and to follow such landowners requirement for removal of such equipment.
Disposal	Maui	Is PV considered to be the lead renewable energy source for the RPS? And if so, how will we eventually dispose of these panels?	The company does not have a lead renewable energy source in mind for reaching RPS. While the Company has procured a significant amount of PV+BESS in recent years, in order to reach 100%, it is anticipated that a diverse mix of renewable resources will be required. Disposal and site restoration at the conclusion of a contract are solely the responsibility of the Seller.

SUBJECT	ISLAND	QUESTION	RESPONSE
DOD	Oahu	does HECO's contract with the military subsidize residents? If not, why not?	The Company interprets "HECO's contract" to refer to the partnership between the Army and Hawaiian Electric related to the Schofield Generating Station. Area residents are not subsidized directly as a result of the partnership. However, the cost for this project compared to a similar facility sited off-base is lower and at the same time, provides resilience and emergency support benefits to all residents of the island. In this sense the partnership saves all customers money while providing value to all.
EIS	Hilo/Kona	Please consider completing EIS before doing renewable energy! Why not?	The Company requires developers of renewable energy projects that are selected to comply with all applicable federal, state, and local laws. If an EIS is required by an applicable federal, state, or local law for a specific project, the developer is required to complete an EIS before the project may begin construction.
Energy efficiency	Hilo/Kona	What encouragements will be used to reduce energy use and not just the cost? (Submitted by Jim Klyman and Carey Yost)	"Hawai'i Energy has two full time Energy Advisors on Hawai'i Island who promote and support delivery of its commercial and residential program offerings that are available to HECO customers in Honolulu, Maui, and Hawai'i counties. For the residents of Hawai'i Island, Hawai'i Energy works with Pono Homes to provide residential direct installation of lighting measures, water measures, and advance power strips at no cost to the resident. This includes both single family homes and multifamily properties in disadvantaged, hard-to-reach communities. Hawai'i Energy also offers residential education, including free energy literacy workshops to communities, energy efficiency lessons for K-12 classrooms, and professional development training for teachers to integrate energy curriculum into their classwork. For commercial businesses, Hawai'i Energy provides professional development training and educational workshops, ranging from technical courses for engineers, architects and contractors to a Green Realtor workshop focusing on efficiency in the residential home market, with the most recent one being held at the Hilton Waikoloa in early March 2020. The on-island Energy Advisors meet frequently with various commercial customers of all sizes – from government agencies and hotel engineering teams, to small mom-and-pop retailers – to help them plan for and prioritize efficiency measures. Hawai'i Energy's work with the County's Department of Water Supply (DWS) to address the important Water-Energy Nexus is an ongoing continuous improvement of the DWS leak detection Program. In calendar year 2018, the leak detection system was able to identify numerous leaks and avoid the loss of approximately 2.9 million gallons of water and save approximately 1.48 million kWh. The advisors also communicate regularly with HECO community outreach staff and KAMs to help identify opportunities for customers. Hawai'i Energy and HECO are working together to help reduce energy consumption in cost in North Kohala, which can also provide additional deferral of capital investment in the transmission system. Past efforts include PY18's Rapid Response Program, which saw nearly doubled incentive levels for most of our common rebate offerings for ALL of Hawai'i Island in response to the Puna Geothermal shutdown due to the Kilauea Eruption."
Energy efficiency	Oahu	Increase Demand load conservation and efficiency goals/efforts. Less we use, less we need to build MW Supply.	For Program Year 19 (ending June 30, 2020), Hawaii Energy's EE goal is a first year energy reduction of 100,930 MWh and lifetime energy reduction of 1,149,116 MWh.

SUBJECT	ISLAND	QUESTION	RESPONSE
Energy efficiency	Oahu	What's an example of a large energy efficiency project or initiative that crosses public and private sectors?	Board of Water Supply is currently working on a large EE project to update their infrastructure that impacts both private and public sector. Another example where Hawaii Energy provided rebates is Kahauiki Village.
Energy policy	Maui	Why aren't commercial bus. like Target, new Safeway & even the new Kihei high school not required to have both solar water and PV electric?	Legislation is necessary in order to make this renewable implementation a requirement.
Energy policy	Maui	Does this new law require EVERYONE to get on board and use renewable energy?	When Governor Ige signed HB 632 into law, it set a goal of 100 percent renewable energy for public utilities sales by 2045. Electric utilities must increase its Renewable Portfolio Standards over time. Upcoming goals include 40 percent renewables by 2030, 70 percent renewables by 2040, and 100 percent renewables by 2045.
Energy policy	Oahu	how well are we avoiding "regulatory capture" on a local/state level when it comes to energy/environmental policy?	Hawaiian Electric is not able to provide a response to this question. This question would better be answered by the Office of Sustainability and Resiliency.
Energy programs	Hilo/Kona	"Integrated should mean integrating consumers in the equation. More dynamic tariffs are essential. Any ideas? • Didn't ask"	Indeed, customers are integrated into the planning and operations of Hawaii's power system. This is done through various programs to buy distributed energy, enable participation in programs to provided needed grid services and through time varying rates, such as for electric vehicles. These are being explored in the Advanced Rate Design Strategy docket.

SUBJECT	ISLAND	QUESTION	RESPONSE
Energy programs	Hilo/Kona	"Green Mountain Power (GMP) in Vermont uses innovative strategies. Will Hawaiian Electric use any of these? • For customers going off-grid—GMP does an energy-efficiency audit and gives advice on solar and battery technology • Off-grid and on-grid customers can buy or lease solar systems and batteries from GMP, or use third-party companies and still get GMP support • For peak demand times, GMP draws on some customers' home batteries, so GMP needs less fossil fuel backup. Participating customers get incentive payments. GMP notifies people in advance of peak events, by text or smartphone app. • GMP will let customers with rooftop solar sell power directly to businesses. GMP will get a 5% fee on transactions • GMP provides free level 2 charges to its customers who buy electric vehicles • GMP is also building large battery storage facilities • GMP uses hydro and wind, and may use methane digesters *(Submitted by Corey Harden)"*	"Hawaiian Electric follows GMP closely and has adopted some policies similar to that organization, but tailored to Hawaii and our unique, small, island-by-island stand-alone grids. In addition, executives from GMP flew to Hawaii several years ago to learn from our efforts to integrate national-leading levels of DER and other renewables onto our system. We are adding large energy storage facilities to our grids, for example. We recently helped a mainland partner giveaway 300 EV chargers to residents and 50 chargers to businesses. We are always looking for ways to repeat that, if we can do it in a way that is not a burden on other customers who do not get the free deal. We have programs that incentivize customers to shift or reduce electricity use to help us maintain the grid and increase renewable energy. Unfortunately, everything that works in Vermont does not work here. We have very little hydro-electric capacity as we have few running rivers and lately community opposition to wind projects has added risk to those types of projects. We look for new ideas and innovation wherever we can find it and in fact many utilities look to us to learn how we do things here, including adding a nation leading percentage of rooftop solar to our grids and having one of the highest per capita EV use in the nation. "
Energy programs	Maui	Will Time Of Use rates be available, and if so, when?	Time-of-use rate options are currently available to all residential and commercial customers. The Company continues to explore revised time-of-use rate designs that can be used with smart meters in the near future.

SUBJECT	ISLAND	QUESTION	RESPONSE
Energy storage	Hilo/Kona	Resilience is best if an outage is avoided in the first place. Batteries in the right places can accomplish this, and the batteries don't have to be all on the utility side. Would you support the encouragement of consumer side batteries?	Yes. In fact, approximately 80 percent of all new rooftop solar systems have batteries on the consumer side of the meter. Customer-sited batteries are important since they can enable our customers to start providing us grid services for compensation. In August of last year, the Company issued an RFP for grid services from customer-sited distributed energy resources which could include storage to help system operators manage reliability of the grid. The Company sought grid services such as fast frequency response and capacity for Oahu, Maui, and Hawaii islands. This will create an opportunity for customers to play a direct role in modernizing the electric grid and integrating more renewable energy through aggregated customer-sited resources. EVs also function as batteries which can be charged during periods with excess solar power. Our most recent purchase power agreements for renewable energy include and will continue to include solar-with-storage and standalone storage. As storage becomes less expensive it will increasingly be used to boost our renewable generation and make daytime solar available at night.
Energy storage	Maui	Are batteries the only energy storage solution?	Batteries and other energy storage solutions like pumped storage hydro are considered in our long-term planning. Batteries can provide regulating reserve and fast frequency response and several paired PV plus battery projects have been approved thru our Stage 1 procurement. To date, no pumped storage projects have proven to be cost effective. In addition, Hawaiian Electric has a few programs in which thermal storage (mostly hot water heating) are also use to provide a level of energy shifting/energy storage.
Energy storage	Maui	Is the 4x battery capacity for solar expected to be a base requirement for solar PV RFP?	In the recent Stage 2 RFPs, paired storage was not a requirement for all islands. However, if storage was proposed, there was a requirement that the storage "be sized to support the Facility's Allowed Capacity (in MW) for a minimum of four (4) continuous hours throughout the term of the RDG PPA." Going forward, the storage requirements will be driven by the system needs identified for that procurement.
Energy storage	Maui	Storage batteries will replace power plants, what is the life span of those batteries and is there a disposal plan?	Energy storage systems such as batteries can replace some capabilities of power plants, and will be a critical element of our transition to 100% renewable energy. The life span of individual battery units depends upon how they are used. Individual battery units are incorporated into battery systems which are designed to last for the life of the project, which is usually 20 years. The individual owners of battery systems will be responsible for their removal and disposal at the end of each project according to regulations in place at that time. Battery recycling is available for system owners to take advantage of. For those battery systems owned by Hawaiian Electric, we intend to recycle the batteries when they are no longer required.
Energy storage		I didn't hear much about the benefits of storage to issues like frequency regulation and reserves contribution.	Batteries and other energy storage solutions like pumped storage hydro are considered in our long-term planning. Batteries can provide regulating reserve and fast frequency response and several paired PV plus battery projects have been approved thru our Stage 1 procurement. To date, no pumped storage projects have proven to be cost effective. In fact, Hawaiian Electric is currently performing a procurement for grid services and expect bids to the tender to come from distributed energy storage systems.

SUBJECT	ISLAND	QUESTION	RESPONSE
Fuel	Hilo/Kona	I have an account with NextEra/Forida Power and light- My RPL monthly bill keeps decreasing/ KWH FPL converted fossil oil generation to cheap natural gas. Why has HELCO not taken advantage of cheap natural gas as an interim? (Submitted by Bob Erust)	Cheap natural gas is not readily available in Hawaii like it is on the mainland. The Companies looking into a large project using natural gas in 2016, including Keahole on the island of Hawaii. See https://www.hawaiianelectric.com/documents/about_us/news/2016/20160518_he_propose_to_use_lng_for_a_cleaner_less_expensive_transition_to_100_percent_renewables.pdf, but the State wanted the Companies to focus on renewable energy instead.
Fuel	Maui	Where does the fuel come from before it gets refined in Oahu ?	Under our fuel supply agreement with Par, Par is free to source their crude from anywhere in the world. For further information, please contract Par at https://www.parpacific.com/.
Grid defection	Hilo/Kona	If I can generate all the electricity I need (through solar wind) should I remain connected to the grid or is it better to go off grid? Note: I have 36 hours worth of battery storage	A decision to remain connected to the grid or go off-grid is a personal decision. The benefits of being connected to the grid is the ability to get backup power during adverse weather conditions, such as multiple days of cloudy/rainy weather as well as to provide services back to the grid and be compensated for doing so.
Grid modernization	Hilo/Kona	What are the issues and costs associated with modifying the grid to accommodate extensive distributed production (rooftop solar) and what role will storage play in such modifications? (Submitted by Leslie Hittner)	"At the distribution level, extensive distributed production can result in circuit thermal and high voltage issues. Mitigations include use of advanced inverter functions (volt/var and volt/watt), dynamic var devices, and reconductoring. Energy storage will have a role in mitigation by shifting generation from high distributed production times to low distributed production times. At the bulk system level, extensive distributed production can result in excess generation during the daytime. This will result in cycling existing synchronous generation off during high distributed production. Synchronous generation provide ancillary services such as inertia, fast-frequency response, frequency regulation (droop), and fault current to the grid. Energy storage can provide these ancillary services in addition to shifting generation from high distributed production times to low distributed production times. The cost for these mitigation measures can range significate depending on the specific scope of the remediation."
Grid modernization	Maui	What does grid modernization look like in the next 5 years, 10 years ?	Within the next 5 years, the Companies plan to implement an array of technologies to allow the Companies to safely incorporate more renewables onto the grid, and to also grid operators or more reliably operate the electric system. This includes investments in advance meters, grid sensing devices, a telecommunications network, and management systems. The next 10 years and beyond are a little uncertain as technology is quickly changing. The Companies' Integrated Grid Planning activities, of which stakeholder feedback and involvement are sought, are designed to help inform and provide input into the development of the future needs and technology solutions for the grid.

SUBJECT	ISLAND	QUESTION	RESPONSE
Grid modernization	Oahu	Why is Hawaiian Electric pursuing advanced meters as part of Grid Modernization? Like others I know, I'm electro-sensitive to EMFs.	Hawaiian Electric's deployment of advanced meters for Grid Modernization is currently based on an opt-in basis, where customer need to specifically sign for an advanced meter either through participation in a renewable energy program or through request. Thereby, advanced meter with communications are not planned to be deployed to all customer. However, certain renewable programs may require the installation of an advanced meter in order to enable participation.
Grid modernization	Oahu	Can water efficiency and conservation projects be combine with the energy projects within the smart grid?	Grid Modernization aims to provide customers access to their energy usage date to enable them to more effectively make decisions on how to manage their energy usage. This would complement energy savings initiatives. Pairing with water efficiency initiatives, will allow customers to contribute to a greener Hawaii.
Grid modernization	Oahu	Will Biodigestors (food waste, manure) be a possible part of the smart grid projects?	"It is assumed that the biodigesters referenced here refer to the equipment used in anaerobic digestion to convert organic matter, including food waste, animal manure, agriculture waste, and municipal waste and wastewater/sludge, to a biogas using microorganisms in an oxygen-free environment. The resulting biogas is composed of primarily methane, and must be processed to remove carbon dioxide, moisture, and impurities such as hydrogen sulfide before being used as a fuel. The converted methane can be stored and burned to produce process heat and power (e.g., using reciprocating engines). The most common use case is to meet internal process heat and power requirements for waste processing facilities; however, there are other applications for the biogas. For example, here in Hawaii, one City & County of Honolulu wastewater treatment plant produces and sells biogas as a renewable fuel and another plant uses biogas from anaerobic digestors to produce heat to dry the sludge used to make pelletized fertilizer. Anaerobic digesters can be an expensive method of making methane, so the accompanying electricity generating assets typically do not benefit from economies of scale. Although anaerobic digestion is a mature commercial technology, widespread use and large-scale production of electricity in Hawaii has been limited by resource (waste organic matter) availability and associated economies of scale. Anaerobic digestion for electricity production is considered a generation resource and not viewed as a smart grid technology that can modernize the electric grid to support utility and customer needs. In addition, anaerobic digestion processes and power production are not suited for high cycling operation or grid support services due to their operating nature. However, these facilities can provide renewable energy that can help the State of Hawaii meet its Renewable Portfolio Standards goals."

SUBJECT	ISLAND	QUESTION	RESPONSE
Hydrogen	Oahu	Why is HECO not pursuing hydrogen as a renewable firm power fuel.	"Hydrogen, as both a fuel and storage resource, was evaluated in Hawaiian Electric's Power Supply Improvement Plan (PSIP). Utility-scale production of hydrogen from the electrolysis of water using renewable energy and then conversion back to electricity is inefficient and capital-intensive, and therefore, not cost-competitive at this time. Currently, the high costs to produce, handle, store, and transport hydrogen along with an insufficient local demand makes hydrogen more expensive to use for electricity. More development of hydrogen infrastructure and scale-up of manufacturing capacities (domestically and internationally) are needed to reduce costs, increase performance, and improve durability to a level that supports market development and the use of hydrogen as a renewable firm power fuel. Hawaiian Electric continues to monitor hydrogen production and storage technologies and evaluate the viability of hydrogen resources in its IGP process. In addition, Hawaiian Electric continues to engage other entities, including the Hawaii Natural Energy Institute (HNEI) of the University of Hawaii and the Electric Power Research Institute (EPRI), to evaluate the viability of hydrogen and investment horizons."
IGP process	Hilo/Kona	How are you going to reach the people not here tonight and explain to them Integrated Grid Planning and their role in sustainable energy?	Hawaiian Electric's subject matter experts and public meeting panel members will work to address the questions posed by participants at our public meetings. The meeting materials for all of our stakeholder meetings are posted on our website for viewing at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement.
IGP process	Hilo/Kona	On renewable definition: How critical is the carbon footprint/ net green house gas emissions in our execution of solutions? (Submitted by Noel Morin)	Hawaiian Electric plans to meet the renewable portfolio standard (RPS) requirements as mandated by State law. However, some renewable projects are not 100% carbon free or carbon neutral especially when considering emissions generated over their entire lifecycle. New projects must balance the contribution toward our RPS requirements with its bill impact to customers as we plan to achieve our goal of 100% renewable by 2045.
IGP process	Maui	How do renewable energy projects that do not fit in a traditional RFP apply?	Depending on the type of project, a renewable energy project could apply to one of our customer renewable programs. More information can be found here: https://www.hawaiianelectric.com/products-and-services/customer-renewable-programs. As our grid needs change, our requests for future project proposals will also change so a project that does not fit in a traditional RFP today may fulfill a future grid need in a later RFP.
IGP process	Oahu	What follow-up will be taken by the utility on the crucial recommendations, observations and actions items your panelists brought up here?	Hawaiian Electric's subject matter experts and public meeting panel members will work to address the questions posed by participants at our public meetings. The meeting materials for all of our stakeholder meetings are posted on our website for viewing at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement.
IGP process	Oahu	Good information about IGP in a way that the everyday person can understand. This should be shared throughout all communities.	Hawaiian Electric's subject matter experts and public meeting panel members will work to address the questions posed by participants at our public meetings. The meeting materials for all of our stakeholder meetings are posted on our website for viewing at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement.

SUBJECT	ISLAND	QUESTION	RESPONSE
Large customers	Hilo/Kona	How much does Hawaiian Electric do to educate large electrics users (hotels, government, astronomy, commercial users) to help with conservation, use reduction? What incentives do you offer?	The Commercial Account Managers (CAMs) work closely with the large commercial customers to address their operating needs such as managing their electric bill, executing on the customer's corporate strategies with regards to energy conservation, renewable energy and other challenges. The CAMs perform walks-throughs of the customer's facilities as requested to provide energy conservation ideas. The Commercial Account Managers also work closely with Hawaii Energy. Hawaii Energy is a unaffiliated separate company that has been tasked by the Public Utilities Commission (PUC) to help island families and businesses to reduce energy consumption. Hawaii Energy provides rebates to qualifying situations to encourage energy efficiency.
Maui Pono	Maui	Is Maui Pono involved in this plan? Perhaps including biodiesal or wind,solar on their ag land?	No, Mahi Pono is not involved in our IGP plans at this time.
Microgrids	Hilo/Kona	How to support existing subdivision micro-grids?	The Company interprets this question to be: How does Hawaiian Electric (and IGP) support existing subdivisions that choose to implement a microgrid? Hawaiian Electric is currently working with the PUC and stakeholders to develop a Tariff to support non-utility implementation of "hybrid microgrids," while maintaining safety, reliability, and equity among customers. An existing subdivision that intends to develop a microgrid would fall under the definition of a hybrid microgrid, which is a microgrid that utilizes utility infrastructure. In addition, the IGP process may identify specific areas which derive the most value with a microgrid installation, upon which the utility would work to procure and implement a utility or non-utility microgrid.
No grid	Hilo/Kona	There is an interesting prototype project in the South Pacific where the traditional grid was never built; instead, electric vehicles, solar charged during the day, go home at night with full batteries to provide daytime electricity. Time shifting demand and eliminating grid maintenance, as Riley Saito described. What has Hawaiian Electric done in studying this model? Can it work in N. Kohala (particularly)?	Localized energy ecosystem as described is similar to a community microgrid that the Company is pursuing for North Kohala. A key technology for both is energy storage batteries, whether from vehicles or stationery – it is the same lithium-ion technology. In the Company's concept North Kohala would remain connected to the grid so that the local resources may also mutually benefit from being connected to the island's power system during normal conditions.
Nuclear	Oahu	What about nuclear?	Commercial nuclear fission in Hawaii is not permissible under the State Constitution and will require 2/3 vote of the State legislature to overturn it, so it is unlikely that Hawaii law is going to change to allow nuclear reactors.

SUBJECT	ISLAND	QUESTION	RESPONSE
Offshore wind	Oahu	How do you feel about Offshore wind as a source of energy?	If we are going to achieve our renewable energy goals as a state, we need to consider all available options and weigh the pros and cons of what is best for our community. However, a concern with offshore wind facilities has been ensuring there are robust and well-thought-out plans and resources in place for decommissioning or repowering them, regardless of that being several decades away. It is an important and real cost of doing business that must be factored into a responsible, sustainable operations plan. Also, not all offshore wind projects are the same. Those that are further from beaches, for example, will have less visual impact. Those that avoid major sea lanes and/or migratory bird paths would be preferred over those that do not. Consideration will need to be given on the impact such wind farms will have on military training in Hawaii and on how to safely bring high voltage transmission lines from these windfarms to the shoreline and onto the island's electrical system.
Ownership	Oahu	When will HECO be owned by Hawaii communities? Eliminate economic bias of shareholders who only care about financial gain.	The electric investor-owned utilities are regulated by the Hawai'i Public Utilities Commission and monitored by the State of Hawai'i O×ce of Consumer Advocacy to ensure service is reliable, rates are fair, and projects and plans are in the best interest of all customers. Investor-owned utilities must operate e×ciently to attract investors who have choices about where to put their money and to convince banks they are worthy of borrowing and repaying large amounts of money. Utilities are capital intensive, that is, they need a lot of money to maintain and improve service. Investor-owned utilities have a proven record of e×ciently raising the significant levels of capital needed to support reliable service at reasonable rates and to upgrade and modernize equipment. Utilities in Hawaii in particular need to invest a lot to achieve the state's ambitious clean energy goals.
Protests	Oahu	How do you feel abt civil disobedience like we saw in Kahuku? For act thia	In regards to renewable energy development, communities want transparency, the opportunity to engage in meaningful dialogue with developers, and to participate in the process. Hawaiian Electric is continuing to update its renewable energy procurement processes to strengthen community engagement requirements and to have community concerns addressed through careful listening, thoughtful responsiveness, and a commitment to respect the environmental and cultural values of Hawai'i.
Rates	Hilo/Kona	Why can't our electrical utility Kamaaina company address our kupuna aging population, that wish to remain in their own homes than in a life care facility with a sliding fee scale based on their income monthly?	Hawaiian Electric understands that many customers, both elderly and others, may face challenges paying electric bills from time to time. We ask that customers contact our customer service representatives for assistance in the payment options that are available. Hawaiian Electric has a rate discount program for customers who qualify under the LIHEAP guidelines.
Rates	Hilo/Kona	The LIHEAP is an annual program. Is there any considerations as you move forward?	Hawaiian Electric offers certain residential rate discounts to customers who participate in LIHEAP programs. However, LIHEAP is a federal government program that is administered in Hawaii through the state's Department of Human Services. Any changes in LIHEAP benefits or in the frequency of LIHEAP benefits will be established by the government and not by Hawaiian Electric.
Rates	Maui	Would the living cost be affected?	Quote from hawaiianelectric.com "Hawaiian Electric works hard to keep costs to our customers as reasonable as possible while still ensuring the reliable service they expect and deserve."

SUBJECT	ISLAND	QUESTION	RESPONSE
Rates	Oahu	Why don't we see the lower utility PPA of $0.08/kWh reflected on our HECO bill?	The PPA projects that have been announced at $0.08/kWh as part of the Company's solicitation for renewable energy will not go into service until 2021-2022. At that point they will lower the energy costs for all customers based on the share of energy they contribute to the overall system.
Resiliency	Hilo/Kona	On resilience: How are we preparing for the consequences of climate change? (Submitted by Noel Morin)	The Company is engaged with various government agency working groups regarding climate change. The Company is aware of the forecasted impacts and currently plans future infrastructure development to accommodate 3.2 feet of sea level rise. As needed, the Company has also taken the opportunity to increase the installation height when replacing aging equipment that could be susceptible to flooding from sea level rise. The Company understands there will be even greater needs to plan a "managed retreat" from coastlines and is looking for guidance from state and county agencies to determine the process and timing for such a retreat.
Resiliency	Oahu	Why didn't the state join C+C's fossil fuel lawsuit? Is state climate policy "balanced"?	Hawaiian Electric is not able to provide a response to this question. This question would better be answered by the Office of Sustainability and Resiliency.
Resiliency	Oahu	We tend to think of renewables from an environmental standpoint. How much attention do we pay to the domestic security / resiliency aspect?	This is actually a critical objective of the IGP process to diversify the renewable portfolios on each island, both geographically and the types of technology. This diversity will not only serve the environmental benefit, but will also enhance the grid's resiliency through many more generating stations throughout the island that can then be used to more quickly recover after a severe event causing widespread outages.
Resiliency	Oahu	What does the utility think about Joshua's comment to prioritize energy efficiency as a critical piece of this process?	Without understanding the context of Joshua's comment, energy efficiency continues to be valued in the IGP process. The modeling and forecasting used by the Company takes into account ever-evolving technologies that promote energy efficiency with our customers.
Rooftop PV	Oahu	Lowest cost possible means quick & most simple (so land mount wind or solar) NOT harder like using existing rooftops (new ones)	This question is unclear.
Rooftop PV	Oahu	How abt solar on all houses vs solar farms	To get to 100 percent renewable energy by 2045 will not be an either-or proposition but an all-of-the-above solution. We don't have the land, particularly on Oahu, for enough large, grid-scale solar facilities to fill our needs as we phase out fossil-fuel generation. We have solar on about a third of single-family homes on Oahu (roughly 20 percent statewide) and we need to more than double that to get to 100 percent. So yes, solar on as many rooftops as practical and as much grid-scale solar and other technologies as possible will all be needed.

SUBJECT	ISLAND	QUESTION	RESPONSE
RPS	Maui	Does the utility work with other state depts to coordinate movement to 100% RPS? If so, which depts?	"RFPs are currently underway with the intent to procure large amounts of renewable energy on the islands of O'ahu, Hawai'i, and Maui. Future RFPs are slated for community based renewable energy projects in the near term. In addition to customer adoption of distributed energy resources, all of these initiatives will accelerate Hawaiian Electric's renewable portfolio standard (RPS) achievement and further displace fossil fuel consumption. Hawaiian Electric is planning for long term needs in its IGP process. The IGP, through its stakeholder engagement model, has various working groups tackling parts of the IGP process to be more streamlined. A technical advisory panel provides independent technical review of the working groups' deliverables and a stakeholder council provides strategic input on the IGP process development. The stakeholder council is composed of members of the local county governments as well as the Public Utilities Commission, Division of Consumer Advocacy, and State Energy Office."
RPS	Maui	I missed that, what does RPS mean? It was said it would go down if more people started using renewable electric?	"RFPs are currently underway with the intent to procure large amounts of renewable energy on the islands of O'ahu, Hawai'i, and Maui. Future RFPs are slated for community based renewable energy projects in the near term. In addition to customer adoption of distributed energy resources, all of these initiatives will accelerate Hawaiian Electric's renewable portfolio standard (RPS) achievement and further displace fossil fuel consumption. Hawaiian Electric is planning for long term needs in its IGP process. The IGP, through its stakeholder engagement model, has various working groups tackling parts of the IGP process to be more streamlined. A technical advisory panel provides independent technical review of the working groups' deliverables and a stakeholder council provides strategic input on the IGP process development. The stakeholder council is composed of members of the local county governments as well as the Public Utilities Commission, Division of Consumer Advocacy, and State Energy Office."
RPS	Maui	How does the renewable energy benefit Hawaiian electric, the community and the environment?	"Hawaiian Electric's Response: RFPs are currently underway with the intent to procure large amounts of renewable energy on the islands of O'ahu, Hawai'i, and Maui. Future RFPs are slated for community based renewable energy projects in the near term. In addition to customer adoption of distributed energy resources, all of these initiatives will accelerate Hawaiian Electric's renewable portfolio standard (RPS) achievement and further displace fossil fuel consumption. Hawaiian Electric is planning for long term needs in its IGP process. The IGP, through its stakeholder engagement model, has various working groups tackling parts of the IGP process to be more streamlined. A technical advisory panel provides independent technical review of the working groups' deliverables and a stakeholder council provides strategic input on the IGP process development. The stakeholder council is composed of members of the local county governments as well as the Public Utilities Commission, Division of Consumer Advocacy, and State Energy Office."

SUBJECT	ISLAND	QUESTION	RESPONSE
RPS	Oahu	How fast do you think we can get to 80%?	"RFPs are currently underway with the intent to procure large amounts of renewable energy on the islands of O'ahu, Hawai'i, and Maui. We expect these current RFPs to result in neighbor islands achieving about 80% RPS or higher by 2025. Future RFPs are slated for community based renewable energy projects in the near term. In addition to customer adoption of distributed energy resources, all of these initiatives will accelerate Hawaiian Electric's renewable portfolio standard (RPS) achievement and further displace fossil fuel consumption. Hawaiian Electric is planning for long term needs in its IGP process. The IGP, through its stakeholder engagement model, has various working groups tackling parts of the IGP process to be more streamlined. A technical advisory panel provides independent technical review of the working groups' deliverables and a stakeholder council provides strategic input on the IGP process development. The stakeholder council is composed of members of the local county governments as well as the Public Utilities Commission, Division of Consumer Advocacy, and State Energy Office."
RPS	Oahu	Is there opportunity to make a few counties 100% to boost morale?	"RFPs are currently underway with the intent to procure large amounts of renewable energy on the islands of O'ahu, Hawai'i, and Maui. Future RFPs are slated for community based renewable energy projects in the near term. In addition to customer adoption of distributed energy resources, all of these initiatives will accelerate Hawaiian Electric's renewable portfolio standard (RPS) achievement and further displace fossil fuel consumption. Hawaiian Electric is planning for long term needs in its IGP process. The IGP, through its stakeholder engagement model, has various working groups tackling parts of the IGP process to be more streamlined. A technical advisory panel provides independent technical review of the working groups' deliverables and a stakeholder council provides strategic input on the IGP process development. The stakeholder council is composed of members of the local county governments as well as the Public Utilities Commission, Division of Consumer Advocacy, and State Energy Office."
System planning	Hilo/Kona	"• How will Hawaiian Electric use these approaches? o Distributed generation o Energy storage o Energy efficiency demand response o Grid software and controls (Submitted by Corey Harden)"	"In the IGP, Hawaiian Electric will be considering a portfolio of resource options including customer sited distributed energy resources, energy efficiency and demand response as well as grid-scale PV, wind and energy storage. Future PV and other grid-scale renewable projects will need some length of transmission line to interconnect. As the resource potential for renewable resources is developed on island, future cost effective projects may be located farther from existing transmission infrastructure and require longer transmission lines. As we've seen in our recent renewable project procurements, the Public Utilities Commission approved projects that paired PV with energy storage. The storage component to these projects provide flexibility to shift the PV energy to other parts of the day. The IGP will also consider both distributed and grid-scale resources to serve as non-wires alternatives to traditional wire solutions. A non-wires alternative effectively locates the generation at the load center to defer, for example, the construction of a new substation to serve load growth."

SUBJECT	ISLAND	QUESTION	RESPONSE
System planning	Hilo/Kona	Have you considered a DC backbone grid to decrease radiation losses and RF noise?	While there are advantages to using DC transmission such as decreased losses, DC installations are very expensive and a DC substation requires much more equipment to convert the power back to AC for use in our homes and businesses. Because of this DC transmission is only economical at very high voltages and long distances which do not exist in Hawai`i.
System planning	Hilo/Kona	What is the ideal percent of eco-thermal supply? *(Submitted by Richard An)	The Company interprets "eco-thermal supply" to refer to geothermal energy such as the Puna Geothermal Venture (PGV) facility located in Puna on the island of Hawai`i. The optimal output of all dispatchable generation facilities is the combination that meets the system load, at the lowest cost, subject to transmission and operational constraints. Therefore there is no "ideal" percent of geothermal supply.
System planning	Hilo/Kona	Will Hawaiian Electric avoid cross-island power delivery, to reduce line losses, risks of damage to lines, and expensive maintenance? (Submitted by Corey Harden)	"In the IGP, Hawaiian Electric will be considering a portfolio of resource options including customer sited distributed energy resources, energy efficiency and demand response as well as grid-scale PV, wind and energy storage. Future PV and other grid-scale renewable projects will need some length of transmission line to interconnect. As the resource potential for renewable resources is developed on island, future cost effective projects may be located farther from existing transmission infrastructure and require longer transmission lines. As we've seen in our recent renewable project procurements, the Public Utilities Commission approved projects that paired PV with energy storage. The storage component to these projects provide flexibility to shift the PV energy to other parts of the day. The IGP will also consider both distributed and grid-scale resources to serve as non-wires alternatives to traditional wire solutions. A non-wires alternative effectively locates the generation at the load center to defer, for example, the construction of a new substation to serve load growth."
System planning	Hilo/Kona	Capacity factor means that you just need to overbuild and have storage. Is this recognized?	The capacity factor, or potential generation of variable renewable resources, needs to be considered in order to plan for an adequate supply of generation. The capacity factors and the ability of storage to be used for energy arbitrage is accommodated within the analysis to performed in IGP.
System planning	Maui	Will the new IGS allow for grid-scale Solar projects to connect to the grid at their location or will trans lines to MECO be needed?	"In the IGP, Hawaiian Electric will be considering a portfolio of resource options including customer sited distributed energy resources, energy efficiency and demand response as well as grid-scale PV, wind and energy storage. Future PV and other grid-scale renewable projects will need some length of transmission line to interconnect. As the resource potential for renewable resources is developed on island, future cost effective projects may be located farther from existing transmission infrastructure and require longer transmission lines. As we've seen in our recent renewable project procurements, the Public Utilities Commission approved projects that paired PV with energy storage. The storage component to these projects provide flexibility to shift the PV energy to other parts of the day. The IGP will also consider both distributed and grid-scale resources to serve as non-wires alternatives to traditional wire solutions. A non-wires alternative effectively locates the generation at the load center to defer, for example, the construction of a new substation to serve load growth."

SUBJECT	ISLAND	QUESTION	RESPONSE
System planning	Maui	Is there a point when Solar PV will no longer be allowed to be installed on the grid due to oversaturation?	"In the IGP, Hawaiian Electric will be considering a portfolio of resource options including customer sited distributed energy resources, energy efficiency and demand response as well as grid-scale PV, wind and energy storage. Future PV and other grid-scale renewable projects will need some length of transmission line to interconnect. As the resource potential for renewable resources is developed on island, future cost effective projects may be located farther from existing transmission infrastructure and require longer transmission lines. As we've seen in our recent renewable project procurements, the Public Utilities Commission approved projects that paired PV with energy storage. The storage component to these projects provide flexibility to shift the PV energy to other parts of the day. The IGP will also consider both distributed and grid-scale resources to serve as non-wires alternatives to traditional wire solutions. A non-wires alternative effectively locates the generation at the load center to defer, for example, the construction of a new substation to serve load growth."
System planning	Maui	I know that most of our energy is coming from outsourced fossil fuels. Do we have any renewable energy set up here on Maui already?	As reported in Hawaiian Electric's 2019 to 2020 Sustainability Report, nearly 41% of the energy generated in Maui county comes from renewable sources. The renewable mix consists of 21% wind, 18% customer-cites solar, 1.7% grid-scale solar and 0.1% biofuels.
System planning	Maui	When is the Stage 2 RFP expected to be released?	The Final Award Group was notified on May 8, 2020.
System planning	Maui	What are you building in N Kihe along the highway and across from Maui Lani on the highway?	With continued growth and development anticipated for Central and South Maui that will require more reliable and clean energy, these are our newest substations that enable electricity to be reliably distributed to homes, schools, and businesses. Ka'ono'ulu Substation is on the mauka side of Pi'ilani Highway in South Maui and the Kuihelani Substation is near the intersection of Kuihelani Highway and Maui Lani Parkway. See our related news releases on the Kuihelani Substation and Ka'ono'ulu Substation.
System planning	Oahu	All panel - what does 100% RPS look like to you? What types of renewable resources and energy efficiency programs are part of your vision?	Hawaiian Electric is forging a path forward to 100% renewable energy that is being watched across the World and we are on track to meet our year-end 2020 goal of 30% RPS. Getting there will require a diverse set of resources as well as a modern grid and other utility systems needed to manage variable generation while safely and reliably meeting customer's electricity needs. The solution will combine utility resources with customer owned distributed resources including distributed generation, storage, and demand response. The panel discussions illustrated that renewable resources are desirable, but also introduce challenges including community citing concerns, other societal considerations, and cost. All these issues will need to be balanced in order to achieve 100% RPS in a way that is beneficial to all.
System planning	Oahu	Re-phrasing Cynthia's good question. Why haven't we explored community-scale and distributed infrastructure, at SCALE	In the coming years, we will be adding a lot of grid-scale renewable energy as well as a lot more private customer-sited (rooftop) solar. Distributed customer-sited solar already represents the single largest generation component on our system and we are planning on more than doubling that to reach our renewable goals. Another possibility we are exploring is called "non-wires-alternatives" (NWAs) which means locating solar and other renewable energy facilities in such a way that more expensive substations and wires are not needed. We are committed to exploring NWAs whenever possible to see if they can be equal to or less expensive and as or more reliable than traditional utility infrastructure.

SUBJECT	ISLAND	QUESTION	RESPONSE
Transportation	Hilo/Kona	What specific plans you propose to help electrify transportation?	Hawaiian Electric is not able to provide a response to this question. This question would better be answered by the appropriate county transportation departments.
Transportation	Hilo/Kona	If I were to purchase an electric vehicle, how much would my bill increase if I charge exclusively at home? $110/ month	The increase in electrical consumption would be largely dependent upon how many miles you drive. While your electric will increase, the estimated costs is about 1/3 less than the cost to fuel a typical gasoline vehicle.
Transportation	Hilo/Kona	On EVS: Is vehicle-to-grid technology part of our IGP? If so, what roles does it play? (Submitted by Noel Morin)	Vehicle-to-grid technology could play a role as a resource in the future to provide grid services. While there is technology for vehicles to provide energy to the grid, the market is still developing.
Transportation	Hilo/Kona	"Can HELCO please make all future rapid level 3 public charging stations available 24/7? (i.e., Ungated) o Pahala Gym & Punaluu Bake Shop both gated"	While the charge station at the Pahala Gym is not owned by Hawaiian Electric, the DC fast charging station at Punaluu Bake Shop is. Hawaiian Electric has not only been siting locations which may be highly utilized, but also geographically spread out to alleviate range anxiety. It is the Company's goal to install on properties which are accessible 24/7. It is unfortunate that Punaluu Bake Shop is not accessible 24/7, but it was targeted to support the south side of Hawaii Island.
Transportation	Hilo/Kona	How will HELCO quickly increase electricity supply to provide power for the fast growing number of electric vehicles?	The IGP process is designed to identify the needs of the system, such as when additional electricity supply must be added. The growth of electric vehicles are considered when evaluating the needs of the system and if resources must be added, the company will procure the necessary resources to meet the defined needs.
Transportation	Hilo/Kona	Transit: As the only DOT up on the board that uses our county transit, how does the county plan to deal with the almost daily cancellations and use of contract buses that have drastically impacted the transit reliability? (Submitted by Jim Klyman and Carey Yost)	Hawaiian Electric has and is continuing to work with the counties to propose programs which can lower the cost of electricity to charge buses. Last year, an electric bus pilot rate was introduced to lower the cost of electricity to charge buses during strategic hours of the day. Hawaiian Electric will request approval for a bus "make-ready" pilot which will help lower the cost of construction and installation of electrical infrastructure for bus charging stations.
Transportation	Maui	Is it possible to require car dealerships and rental companies to offer more ev vehicles?	Without a change in the state law, it is not possible to require car dealerships and rental companies to offer more EVs. In the last legislative sessions a bill was introduced to require state and county employees to rent EVs for official government business. This bill did not pass.
Transportation	Maui	Is Hawaiian Elec planning to change its vehicle fleet to EVs?	Hawaiian Electric has had electric vehicle in their fleet for over a decade. Early EVs were converted gasoline vehicles. Currently, approximate 20% of our passenger fleet are electric. Although the heavy-duty vehicle market is still maturing, some of our heavy duty trucks are partially electrified.
Transportation	Maui	Can the utility do more to incentivize government departments to purchase more EVa?	Yes, the Company is currently developing a Make Ready infrastructure program, designed to build, own, and operate charging infrastructure behind the meter. This “make ready” work is typically one of the largest cost components of electrification, besides the purchase of the vehicles themselves. This should help incentivize government departments to electrify. In addition, the Company is developing new rates which incentivize daytime charging when electricity is cheaper, which should help to address the cost of electricity for government agencies assuming the fleets can charge during those times.

SUBJECT	ISLAND	QUESTION	RESPONSE
Transportation	Maui	What is the utility doing to accelerate electrification of transportation?	Hawaiian Electric's Electrification of Transportation Strategic Roadmap, available online, outlines 10 areas in which the utility can accelerate the state's transition to electrify transportation. Some of these areas are to expand the availability of charging infrastructure, work with partners in education of EVs and programs to lower EV purchase costs, provide programs to lower customer bills in return for "smart charging", and to encourage medium and heavy-duty fleets. As a result, the Company is currently developing new electric rates and "make-ready" infrastructure programs which will provide electrical infrastructure to parking spaces for commercial, condominiums, and transit properties.
Transportation	Oahu	What role does transportation play in achieving our energy goals?	As EV adoption increases and as batteries capacity increases, these vehicle batteries can be used as flexible energy storage. This flexibility will allow the utility to provide programs which will allow vehicles to be charged during times which best utilize renewable energy and efficiently support the grid.
Wave energy	Maui	Whatever happened to wave energy?	Wave energy is not yet a commercially mature energy resource. Open sea testing facilities encourage ocean energy development through practical experience of installation, operation, maintenance and decommissioning activities for prototype technologies to advance its commercial viability. Research and demonstration activities continue to occur throughout the world, primarily in the United Kingdom, Australia, and the United States. In Hawaii, ongoing research and testing to assess the performance and durability of wave energy devices continues at the U.S. Navy's Wave Energy Test Site (WETS) offshore at Marine Corps Base Hawaii in Kaneohe. Several wave energy devices have been tested at this multiple-berth test site with more devices either being tested or planned. In December 2019, a 500 kW Ocean Energy buoy arrived in Hawaii for open sea testing at the WETS facility.
Wheeling	Hilo/Kona	How to allow wheeling between tanks?	Hawaiian Electric interprets this question to be: How is it possible to wheel electricity between different non-utility entities? The implementation of wheeling on island electrical systems where energy on the island needs to be balanced within the island poses implementation challenges, as the electric system will be less optimized in order to accommodate a generator that is operated to "wheel" power to a specific customer to meet the specific demands of that customer. In addition, there is currently no Tariff or Regulatory mechanism in place that allows the transmission of energy from one facility to another, while utilizing utility lines. Hawaiian Electric is currently working with the PUC and stakeholders to develop a Tariff to support non-utility implementation of "hybrid microgrids," while maintaining safety, reliability, and equity among customers. Hybrid microgrids are microgrids which utilize utility lines, and under specific situations allows the transmission of energy from one entity to another.
Wind	Oahu	Does the Office of Sustainability and Resiliency support the windmills in Kahuku?	Hawaiian Electric is not able to provide a response to this question. This question would better be answered by the Office of Sustainability and Resiliency.

SUBJECT	ISLAND	QUESTION	RESPONSE
Workforce	Hilo/Kona	"What is Hawaiian Electric doing to recent skilled employees to assure there is a skilled worker pool here in Hawaii to hire from? o Didn't ask, no time "	In order to recruit skilled workers, the Company participates in career fairs, engages in pre-employment screening and specialized EEI testing, coordinates with local community colleges (i.e. Hawaii Community college) to recruit electrician/linemen pools, fosters an internship program(s) (i.e. Engineering Division) and develops relationships with linkage agencies such as LinkedIn to broaden recruitment outreach. Presently, we are coordinating job postings among all three islands to attract a larger pool of skilled labor. Lastly, the Company will be considering more expansive online recruitment efforts utilizing job specific online sites (i.e. lineman sites), newspaper and radio.

Appendix G

Virtual Online Meeting

Hawaiian Electric

Integrated Grid Planning (IGP)

COMMENT

- Welcome
- Integrated Grid Planning
- Grid Modernization
- Grid-Scale Renewables
- Rooftop Renewable Energy
- Community-Based Renewable Energy
- Electrification of Transportation
- Resilience
- Engagement
- Careers at Hawaiian Electric

Welcome

Welcome to our Virtual Open House

Thank you for your participation in our online engagement! The slides in this session are filled with information about our Integrated Grid Planning, renewables and careers at Hawaiian Electric. Please read the materials and submit your responses to each survey question to help shape our renewable energy future together.

In-Person Public Meetings

You're also invited to join us at our public meetings and learn how Hawaiian Electric uses Integrated Grid Planning to shape our renewable energy future together.

Scheduled Meetings (5:00 p.m. - 7:30 p.m.)

TUESDAY Mar 03
Kealakehe High School (Cafeteria)
74-5000 Puohulihuli Street
Kailua-Kona, Hawai'i 96740

THURSDAY Mar 05
Hilo High School (Cafeteria)
556 Waiānuenue Avenue
Hilo, Hawai'i 96720

TUESDAY Mar 10
Hawaii Pacific University* (Multi-Purpose Room 3)
1 Aloha Tower Drive
Honolulu, O'ahu 96813
**Free parking with validation*

THURSDAY Mar 12
Hawaiian Electric (Maui Auditorium)
210 W Kamehameha Avenue
Kahului, Maui 96732

General Information Survey – 2 Questions

Rank the following in order of importance, where 1 is the most important to you. Drag the options below to change the order.

1: Lowering energy costs
2: Helping to increase the use of renewable energy
3: Adopting energy technology to provide more information and customer control
4: Energy reliability
5: Reducing greenhouse gases

In a few words, what change at your home or business do you plan to make to help Hawaii get to 100% renewables?

Examples: purchase an energy saver appliance, use LED lights, install an advanced meter

Submit Your Response

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Hawaiian Electric

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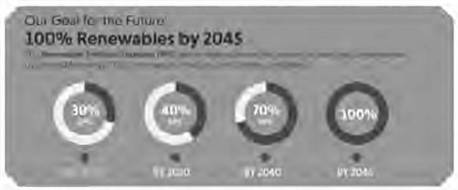
Integrated Grid Planning

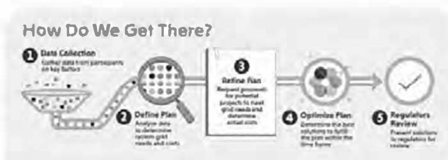
An energy planning process to identify the best options for customers to move Hawai'i toward a clean energy future.

Planning Hawaii's Grid for Future Generations

With a renewed focus on comprehensive energy planning, Hawaiian Electric proposed an Integrated Grid Planning ("IGP") process that we believe will benefit customers by identifying the best options to affordably move Hawai'i toward a reliable, resilient clean energy future with minimal risk. In addition, we believe the State will benefit from expanded market opportunities for resource, grid services, and non-wires alternatives for transmission and distribution ("T&D"), which can foster innovative solutions for a new energy economy.

Click each of the three (3) images below to enlarge.





IGP Overview Survey – 7 Questions

How interested are you in installing rooftop solar?
- Already have/do
- Actively pursuing (1–2 years)
- Waiting (3–5 years)
- Interested, need more info
- Not interested

How interested are you in installing an advanced meter?
- Already have/do
- Actively pursuing (1–2 years)
- Waiting (3–5 years)
- Interested, need more info
- Not interested

How interested are you in installing a battery storage system?
- Already have/do
- Actively pursuing (1–2 years)
- Waiting (3–5 years)
- Interested, need more info
- Not interested

How interested are you in buying an electric vehicle?
- Already have/do
- Actively pursuing (1–2 years)
- Waiting (3–5 years)
- Interested, need more info
- Not interested

How interested are you in using transit or carpooling regularly (most trips)?
- Already have/do
- Actively pursuing (1–2 years)
- Waiting (3–5 years)
- Interested, need more info
- Not interested

How interested are you in installing a hot water or grid interactive water heater?
- Already have/do
- Actively pursuing (1–2 years)
- Waiting (3–5 years)
- Interested, need more info
- Not interested

What type of help would you need to make renewable or energy efficient upgrades to your home or business?

Submit Your Response

Hawaiian Electric

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- Engagement

- Engagement

COMMENT

Grid Modernization

Grid modernization is transforming our energy grid to be a dynamic, two way stream of power, shifting back and forth between customers and Hawaiian Electric.

What's in it for the Customer?

There are several benefits of grid modernization for Hawaiian Electric customers.

Click each of the two (2) images below to enlarge.

Grid Modernization | **Advanced Meters**

Advanced meters are an important part of our Grid Modernization Strategy. Along with the other Grid Modernization technologies, advanced meters enable customers to:

- View your daily energy usage from your phone or computer
- Manage your energy use to reduce your bill
- Help to improve restoration times during power outages
- Help Hawai'i reach a 100% clean energy future

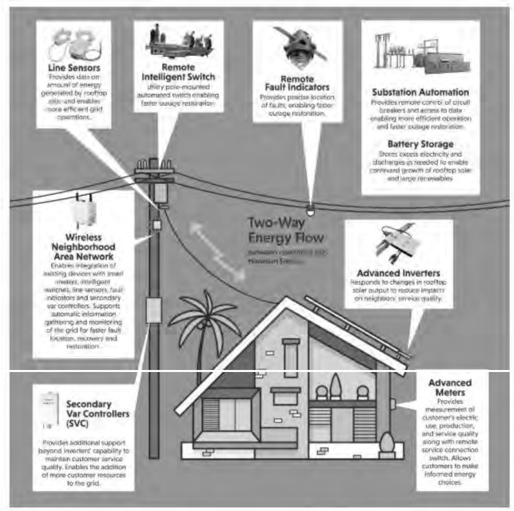
Learn More

Advanced Meters

How does Grid Modernization Technology Work?

Customers' resources are an important part of the grid. Reliability is critical as more and more customers provide resources to the grid. Learn about the new technology as we move toward changing yesterday's grid to tomorrow's grid.

Click the image below to enlarge.



Learn More

Grid Modernization Technologies

Hawaiian Electric

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COMMENT

Grid-Scale Renewables

Existing and planned generating facilities in our service area and the maximum potential power in megawatts (MW) they can produce.

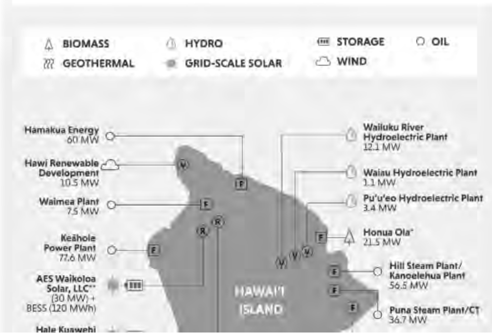
Hawaiian Electric Projects

High-level snapshots of various grid-scale renewable projects around the islands are shown below. To see the current progress of each of our grid-scale renewable projects, visit our Clean Energy Portfolio.

Learn More

Clean Energy Portfolio

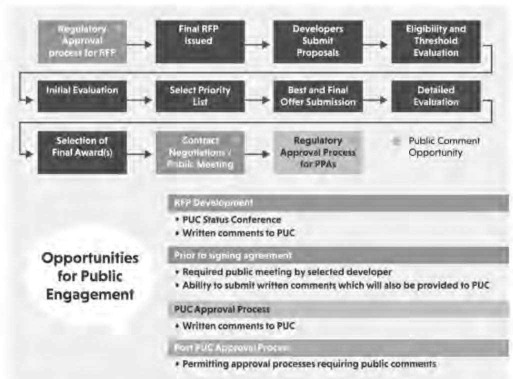
Click each of the three (3) images below to enlarge.



Project Selection Process

We have a process for selecting, evaluating, and contracting new renewable projects. Several parts of the process include opportunities for public engagement and input.

Click the image below to enlarge.



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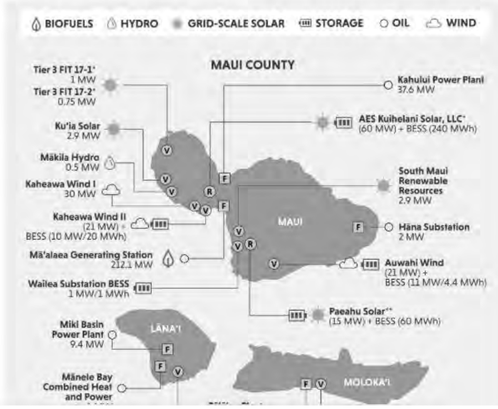
F FIRM GENERATION: Energy available on demand, which can be adjusted as needed.

V VARIABLE GENERATION: Energy that may not always be available or controllable.

R RENEWABLE DISPATCHABLE GENERATION

BESS: Battery Energy Storage System

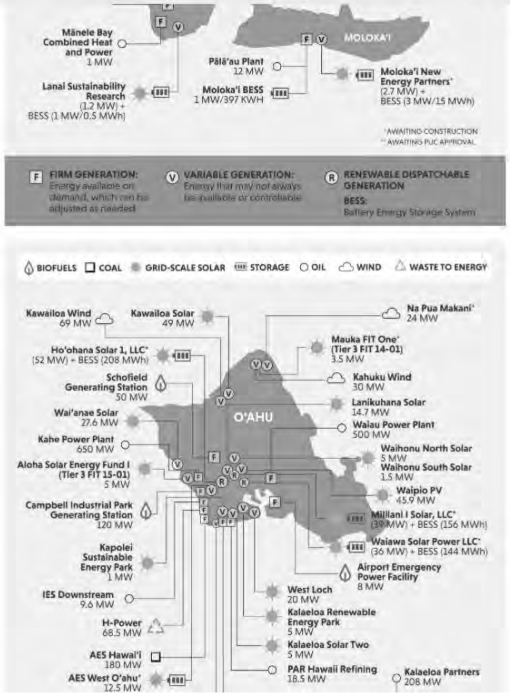


	O'AHU	HAWAI'I ISLAND	MAUI
Stage 2 Renewable RFP	1,300,000 MWh + 200 MW Storage 50 MW Contingency Storage	70,000–444,000 MWh + 18 MW Contingency Storage	295,000 MWh + 40 MW Storage
Acres	3,000 (equivalent to 29 Aloha Stadiums)	160–1,000 (equivalent to 2–10 Aloha Stadiums)	700 (equivalent to 7 Aloha Stadiums)

Hawai'i has many factors which must be considered when selecting renewable projects

- Land Availability
- Endangered Species
- Community Interest
- Availability of Materials
- Resilience

Integrated Grid Planning (**IGP**)



COMMENT

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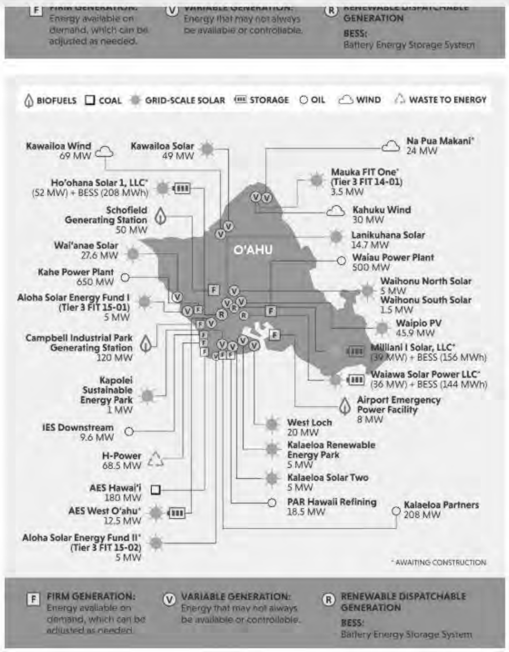
Integrated Grid Planning (**IGP**)

COMMENT



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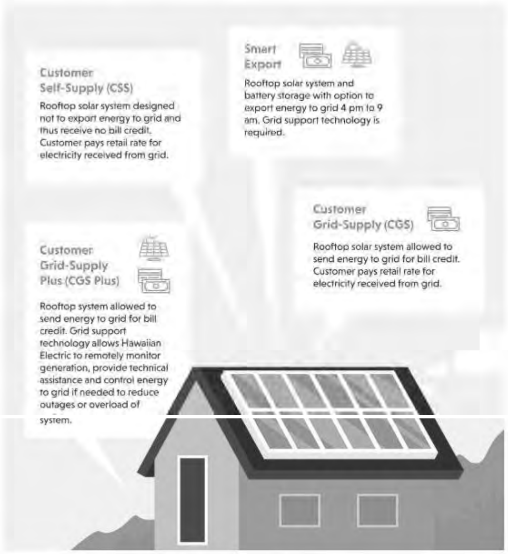
Rooftop Renewable Energy

For residential and small business customers who want to reduce their bills by installing solar systems that meet specific program requirements.

Rooftop Solar Options

These programs are the available options for new solar customers to install PV panels on their rooftops.

Click the image below to enlarge.

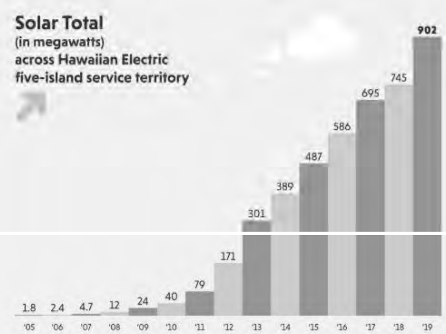


Installation Opportunities

Many customers have rooftop solar system on homes and businesses. And there are still opportunities to install rooftop solar on your residence or business to save money and help Hawai'i reach a clean energy future.

Click the image below to enlarge.

	Number of PV Systems			PV Capacity, MW		
	Number	% Residential	% Commercial	Capacity	% Residential	% Commercial
O'ahu	55,353	96%	4%	674	45%	55%
Hawai'i	13,410	94%	6%	103	66%	34%
Maui	13,020	92%	8%	125	57%	43%
Total	81,783			**902**		



Hawaiian Electric Company, Inc

Hawaiian Electric

- Welcome
- Integrated Grid Planning
- Grid Modernization
- Grid-Scale Renewables
- Rooftop Renewable Energy
- Community-Based Renewable Energy
- Electrification of Transportation
- Resilience
- Engagement
- Careers at Hawaiian Electric

Hawaiian Electric Company, Inc

COMMENT

Community-Based Renewable Energy

Community-Based Renewable Energy (CBRE), or community-solar, provides a way for participating subscribers without privately-owned rooftop solar to benefit from electricity generated by a renewable energy facility located in their community.

The Next Phase: 'Solar without a Roof'

Community solar is a hybrid: owned or leased by customers who don't or can't have solar, often because they are renters or live in apartment buildings, but sized and sited like a grid-scale solar facility.

Click the image below to enlarge.

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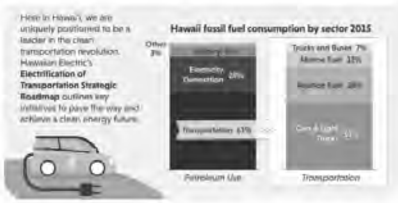
Electrification of Transportation

Electrification of Transportation (EoT) plays a key role in allowing us to integrate more renewable energy generation.

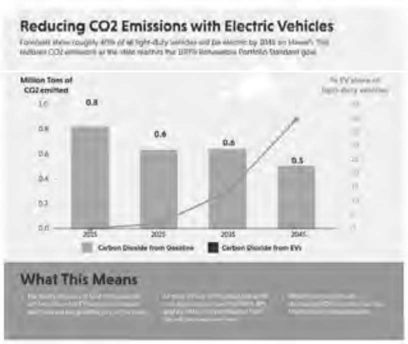
EoT Strategic Roadmap

Click the image below to enlarge.



Emissions on Hawai'i

Click the image below to enlarge.



For Community and Customers

Click each of the two (2) images below to enlarge.

Learn More

EoT Strategic Roadmap

- Welcome
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- Grid-Scale Renewables
- Rooftop Renewable Energy
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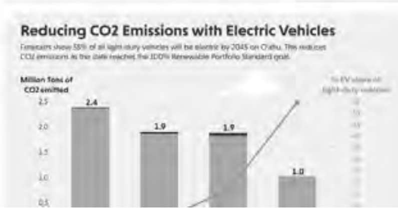
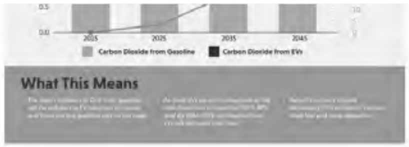
Emissions on O'ahu

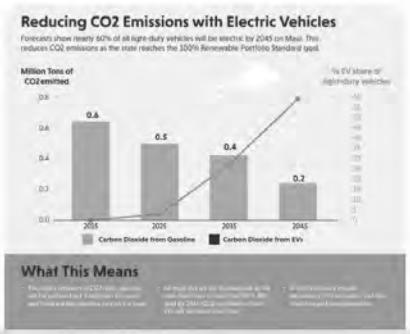
Click the image below to enlarge.





Emissions on Maui

Click the image below to enlarge.



Hawaiian Electric

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» Community-Based Renewable Energy
» Electrification of Transportation
» Resilience
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COMMENT

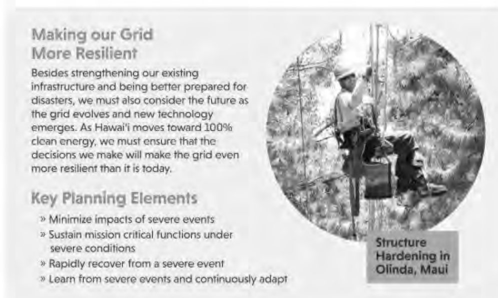
Resilience

Making our grid more resilient with key planning elements.

Definition and Understanding

"Resilience is the ability of a system or its components to adapt to changing conditions and withstand and rapidly recover from disruptions."
—Public Utilities Commission Staff

Click the image below to enlarge.



Learn More

Our Vision & Commitment

Resilience on Hawai'i

Click the image below to enlarge.

Resilience on other islands

Click the image below to enlarge.

» Resilience
» Engagement
» Careers at Hawaiian Electric

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Hawaiian Electric

Integrated Grid Planning (IGP)

COMMENT

Engagement

We Want to Hear From You

We welcome your input! There are many ways to stay connected with us.

Email:
igp@hawaiianelectric.com

Website:
www.hawaiianelectric.com/igp

Social:

HawaiianElectric

hwnelectric

hawaiianelectric

Public Engagement Survey – 8 Questions

How did you hear about this meeting?

- Social media
- Newspaper
- Radio
- Flyer/banner
- IGP Website
- Word of Mouth
- Other

In the future, what type of Integrated Grid Planning information would you be most interested in receiving? (Select up to 3)

- General updates
- Input opportunities
- Advanced meters
- Grid modernization
- Renewables – Rooftop and Community Solar
- Renewables – Utility scale projects
- Electrification of Transportation
- Resilience
- Employment opportunities
- Incentive programs
- Other

What would be your preferred method to receive future information on Integrated Grid Planning? (Select up to 2)

- Social media
- IGP website
- Email
- Mail
- Newspaper
- Radio
- Other

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» Electrification of Transportation
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Share any additional thoughts—we're listening!

The following demographics questions are optional.

Where is your home or business located?

- Hawai'i (Big Island)
- O'ahu
- Maui
- Moloka'i
- Lāna'i

Do you make the purchasing decisions for your home or business?

- Yes
- No

Do you rent or own the location of that home or business?

- Rent
- Own

What is your age?

- Under 18
- 18–24
- 25–34
- 35–44
- 45–54
- 55–64
- 65–74
- 75 and older

Submit Your Response

javascript:setArrow(1)

» Community-Based Renewable Energy
» Electrification of Transportation
» Resilience
» Engagement

Careers at Hawaiian Electric

Information and opportunities for ***joining the team.***

Click each of the two (2) images below to enlarge.

Learn More

Hawaiian Electric Careers

Hawaiian Electric

- Welcome
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- Rooftop Renewable Energy
- Community-Based Renewable Energy
- Electrification of Transportation
- Resilience
- Engagement

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COMMENT

Welcome

Welcome to our Virtual Open House

Thank you for your participation in our online engagement! The slides in this session are filled with information about our Integrated Grid Planning, renewables and careers at Hawaiian Electric. Please read the materials and submit your responses to each survey question to help shape our renewable energy future together.

In-Person Public Meetings

Thank you to everyone who attended one of our public engagement opportunities March 3–12, 2020 or our virtual open house.

General Information Survey – 2 Questions

These surveys are now closed. Thank you for your interest and participation.

igp.hawaiianelectric.com

All Users
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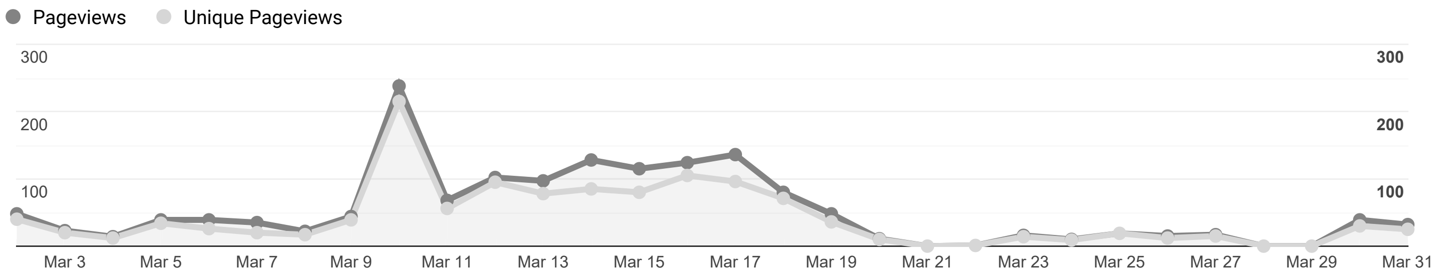
Mar 2, 2020 - Mar 31, 2020

Report Tab



Source	Pageviews	Unique Pageviews
	1,560 of Total: 0.29% 535,960)	1,260 of Total: 0.29% 430,363)
1. direct)	1,081 69.29%)	835 66.27%)
2. hawaiianelectric.com	115 7.37%)	96 7.62%)
3. m.facebook.com	67 4.29%)	65 5.16%)
4. ads-bidder-api.twitter.com	65 4.17%)	53 4.21%)
5. google	56 3.59%)	50 3.97%)
6. facebook.com	45 2.88%)	45 3.57%)
7. bing	15 0.96%)	14 1.11%)
8. hawaiielectriclight.com	15 0.96%)	10 0.79%)
9. clremail	13 0.83%)	12 0.95%)
10. infohana.net	13 0.83%)	13 1.03%)
11. igp.hawaiianelectric.com	12 0.77%)	9 0.71%)
12. media.hawaiianelectric.com	11 0.71%)	11 0.87%)
13. eservice.hawaiianelectric.com	10 0.64%)	9 0.71%)
14. instagram.com	9 0.58%)	9 0.71%)
15. ad-review-tool.twitter.biz	4 0.26%)	3 0.24%)
16. ads.google.com	4 0.26%)	3 0.24%)
17. l.facebook.com	4 0.26%)	4 0.32%)
18. zoho.hdrstratcomm.com	3 0.19%)	3 0.24%)
19. hestaging.ingeniuxondemand.com	2 0.13%)	1 0.08%)
20. kuleanasurvey.hawaiianelectric.com	2 0.13%)	2 0.16%)
21. mauielectric.com	2	2

		(0.13%)	0.16%)
22.	page.report	**2** **0.13%)**	1 0.08%)
23.	qwant.com	**2** **0.13%)**	2 0.16%)
24.	cdnapisec.kaltura.com	**1** **0.06%)**	1 0.08%)
25.	ecosia.org	**1** **0.06%)**	1 0.08%)
26.	footprint.hawaiianelectric.com	**1** **0.06%)**	1 0.08%)
27.	j2dci.hawaiianelectric.net:53600	**1** **0.06%)**	1 0.08%)
28.	medium.com	**1** **0.06%)**	1 0.08%)
29.	pages.hawaiianelectric.com	**1** **0.06%)**	1 0.08%)
30.	sharepoint	**1** **0.06%)**	1 0.08%)
31.	t.co	**1** **0.06%)**	1 0.08%)

Rows 1 - 31 of 31

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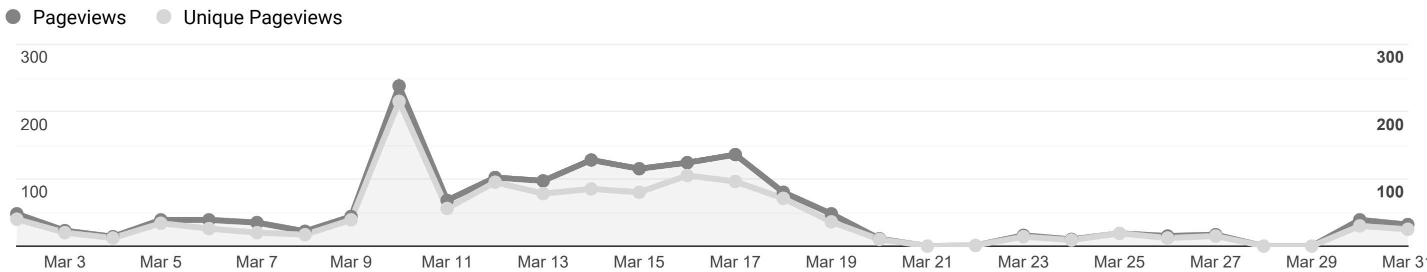

Browser	Pageviews	Unique Pageviews
	1,560 of Total: 0.29% 535,960)	**1,260** of Total: 0.29% 430,363)
1. Android Webview	**476** **30.51%)**	270 21.43%)
2. Chrome	**379** **24.29%)**	317 25.16%)
3. Safari (in-app)	**261** **16.73%)**	253 20.08%)
4. Edge	**162** **10.38%)**	153 12.14%)
5. Internet Explorer	**133** **8.53%)**	126 10.00%)
6. Safari	**126** **8.08%)**	119 9.44%)
7. Firefox	**11** **0.71%)**	11 0.87%)
8. Samsung Internet	**8** **0.51%)**	7 0.56%)
9. not set)	**2** **0.13%)**	2 0.16%)
10. Bluebeam Revu Browser - cef version: 57.0.0.0	**1** **0.06%)**	1 0.08%)

Rows 1 - 10 of 11

Analytics All Sites
All Web Site Data (master ...

Go to report

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All Users
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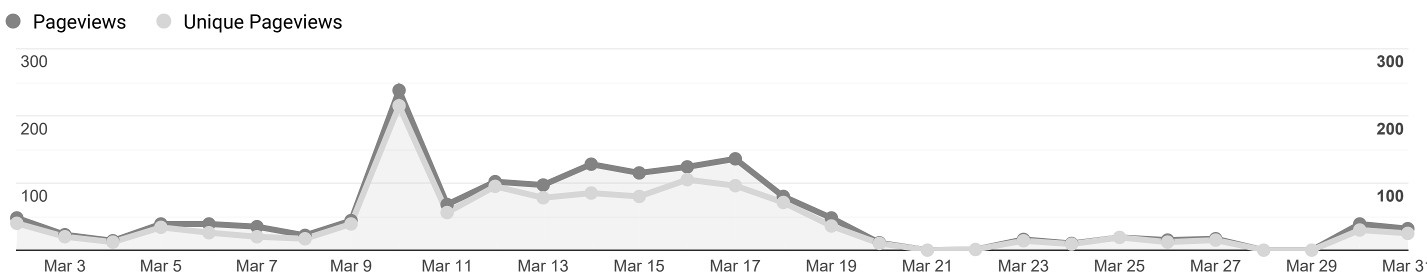

Date	Pageviews	Unique Pageviews
	1,560 of Total: 0.29% 535,960)	1,260 of Total: 0.29% 430,363)
1. 20200302	48 3.08%)	40 3.17%)
2. 20200303	23 1.47%)	20 1.59%)
3. 20200304	14 0.90%)	12 0.95%)
4. 20200305	39 2.50%)	34 2.70%)
5. 20200306	39 2.50%)	26 2.06%)
6. 20200307	35 2.24%)	20 1.59%)
7. 20200308	22 1.41%)	17 1.35%)
8. 20200309	44 2.82%)	39 3.10%)
9. 20200310	238 15.26%)	215 17.06%)
10. 20200311	68 4.36%)	56 4.44%)
11. 20200312	102 6.54%)	95 7.54%)
12. 20200313	97 6.22%)	78 6.19%)
13. 20200314	128 8.21%)	85 6.75%)
14. 20200315	115 7.37%)	80 6.35%)
15. 20200316	124 7.95%)	105 8.33%)
16. 20200317	136 8.72%)	96 7.62%)
17. 20200318	80 5.13%)	71 5.63%)
18. 20200319	48 3.08%)	36 2.86%)
19. 20200320	11 0.71%)	10 0.79%)
20. 20200322	1 0.06%)	1 0.08%)
21. 20200323	16	14

		(1.03%)	1.11%)
22.	**20200324**	10 0.64%)	9 0.71%)
23.	**20200325**	19 1.22%)	19 1.51%)
24.	**20200326**	15 0.96%)	12 0.95%)
25.	**20200327**	17 1.09%)	15 1.19%)
26.	**20200330**	39 2.50%)	30 2.38%)
27.	**20200331**	32 2.05%)	25 1.98%)

Rows 1 - 27 of 27

Analytics All Sites
All Web Site Data (master ...

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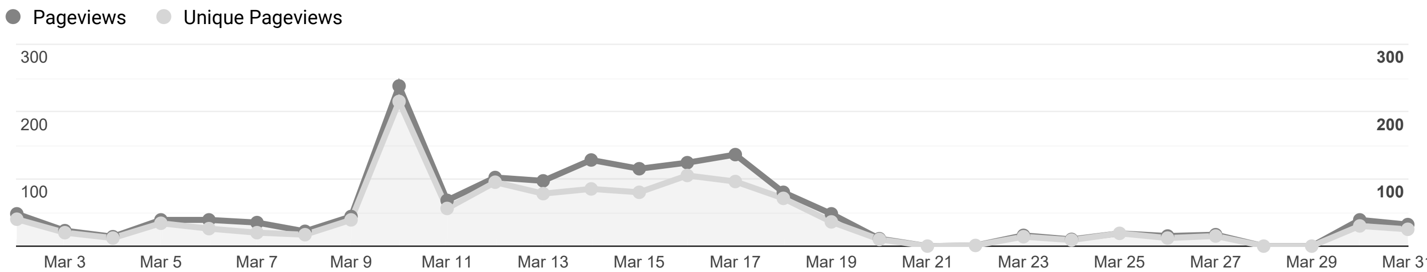

Device Category	Pageviews	Unique Pageviews
	1,560 of Total: 0.29% 535,960)	**1,260** of Total: 0.29% 430,363)
1. mobile	**822** **52.69%)**	612 48.57%)
2. desktop	**659** **42.24%)**	587 46.59%)
3. tablet	**79** **5.06%)**	61 4.84%)

Rows 1 - 3 of 3

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