March 4, 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's Reply Comments

In accordance with Order No. 37604 *Establishing a Procedural Schedule for the First Review Point* issued on February 4, 2021 in the subject proceeding, Hawaiian Electric[1] respectfully submits its reply to the Consumer Advocate's and Intervenors' Comments on its Integrated Grid Planning ("IGP") Review Point ("First Review Point") filed January 19, 2021.[2]

The attached document, *Integrated Grid Planning Stakeholder Feedback Summary*, is a result of feedback received from a wide spectrum of meetings including more than 23 working group meetings, several presentations to the Stakeholder Council ("SC") and Technical Advisory Panel ("TAP") as well as written comments received and filed in this proceeding[3] on initial drafts of the two key deliverables (Inputs and Assumptions Report[4] and Grid Needs Assessment Report[5]) over the course of the IGP development process in 2019-2020. Almost 400 individual comments, questions, suggestions, and edits were provided from Stakeholders and captured by the Companies. Of the 400, over 140 questions or suggestions – both written and verbal – resulted in specific changes in assumptions, methods or analysis that clarified or modified the

[1] "Hawaiian Electric" or "Companies" refers to Hawaiian Electric Company, Inc., Maui Electric Company, Limited, and Hawai‘i Electric Light Company, Inc.. Hawaiian Electric Company, Inc., Maui Electric Company, Limited, and Hawai‘i Electric Light Company, Inc. are each doing business as "Hawaiian Electric" and have jointly registered "Hawaiian Electric" as a trade name with the State of Hawai‘i Department of Commerce and Consumer Affairs, as evidenced by Certificate of Registration No. 4235929, dated December 20, 2019.

[2] See Hawaiian Electric Companies Updated IGP Workplan and Review Point filed January 19, 2021 in the subject docket.

[3] The attached document is not an exhaustive reply to the Consumer Advocate's and Intervenors' Comments. The Companies offered replies to key comments filed on February 24 and February 25, 2021 in this docket by the Consumer Advocate and Intervenors. The Companies reserve the right to comment on other aspects of submitted comments in the future.

[4] Draft Inputs and Assumptions Report, available at https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200925_draft_IGP_inputs_and_assumptions.pdf

[5] Draft Grid Needs Assessment Report, available at 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

results presented in the Inputs and Assumptions Report and Grid Needs Assessment Report. Over 250 comments received were questions or requests for clarification to which the Companies provided additional information, either verbally in working group sessions or by capturing and responding to these comments in the meeting notes.

The Companies are appreciative of the significant stakeholder efforts to date in this proceeding and active engagement of the Intervenors. With stakeholder input, Hawaiian Electric has been able to improve the IGP process, specifically with respect to transparency, resource costs, renewable resource potential, sensitivities, and generation unit retirements, and can now turn from broad discussion of inputs and assumptions to a more focused attention on the specific changes that have been incorporated. The Companies respectfully submit the substantial changes that have been incorporated for the Commission's review, and believe that the IGP process is at a reasonable starting point for its first cycle to move forward.[6]

Sincerely,

/s/ Kevin M. Katsura

Kevin M. Katsura
Director, Regulatory Non-Rate Proceedings

Enclosure

c: Service List

[6] As mentioned in the Reply Comments, the Companies note that certain items still need to be fully developed or completed before the Grid Needs Assessment ("GNA") phase, including an additional NREL solar potential scenario, as well as development of the high and low bookend sensitivities to reflect various adoption levels of various types of DER including EVs, EE, and TOU rates. Upon these additional items being completed, along with consideration of any additional guidance provided by the Commission, the GNA phase will commence. The Companies also note that as part of the recent changes to the Stakeholder Council, the council has identified inputs and assumptions as one strategic topic to discuss.

Hawaiian Electric

Integrated Grid Planning
Stakeholder Feedback Summary

March 2021

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Executive Summary

The Stakeholder feedback summarized in this Report informed two key deliverables from the Forecasting and Assumptions Working Group ("FAWG") and the Solution Evaluation Optimization Working Group ("SEOWG"):

- 2020 Integrated Grid Planning – Inputs and Assumptions ("I&A Report")
- 2020 Integrated Grid Planning – Grid Needs Assessment ("GNA") and Solution Evaluation Methodology ("GNA Report")

Feedback was received from a wide spectrum of meetings including more than 23 working group meetings, several presentations to the Stakeholder Council ("SC") and Technical Advisory Panel ("TAP") as well as written comments received on initial drafts of the two key deliverables, and public meetings, over the course of the IGP development process in 2019-2020. Almost 400 individual comments, questions, suggestions, and edits were provided from Stakeholders and captured by the Companies. Of the 400, over 140 questions or suggestions – both written and verbal – resulted in specific changes in assumptions, methods or analysis that clarified or modified the results presented in the I&A and GNA Reports. Over 250 comments received were questions or requests for clarification to which the Companies provided additional information, either verbally in working group sessions or by capturing and responding to these comments in the meeting notes.

Key themes from stakeholders that informed the IGP I&A Report include:

- The TAP stated[1] that the layering approach for load forecasting is reasonable and important to identify and understand the impacts of the important drivers (*e.g.,* DER growth, energy efficiency, electric vehicles, etc.)
- The TAP recommended that scenario and sensitivity analysis (*i.e.*, "bookend") is an important modeling and analysis approach to better test the sensitivity of the models and resulting resource portfolios against a wide range of load forecasts.

[1] *See* The Companies' Updated Workplan filed in Docket No. 2018-0165 on January 19, 2021 ("Updated Workplan"), Exhibit A.3, Integrated Grid Planning Technical Advisory Panel Review.

- The treatment of DER in the modeling and forecasting, including suggestions to model future DER programs as exporting systems rather than strictly self-consumption.
- Stakeholders expressed concern that some layers like energy efficiency may be too aggressive.
- Some stakeholders provided comments and suggestions that the potential for larger, grid-scale solar systems may be underestimated and wanted to look at ways to evaluate higher integration of solar in the forecasts. Other stakeholders felt that the current solar potential may already be too high given the land constraints on O'ahu.
- Stakeholders, through workshops, presentations, and written comments, expressed a strong interest in developing a better shared understanding of:
    - The drivers for adoption and barriers for adopting DER, energy efficiency and electric vehicles and how these were considered in the forecast development and modeled in the GNA,
    - The IGP process, including inputs, outputs, and timing,
    - The GNA methodology and modeling/analysis process, and
    - The definition for grid services and how they are modeled.

  The discussion that took place on these subjects substantially informed the forecast assumptions as well as identified the need for sensitivity (bookend) analysis which has been adopted by the Companies in the GNA process.

Key input from stakeholders that informed the IGP GNA Report includes:

- Inputs and methodology descriptions for the ecosystem of models used in the GNA (RESOLVE and PLEXOS models for the resource needs, PSS/E, PSCAD, and ASPEN for transmission and system security needs, Synergi and LoadSEER for distribution needs) to help stakeholders understand the strengths and limitations of the modeling framework and the iterative modeling approach taken within the system security step to fully address grid needs between these models;
- Coordination with the Forecast Assumptions Working Group to share forecast assumption inputs earlier in the stakeholder engagement process to facilitate more robust discussion on sensitivity analysis;
- Incorporation of utility programs and non-wires alternatives ("NWA") RFP within the IGP process to provide equal evaluation across resource types;
- Clarification on the definitions and methodologies used to support identification of the Grid Needs;
- Development and evolution of a diagram that depicts a high-level connection between one procurement cycle and the next to clarify the overarching process, then developing procurement cycles for the next 10 years to allow for the development of other resources with longer development times; and

- Development and evolution of diagrams that show detail of the Transmission and Distribution Needs, and Grid Needs assessment processes.

As a direct result of the stakeholder engagement process, substantial changes to the Inputs and Assumptions and Grid Needs Assessment were or will be made, including:

Increased Transparency

The Companies provided a workbook containing inputs and assumptions ("I&A Workbook") used in the RESOLVE model, including the annual hourly ("8760 hourly" or "8760s") profiles that define the load forecast and its layers for the underlying forecast, distributed energy resources, electric vehicles, and energy efficiency, the available generation from variable renewable resources and reserve requirements for FFR, inertia, and regulating reserves.

Resource Costs and New Resource Options

The resource costs assumed for the various candidate options were updated for several changes in 2020.

- The Federal ITC schedule for grid-scale PV, distributed PV, onshore wind, and offshore wind was updated in December 2020.
- Updated forecasts were provided by IHS Markit in December 2020 for grid-scale and distributed PV, onshore wind, and in January 2021 for utility and distributed storage.
- The latest 2020 Annual Technology Baseline ("ATB") was used to update the source data for geothermal, biomass, offshore wind, and concentrated solar power as well as the future trendlines for combustion turbines, internal combustion engines, municipal solid waste, and synchronous condensers.

NREL is working with the Bureau of Ocean Energy Management and Hawaii State Energy Office to conduct a Hawai'i specific offshore wind cost modeling study. The study was introduced through a kickoff meeting in the SEOWG and Stakeholders were supportive of using the specific costs established by the study in IGP.

For distributed energy resources, a paired residential PV+BESS resource was also made available as a resource option within the RESOLVE modeling with a developable potential defined as the difference between the technical potential provided by NREL and the capacity assumed in the market forecast. This incremental DER above the forecast would be able to export and participate in grid services.

Renewable Resource Potential

NREL will be re-engaged to model an additional scenario to modify the assumptions made on slope, land exclusions, minimum wind speed, and minimum parcel size and array density for grid-scale solar potential, as suggested by a stakeholder.

High and Low Bookend Sensitivities

Bookends will be evaluated as a sensitivity around the reference forecast, to establish a plausible set of assumptions for each of the layers within the load forecast to define a

cumulative high forecast and cumulative low forecast. These high and low bookends could include the evaluation of higher and lower adoption of distributed energy resources, electric vehicles, energy efficiency, and time-of-use ("TOU") rates adoption. The bookends can also incorporate high and low assumptions on variable renewable generation. While the market forecast and renewable profiles provided in the inputs workbooks represent the best estimate of those assumptions, the results of the bookends will be useful to directionally inform how the resource plan and system costs will change as load and the need for renewable generation increases or decreases.

- For electric vehicles, a factor can be applied to the unmanaged charging to account different levels of adoption.
- A wider range of energy efficiency measures will be incorporated; however, modeling more detailed energy efficiency sensitivities will require additional guidance and information to do so.
- For time-of-use rates, initial "best guess" assumptions for TOU adoption and load shapes will be developed as a placeholder until proposals can be finalized in the ARDS track of the DER docket.

An initial proposal for the bookends is provided below. In sum, the low and high bookends, labeled as Slower Customer Technology Adoption and Faster Customer Technology Adoption respectively, represent a deceleration and acceleration of customer adoption of distributed energy resources, electric vehicles, energy efficiency, and time-of-use rates which are all key drivers of the load forecast.

Table 1: Proposal for Bookends Sensitivity

Assumption	Slower Customer Technology Adoption	Base	Faster Customer Technology Adoption
DER	• Market Forecast • DER aggregator as a resource option	• Market Forecast • DER aggregator as a resource option	• Increase DER layer in market forecast by 30%, capped at the technical potential established by NREL • DER aggregator as a resource option
Electric Vehicles	• Reduce electric vehicle layer in market forecast by 30%	• Market Forecast	• Increase electric vehicle layer in the market forecast by 30%, capped at the same market saturation levels in the Market Forecast
Energy	• Reduce energy	• Market Forecast	• Increase energy

Assumption	Slower Customer Technology Adoption	Base	Faster Customer Technology Adoption
Efficiency	efficiency layer in market forecast by 30%		efficiency layer in market forecast by 30%
TOU	• Market Forecast (no assumed TOU)	• Managed EV TOU • Managed DER TOU	• Higher Managed EV TOU adoption • Higher Managed DER TOU adoption

Generation Unit Retirements

A fossil generation retirement plan will be provided for O'ahu to mitigate the risk of an aging generation fleet and to assess the impact of accelerating renewable resource development as generating unit utilization declines.

Appendices A and B of this Report provide a detailed listing of the specific comments, suggested edits, and questions received from stakeholders over the course of the FAWG and SEOWG stakeholder engagement process and deliverables development.

Hawaiian Electric has published this Report in conjunction with, and complimentary to the drafts of the I&A Report,[2] the I&A Workbook,[3] and the GNA Report.[4]

[2] Draft Inputs and Assumptions Report, available at https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200925_draft_IGP_inputs_and_assumptions.pdf

[3] Draft O'ahu Inputs and Assumptions Workbook, available at https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200925_draft_oahu_inputs_workbook_1.xlsx and https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20200925_draft_oahu_inputs_workbook_2.xlsx

[4] Draft Grid Needs Assessment Report, available at 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

1 Introduction

1.1 PURPOSE

This Report was developed to document and summarize the feedback that Hawaiian Electric[5] has received from stakeholders throughout the Integrated Grid Planning ("IGP") process development effort that took place beginning in 2019, specifically the activities and deliverables associated with the Forecast Assumptions Working Group ("FAWG") and the Solution Evaluation and Optimization Working Group ("SEOWG"), consistent with the guidance provided under Commission Orders No. 36725 and No.37419 .[6]

1.2 STAKEHOLDER ENGAGEMENT PROCESS

Hawaiian Electric's IGP process is a fully integrated planning and procurement process rooted in stakeholder input. The IGP Stakeholder Engagement Model that was proposed as part of the Companies' Integrated Grid Planning Workplan on December 14, 2018 provided a robust framework that enables the Companies to engage with stakeholders and customers to gather their input and feedback throughout the IGP process development and leverage global insights on emerging best planning practices in a systematic manner.

Stakeholders were engaged in the development of forecast assumptions, modeling inputs and methodologies and scenario development critical to the overall IGP process as well as providing review and feedback on the analytical tools and proposed methodologies used to develop grid needs.

Consistent with the Commission's direction, the Companies established:

[5] "Hawaiian Electric" or the "Companies" refer collectively to Hawaiian Electric Company, Inc., Maui Electric Company, Limited, and Hawai'i Electric Light Company, Inc.

[6] *See* Order No. 36725 *Providing Guidance*, filed on November 4, 2019, and Order No. 37419 *Providing Guidance*, filed on November 5, 2020, in Docket No. 2018-0165.

- The Stakeholder Council ("SC") to provide strategic input and feedback on the overall IGP process development and the specific stakeholder engagement model and process;
- The Technical Advisory Panel ("TAP") of industry experts to serve as a sounding board on technical issues, new methods and best practices given the leading-edge aspects of the IGP planning and sourcing; and
- Technical Working Groups formed on an as-needed basis to address specific topics in an advisory only capacity and not as a decision-making group. Working Groups were established, completed their respective deliverables, and have stood down upon completion of the chartered work tasks involving their subject-matter expertise. Many comments included in this Report are without attribution as working group meetings were held under modified Chatham House rules; however, where stakeholders or Parties' represented comments outside the working groups, attribution is provided.
- Public Engagement, 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.[7] 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.[8] The virtual open house had 1,260 unique visitors. A summary of Public Meeting and Virtual Open House Feedback is included in the Companies' Updated Workplan, Exhibit C.

On February 4, 2021, the Commission issued a procedural schedule in Docket No. 2018-0165 directing parties to file comments in response to the Companies' first review point that comprised of the September 2020 IGP Inputs and Assumptions ("I&A Report") available on the Companies' website.[9]

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

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

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

This Report and associated attachments are a compilation of feedback received through working group meetings, Technical Advisory Panel meetings, Stakeholder Council meetings, email, public comments, and written comments filed in the docket. The Companies received written comments from Life of the Land,[10] Ulupono Initiative,[11] Joint Parties,[12] Consumer Advocate,[13] and Progression Hawaii Offshore Wind.[14] As described throughout, the Companies have made adjustments to the planning and modeling process in response to feedback received, provided clarifications to questions, or explained why certain feedback was not incorporated.

1.2.1 Forecast Assumptions Working Group (FAWG)

The purpose of the FAWG was to support development of forecast assumptions and sensitivities as part of the initial IGP planning cycle activity preceding the planning for transmission, distribution, and resource needs in the Grid Needs Assessment ("GNA"). This group was tasked with providing specific input on forecast assumptions and related sensitivities in support of using primarily market-based factors in forecasts.

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 Hawai'i experts representing their respective contributions on economic outlook, energy efficiency potentials and program roadmaps, and transportation electrification.

The FAWG engaged 17 different organizations and various docket intervenors during the stakeholder engagement process.[15] The stakeholder engagement process in this working group substantially informed the development of the I&A Report.

Table 2 is a listing of the organizations that participated in the FAWG meetings.

Table 2: Participating Organizations in FAWG

Organizations

[10] On February 24, 2020, Life of the Land filed Comments Re: IGP First Review Point in Docket No. 2018-0165 ("LOL's Comments").

[11] On February 25, 2020, Ulupono Initiative LLC filed Comments on the Hawaiian Electric Companies Updated Integrated Workplan – First Review Point in Docket No. 2018-0165 ("Ulupono's Comments").

[12] On February 25, 2020, the Joint Parties (Hawaii PV Coalition, Hawaii Solar Energy Association, and Blue Planet Foundation), filed Comments on the HECO Companies' First Review Point in Docket No. 2019-0165 ("Joint Parties' Comments").

[13] On February 25. 2020, the Division of Consumer Advocacy filed Comments on the First Review Point in Docket No. 2018-0165 ("CA's Comments").

[14] On February 25, 2020, Progression Hawaii Offshore Wind, LLC filed Comments on Hawaiian Electric Companies' First Review Point in Docket No. 2018-0165 ("PHOW's Comments").

[15] *See* Hawaiian Electric Companies Update IGP Workplan & Review Point Report, January 2021: Section 2.3, page 22.

Organizations

Public Utilities Commission Staff	Rocky Mountain Institute
Hawai'i Energy	Department of Commerce and Consumer Affairs, Division of Consumer Advocacy
O'ahu Economic Development Board	City & County of Honolulu
Hawai'i Island Economic Development Board	Maui County Community
Department of Business, Economic Development, and Tourism	University of Hawai'i Economic Research Organization
Electric Power Research Institute	Electric Reliability Council of Texas
NV Energy	Portland General Electric
Sacramento Municipal Utility District	Life of the Land
Applied Energy Group	

1.2.2 Solution Evaluation and Optimization Working Group (SEOWG)

The purpose of the SEOWG was to develop a Grid Needs Assessment using the Companies' load forecast that was informed by the work of the FAWG along with other key inputs and assumptions used by the RESOLVE and PLEXOS models to develop a reference portfolio to serve load and provide grid services (Grid Needs). The SEOWG was also chartered to develop and recommend a transparent evaluation and optimization method to fairly assess proposed solutions identified in a solution sourcing procurement process.

As part of the process for developing the Grid Needs Assessment, the SEOWG was also tasked with identifying and defining additional services that may be needed in support of IGP Solution Sourcing for the first IGP cycle. As the GNA was being developed, it became evident through discussion and feedback from stakeholders that a separate deliverable for documenting and detailing the Inputs and Assumptions would be necessary and helpful for stakeholders to gain a better understanding of the underlying assumptions and supporting data used to drive the forecasts as well as how those forecasts and assumptions are used as input to the modeling used to generate the GNA. The SEOWG used many of the work products and incorporated detailed data considerations from the FAWG in the development of the IGP I&A Report.

The SEOWG has engaged with 18 different organizations during the stakeholder engagement process.[16] The Company has held fifteen SEOWG meetings through February 2021 in which

[16] *See* Hawaiian Electric Companies Update IGP Workplan & Review Point Report, January 2021: Section 2.6, page 29.

stakeholders discussed the timeline and methodology for (1) identifying the timing, quantity, and value of various Grid Needs, (2) evaluating potential solutions received in a competitive procurement or a utility program, and (3) presenting initial, preliminary results of the RESOLVE model using the assumptions that have been developed through the Forecast Assumptions Working Group and further detailed in the I&A Report.

The SEOWG stakeholder engagement process substantially informed the development of the I&A Report and the IGP Grid Needs Assessment and Solution Evaluation Methodology ("GNA Report").

Table 3 provides a listing of the organizations that participated in the SEOWG meetings.

Table 3: Participating Organization in SEOWG

Organizations

Public Utilities Commission Staff	Rocky Mountain Institute
County of Hawaii	Department of Commerce and Consumer Affairs, Division of Consumer Advocacy
Blue Planet	Energy Island
Hawai'i PV Coalition	Hawai'i Solar Energy Association
Life of the Land	Progression Hawaii Offshore Wind
Renewable Energy Action Coalition of Hawai'i	Ulupono Initiative
Hawai'i Natural Energy Institute	Nexamp
Salt River Project	Hawai'i State Energy Office
Hawai'i Energy	Telos Energy

2 Background

2.1 FAWG AND SEOWG DELIVERABLES

This Report summarizes and documents the feedback Hawaiian Electric received from stakeholders during the Integrated Grid Planning process development effort that took place in 2019-2020, specifically those activities and deliverables associated with the Forecast Assumptions Working Group and the Solutions Evaluation and Optimization Working Group. Stakeholder engagement and feedback proved invaluable in informing the process and the deliverables the FAWG and SEOWG were chartered to develop under the IGP process, consistent with the guidance provided under Commission Orders No. 36725 and No. 37419.

2.1.1 Schedule of FAWG Meetings

A summary of the FAWG meetings held to date are set forth in Table 4. Through these FAWG meetings, stakeholders had an opportunity to learn about the Companies' assumptions and methods for developing the load forecast. The FAWG provided a venue for stakeholders to ask questions and provide feedback on the Companies' proposed load forecast and the assumptions and methodologies used to develop that load forecast.

Table 4: Schedule and Summary of FAWG Meetings

Meeting	Summary of Agenda
2. **May 22-23, 2019 – Panel of Experts**	Panel discussion and presentations on forecast layers by subject matter experts.
3. **July 17, 2019 – Forecast Methodologies**	Discussion on Hawaiian Electric and other utilities' forecast methods.
4. **August 27, 2019 – Forecast Assumptions**	Presentation and discussion of assumptions to develop forecast through breakout sessions.
5. **January 29, 2020 – Preliminary Forecasts**	

Meeting	Summary of Agenda
6. **March 9, 2020 – Model Sensitivities and Forecast Review**	Review of forecasts for IGP and how they will be used in the modeling.
7. **August 14, 2020 – Forecast Review with Technical Advisory Panel**	Review of forecast development process and final figures with TAP.
8. **August 31, 2020 – Forecast Update for COVID**	Review of updated forecasts to account for the impacts of COVID.
9. **February 23, 2021– Review of Stakeholder Feedback on I&A Report**	Review Stakeholder feedback received on the Inputs & Assumptions Report.

2.1.2 Schedule of SEOWG Meetings

A summary of the SEOWG meetings held to date are provided in Table 5. Through these SEOWG meetings, stakeholders had the opportunity to learn about the Companies' methods for developing its Grid Needs Assessment and for conducting its solution sourcing evaluations. The SEOWG provided a venue for stakeholders to provide feedback on the Companies' proposed methodologies to develop the GNA.

Table 5: Schedule and Summary of SEOWG Meetings

Meeting	Summary of Agenda
1. **May 9, 2019 – Kickoff**	Overview of SEOWG and IGP process.
2. **August 1, 2019 – Panel Discussion**	Panel presentations on evaluation methodologies by other utilities. Discuss revisions to IGP process flow.
3. **September 20, 2019 – Resource Needs Planning**	Review resource planning and RFP evaluation process steps in detail.
4. **October 30, 2019 – SEOWG Deliverable Outline Discussion**	Review an initial outline of the SEOWG deliverable.
5. **November 13, 2019 – IGP Process Flow and Future Procurements**	Discuss revisions to IGP process flow and pathway for future procurements, including a long-term RFP .
6. **December 9, 2019 – Solution Evaluation Methodology and Modeling Sensitivities**	Review updates to the IGP process flow and decomposition of the resource planning step. Introduce the RESOLVE and PLEXOS models, a proposal for solution evaluation, and proposed modeling sensitivities developed with stakeholder feedback.

Meeting	Summary of Agenda
7. **January 23, 2020 – Cost Forecasts and Grid Services**	Review the fuel forecast and resource cost forecast for IGP, introduce the set grid services to be evaluated through the planning work, and continue discussions on modeling sensitivities.
8. **February 12, 2020 – IGP Soft Launch Evaluation Methodology**	Review updates to modeling sensitivities. Introduce the evaluation methodology for the IGP Soft Launch.
9. **March 16, 2020 – Stakeholder Feedback on SEOWG Deliverable**	Review stakeholder feedback on the redlined SEOWG deliverable outline and modeling sensitivities.
10. **April 20, 2020 – Grid Needs Assessment**	Review updates to the fuel forecast and resource costs. Review example outputs of the Grid Needs Assessment.
11. **May 22, 2020 – Energy Reserve Margin, Load Build/Reduce, and Grid Service Capability**	Introduce the Energy Reserve Margin service for capacity, methodologies for identifying load build and load reduce needs, and linkage between resources and their grid service capability.
12. **June 30, 2020 – Transmission Needs**	Introduce the transmission planning criteria and planning for transmission needs. Review stakeholder comments on the Grid Needs Assessment and Solution Evaluation.
13. **October 2, 2020 – Preliminary Model Results**	Discuss preliminary results of the RESOLVE modeling using the assumptions developed to date.
14. **January 22, 2021 – NREL Offshore Wind Study**	Discussed proposed Hawaii offshore wind study conducted by NREL.
15. **February 26, 2021 – Review of Stakeholder Feedback on GNA Report**	Review Stakeholder feedback received on GNA Report.

2.1.3 IGP Inputs and Assumptions Report

The IGP I&A Report 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.

The inputs and assumptions that are used in the modeling process were developed and vetted through the FAWG process as described earlier.

Hawaiian Electric uses 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 more accurately as part of the Grid Needs Assessment. The assessment includes the latest available information from relevant Commission dockets and proceedings, including

Stage 1 and Stage 2 procurements for renewable energy, electrification of transportation, community based renewable energy procurements and programs, performance based regulation, and distributed energy resources.

2.1.3.1 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 representative resources to meet planning needs across a long-term horizon. While the RESOLVE modeling will utilize the cost inputs for available candidate technologies to define a least-cost resource plan, the selected resources do not prescribe the specific technology that should be procured. Rather, the selected resources represent a proxy for the grid services that should be procured in that year, such as, the specific amounts of energy, capacity, and ancillary services that are needed by the system. The procurement that follows the GNA will provide a market test of the actual available technologies that can meet the Grid Needs that have been identified and a means to test cost effectiveness of those technologies through the procurement's evaluation.

2.1.3.2 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 resources, including dispatchable DER resources, in operation. Unit commitment (starting and stopping of units) and dispatch levels of generation are generally based on fuel cost and unit efficiency.

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. Each of these resource categories have operating characteristics and constraints that govern their operation and capability to provide grid services that can be captured in the appropriate fields in PLEXOS.

2.1.4 IGP Grid Needs Assessment and Solution Evaluation Methodology Report

The IGP GNA Report describes how Hawaiian Electric uses a combination of the RESOLVE and PLEXOS optimization models, among others, in the IGP Process to:

- Identify the near-term quantity and timing of Grid Needs,[17] including system security needs using other modeling tools, that will drive future program development and procurement in each IGP cycle as part of the Grid Needs Assessment;[18] and

[17] "Grid Needs" means the specific grid services (including but not limited to capacity, energy, and ancillary services) identified in the Grid Needs Assessment, including transmission and distribution system needs that may be addressed through a Non-Wires Alternative.

- Develop resource plans to identify potential pathways to solve for near-term needs and long-term objectives such as achieving the 100 percent renewable energy goal in 2045; and
- Evaluate proposed solutions as part of an RFP to meet the Grid Needs defined in the Grid Needs Assessment.

2.2 STAKEHOLDER FEEDBACK

The Companies collected comments, suggestions, questions and the Companies' responses where applicable, for either clarification (during a working group discussion or SC/TAP presentation) or incorporation into evolving assumptions, methodologies or analysis processes in addition to specific edits on draft deliverable documents throughout the Stakeholder Engagement process, including feedback received through LOL's Comments, Joint Parties' Comments, CA's Comments, PHOW's Comments, and Ulupono's Comments. The following Section 3 summarizes this feedback and the Companies' responses for the Inputs and Assumptions Report and the Grid Needs Assessment and Solution Evaluation Report.

[18] "Grid Needs Assessment" or "GNA" means the process step in the IGP where the technical analyses are conducted to determine the generation, transmission, and distribution grid service(s) needs to serve our customers while meeting state policy objectives, reliability standards, among other goals. The Grid Needs Assessment will be presented to the Commission for review and approval.

3 Stakeholder Feedback

3.1 COMMON THEMES

The Companies engaged with 29 different organizations during the IGP process development period of 2019-2020. Feedback was received in the form of written comments from stakeholder review of the I&A and GNA Reports, as well as through workgroup meetings, workshops, public meetings, and presentations to the IGP Stakeholder Council and the Technical Advisory Panel.

The Companies thank all who participated and provided feedback throughout this process. Comments, questions and specific edits covered a broad range of issues, providing the Companies with a valuable perspective on stakeholders' collective view of the various proposed and evolving IGP processes as well as the inputs and assumptions crucial to the planning, modeling and analysis efforts that are described in the I&A and GNA Reports. While there was broad coverage of issues, there were also some common themes for stakeholder feedback:

- Understanding what specific resource cost assumptions were being used, the source of the cost data and the potential variation in costs over long-term planning horizons.
- Gaining a better understanding of the specific assumptions about adoption of DER and the drivers for and barriers against adoption of various DER technologies.
- Clarifying and better understanding of the specific resource capabilities (capacity, energy, and ancillary services as well as assumptions about resource costs) and how the planning models use that information to develop resource and grid service needs.
- Understanding what grid services are and how they are defined and modeled.
- Developing a better understanding of how base or reference cases are developed and how using a layered approach helps identify the individual impacts of various forecasts (*e.g.*, DER adoption/growth, energy efficiency, electrification of transportation) and how those layers contribute to the overall forecast and resultant grid needs.
- Stakeholder concern that some layers such as energy efficiency may be too aggressive.
- Some stakeholder comments and suggestions that the potential for solar may be underestimated and desire to look at ways to evaluate higher integration of solar in the

forecasts. Other stakeholders felt that the current solar potential may already be too high given the land constraints on O'ahu.

- Agreeing that scenario and sensitivity analysis (*i.e.*, "bookending") is an important modeling and analysis approach to better test the sensitivity of the models and resulting resource portfolios against a wider range of load forecasts by varying the assumptions in the underlying forecast layers.
- Gaining a better understanding about the modeling process itself and the mechanics of the models, both for RESOLVE and PLEXOS, including how the models work together, what they can actually produce and how to best interpret the outputs.
- Developing a better understanding of how Renewable Energy Zones are identified and how potential transmission constraints are identified and modeled in the analysis.
- 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.

3.2 IGP I&A REPORT FEEDBACK

3.2.1 Overview

A majority of the feedback received (both verbal and written) were questions and requests for clarification, which have been addressed either in the working group forums or have been logged and responses developed and presented in the detailed stakeholder feedback provided in Appendix A of this Report.

Feedback on the I&A Report (or the key assumptions work done by the FAWG as input to the I&A Report) consisted of more than 160 distinct comments, suggestions, questions and edits which were grouped into 15 categories as shown in Table 6.

Table 6: I&A Report: Stakeholder Feedback Categories & Responses

No.	Category	Clarification	Incorporated	Total
1	DER Forecast	21	13	34
2	Load Forecast	19	9	28
3	Electrification of Transportation	20	5	25
4	Resource Cost Forecast	13	2	15
5	Edit or Format	3	10	13
6	Energy Efficiency Forecast	9	0	9
7	Model Mechanics	7	1	8
8	Fuel Forecast	5	1	6
9	Other Assumptions	5	1	6
10	Cost Assumptions	2	2	4
11	Modeling Inputs	4	0	4

No.	Category	Clarification	Incorporated	Total
12	Resource Potential	4	0	4
13	AS Requirements	4	0	4
14	Sensitivity Analysis	3	0	3
15	Modeling Outputs	1	1	2

In Table 6, "Clarification" means stakeholder feedback that was provided either as a question or a comment and was responded to for clarification only. This feedback may not have been directly reflected in the I&A Report. "Incorporated" means Stakeholder feedback resulted in either a direct change to the I&A Report, and/or the feedback resulted in a direct change or modification of an analysis or assumption which modified a forecast, which then informed the I&A Report.

3.2.2 Selected Comments and Responses

The following sections present some of the key themes, comments, suggestions, and questions associated with the I&A Report. A full listing of all the stakeholder feedback received and the responses provided is presented in Appendix A.

3.2.2.1 Transparency

- **The Commission's guidance and other stakeholders, including written comments filed in this docket, recommended that more transparency be provided into the modeling and inputs and assumptions.**

  On February 18, 2021, the Companies provided a workbook of inputs and assumptions ("I&A Workbook") used in the RESOLVE model, including the annual 8760 hourly profiles that define the load forecast and its layers for the underlying forecast, distributed energy resources, electric vehicles, and energy efficiency, the available generation from variable renewable resources and reserve requirements for FFR, inertia, and regulating reserves.

  The I&A Workbook for O'ahu is available on the Companies' website.[19] The remaining workbooks for all other islands will be provided by the second week of March 2021. While a large effort, the Companies hope that this will provide the additional transparency that stakeholders are seeking within the IGP process.

  PHOW's Comments at pages 3-4, recognized and appreciated the Companies efforts towards transparency to date.

[19] Available at, https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents

3.2.2.2 DER Forecast

During the May 22 and 23, 2019 FAWG meeting, stakeholders were asked to provide their thoughts and views on the main drivers and barriers for adopting distributed energy resources. Panel discussion covered the main drivers and barriers for adopting distributed energy resources, from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion provided insights which were considered and incorporated into the either the forecast development or in the qualitative consideration for interpreting the results which are summarized in the I&A Report.

Stakeholders identified key drivers and barriers for advancing DER adoption and growth:

- Lower technology cost in the form of PV prices are down 80-90% over last 8-10 years and projections are sensitive to real estate costs, natural gas prices and enacted policies as noted in the Panel of Experts working group meeting;
- Technology advancements in the form of better communications and control capabilities that are compatible with demand response programs enable further adoption by utilities for grid management capability along with 3rd party firms that are offering these management services to utilities.
- Economics alone are not the sole factor for adoption. Other drivers take the form of customer values and beliefs such as environmental concerns, social influence in the form of friends, neighbors, and coworkers, and the desire to have the latest technology.
- Removing current barriers to additional or rapid DER growth which include cost considerations such as solar + storage systems are still expensive for most residential customers, rate design solutions are complex, and as DER becomes more prevalent in utility supply and service solutions, there is an increasingly complex electrical system management challenge which sometimes creates complex installation and operational requirement. Also, there is competition between DER resources that compete for customer adoption (*e.g.*, storage vs. demand response).
- Lack of home ownership was seen as a major barrier to adoption while shared roof space, low consumption/low bill, low income, roof integrity, and lack of financing options were all possible barriers to adoption for residential customers. For commercial customers, stakeholders stated that lack of roof ownership, limited space, and short lease on property were major barriers to adoption while lack of financing options, building aesthetics, and roof integrity were possible barriers.

  Feedback on home ownership and low consumption/low bill was reflected in the residential market size estimate for uptake modeling of DER. Feedback on commercial lack of roof ownership and limited space were reflected in commercial market size assumptions. Other barriers to adoption were indirectly included in the uptake modeling by using local historical adoption rates that have these barriers embedded in the historical adoption.

- Stakeholders stated that cost savings are the main driver; the current cost of storage is a barrier but they expect steady adoption of PV paired with storage over the next few years, but it will not be a rapid adoption like NEM was. Stakeholders felt there is financial merit in PV+BESS, although it is challenging right now. The expectation that adoption will be seen as more viable as costs decline or PPAs free customers from having to justify up front capital costs. Stacking value, like resiliency at sites that value resiliency, become a more important driver over the next 5-10 years.

  This stakeholder input is reflected in the assumptions for the DER uptake modeling, specifically that all residential and small and medium commercial PV is paired with batteries.

During other FAWG and SEOWG meetings, stakeholders also asked a number of questions about the specific assumptions used to drive Hawaiian Electric's DER forecast.

- **How much DER PV and distributed BESS are currently in place on each island?**

  The I&A Report was updated to show that as of June 30, 2020 the cumulative installed DER PV for Hawaiian Electric was 702MW, Hawai'i Electric Light was 105MW and Maui Electric was 128MW. Forecasted Hawaiian Electric incremental installed capacity is approximately 30MW in 2021 and 36MW in 2022.

- **Why were structures greater than six stories excluded from DER?**

  The exclusion of greater than six story buildings was meant to simplify the identification of the number of high-rise buildings that may not have enough rooftop space relative to the number of floors in the building to install a PV system as many of these buildings have other equipment that compete for the same rooftop space. This criteria eliminated less than 30% of commercial buildings on O'ahu, less than 2.5% on Maui and 0% on Hawai`i, Lāna`i and Moloka'i. If the number of floors were missing for a building, the building was included in deriving the market potential.

- **How is the investment tax credit being modeled?**

  In the forecast, Federal tax credits were assumed to start ramping down after 2019. State tax credits were similarly ramped down. The I&A Report provides greater detail on the assumed schedule and rate for the investment tax credits.

- **If forecast assumptions are changed—even in a relatively minor way—does that require all the models to be run again for each island? And would this extend the timeline for some of the products in the IGP process?**

  Stakeholders suggested and Hawaiian Electric agreed that developing sensitivity analysis would be a good way to examine impacts due to changes in selected assumptions. The high and low bookend sensitivities described above will be helpful to account for forecast changes. The forecast itself will not need to be modified if the changes in assumptions cause a change in the forecast that is within the upper and lower bookends. The resource plan analysis includes sensitivities around the DER

forecast, so if assumptions are changed then outcomes should be covered by the range of sensitivities.

- **Hawaiian Electric adopted an assumption that most future PV systems installed under the new tariff will be paired with storage. Is there a specific percentage associated with "most future systems"? And is this true across all distributed generation and other solar resources?**

  The I&A Report was updated to provide more specific details on the percent of systems paired with storage and the size and operating characteristics of the pairings. For residential systems in the near-term, the number of systems paired with storage increased from roughly 60% to as high as 95% for some islands after 2022. All small and medium commercial and all residential systems will be paired with storage after 2022. As described in the I&A Report, a key driver in the adoption of the distributed storage was to offset a customer's own load and avoid electricity purchases at the retail rate (*i.e.*, self-consumption of rooftop DER). Declining storage costs and future TOU rates will further incentivize this adoption as customers continue to offset their own load.

- **Hawaiian Electric stated that 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. How would this threshold change if storage is incorporated as it's expected to be in most new installations? Is this the assumed size for residential customers? If not, what is the assumed system size per customer?**

  The I&A Report was updated to address these questions by including a more detailed explanation of why the 3 kW PV system size was used to determine the customer use threshold to exclude customers with low consumption. System size assumptions were also added to the document.

- **The Joint Parties' Comments assert that more granular forecasts are needed.**

  Through the FAWG, the forecasting team has shared a wealth of information that describes not only the final deliverable forecast, but also the assumptions and methodologies used in its development. Further, the modeling inputs used in RESOLVE and 8760s that underlie the forecast have been shared in the I&A Workbook to promote transparency with stakeholders.

  It is unclear precisely what the Joint Parties intend when asserting that more granular forecasts are needed and that the forecasts do not demonstrate time-based perspective or how load and DERs can evolved and be optimized from a bottom-up perspective. In order to address specific objectives underlying the request for "more granular forecasts" the Companies would request that specific proposals or modifications be proposed by the Joint Parties so that they can be considered by the Companies rather than overly broad statements. However, based on the Companies' interpretation, Hawaiian Electric is in fact providing 8760s and have forecasts broken down by DER program. Additionally, in meeting with the DER Parties in the DER

proceeding, many of who make up the Joint Parties, the Companies provided the DER Parties[20] PV and PV+BESS counts (*i.e.*, number of systems) and average size by rate class, by program, by island. The Joint Parties' Comments footnote 5 references a NARUC-NASEO report at page 9;[21] however, the following page of that report (page 10) cites an article that mentions Hawaiian Electric as an example of best practices for DER forecasting.

- **The Joint Parties' Comments recommend that the Commission order Hawaiian Electric to disaggregate profiles within RESOLVE.**

  The Companies have provided an I&A Workbook that contains 8760s of all load profiles used in the modeling that have been disaggregated by model layer for the underlying load, energy efficiency, DER, and EV impacts. We believe this fully addresses this comment by the Joint Parties.

Conclusion

- The Companies believe that stakeholder questions and clarifications have been addressed and the DER forecasts are reasonable based on the feedback received and in consultation with the TAP.[22]
- Stakeholders inquired what the impact to the resource plans would be, given any uncertainty or changes to the DER forecasts. As described throughout this Report the Companies have agreed to add additional sensitivities to consider upper and lower bound "bookends".
- Although, it's unclear the intent and meaning of the Joint Parties' request to further disaggregate and provide more granular forecasts, the Companies believe the Joint Parties' objectives could be satisfied by the bookend sensitivity cases.

3.2.2.3 Load Forecast

During a FAWG meeting in August 2019, stakeholders were asked to provide their thoughts and suggestions on how to consider a warming trend in average temperatures. Most Stakeholders agreed that the reference case assumption of a warming trend in average temperature of 1°F by 2050 was reasonable, but could be higher. Some stakeholders thought that a wider range in temperature and other variables should be used. Stakeholders provided some additional thoughts on possible alternatives:

[20] Available at, https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20201002_wg_seo_supplemental_data_for_der_freeze_scenario.xlsx

[21] NARUC-NASEO Task Force on Comprehensive Electricity Planning, Silver Cohort Roadmap, available at https://pubs.naruc.org/pub/15305EBB-155D-0A36-310B-4C56D55498E9

[22] *See* Updated Workplan, Exhibit A.3 at 3.

- IPCC Report 2018, stated a global (conservative) increase of 1.5°C by 2035-2052, have to review report to confirm total timeframe of the increase; city climate change commission provides sea level rise projection, which is based on an underlying temperature increase assumption. The Companies reviewed the cited report and no further follow up was needed.
- UH Sea Grant presented a range between highs/lows? Is this a possibility to consider? Scenario analysis (or sensitivity cases) could be useful.
- Look at impact of increasing temperature correlated to PV production.
- Need to consider humidity levels – more energy use; cooling equipment has to use more energy at higher humidity.
- Wind/wind speed – The strength, consistency of trade winds, declining number of trade wind days and strength of trade winds will impact future weather influences on the forecast.
- Consideration of extreme weather days? Is this something that should be taken into consideration in future planning cycles?

Based on stakeholder feedback, the warming trend was increased above the 1°F by 2050 assumption to 1.5°F.

During other FAWG and SEOWG meetings, stakeholders also asked a number of questions about the specific assumptions used to drive Hawaiian Electric's load forecast and the Companies provided responses to those questions or comments:

- **If studies are based on 2018, how do we account for changes in volcanic activities**?

  Hawaiian Electric will apply some factors to adjust our forecast as needed while not affecting any future projection. For Hawai'i Island, the Companies use net system profiles that were modeled based on 2015-2018 actuals. Models were assessed for reasonableness against actuals. Eruption impacts were largely loss of residential customers which would impact the level of sales under the shape more than the shape itself. No large commercial customers were lost.

- **Does the forecast consider specific end-uses for factors such as an increasing aging population and increasing demand for dialysis that will require more medical equipment thus increasing the future load?**

  The forecast does not consider specific end-uses for factors such as an increasing aging population and increasing demand for dialysis that will require more medical equipment thus increasing the future load. If the trend is already occurring, the forecast may account for it to some degree in the underlying trend. A review of the number of dialysis facilities over time and the impact to sales was conducted. The impacts were not significant enough to include as a line item in the way new large loads are included.

- **Will climate change be a factor in population, *i.e.* will unfavorable weather in other locations cause migration to Hawai'i?**

  Weather is immediate and short term; climate is longer term. The economic forecast does not account for possible effects of climate change on population projections; however, the growth in population is slowing.

- **Is life expectancy taken into account? People are living longer and use more energy in their lifetime**.

  Births and deaths are factored into the population forecasts. Birthrates have been slowing over the last decade. Current studies show that O'ahu's population has been declining.

- **Ulupono's Comments seek additional information on the selection of RESOLVE day weights, daily loads and sample days used in the model, and recognizes the need for to plan for a "worst case" scenario.**

  The Companies will add additional explanation on how the sample days are selected, *i.e.,* gathering historical data, back casting where needed to fill in common data ranges, run day weight module, and run profile reshape to fit profiles to the day weights.

  While RESOLVE uses weighted 30 days to conduct the resource optimization, PLEXOS will use full 8760 profiles (*i.e.,* all 24 hours of every day in the year) for the load, including customer-sited storage, and renewable generation. Sensitivity analyses in RESOLVE and PLEXOS can examine the effect of introducing variability to these profiles and examining the resulting change in the portfolio, as proposed by the TAP through bookend sensitivities.

  In the Grid Needs Assessment Report resulting from the SEOWG, the Companies have proposed to model a low renewable scenario that evaluates the reliability and resilience of the system due to prolonged bad weather. The Companies will work with the TAP and stakeholders on how best to model this scenario for worst case conditions. The initial approach is to look at recorded historical data to establish a plausible set of low renewable profiles that could be used in this analysis. Similar historical data could be examined to develop high load profiles to define a worst case, most difficult day to be solved in RESOLVE. This would modify the low renewable sensitivity to examine both renewable generation and load.

Conclusion

- The Companies increased the warming trend in the development of the load forecasts.
- As previously stated in the GNA Report, the Companies will evaluate a low renewable scenario that simulates prolonged poor weather to test the resilience and reliability of the resource portfolio.
- The Companies will provide additional information regarding the RESOLVE day sampling tool in the next I&A Report update.

3.2.2.4 Electrification of Transportation

During a FAWG meeting in August 2019, Stakeholders were asked to provide their thoughts and suggestions on drivers and barriers for adoption of electric vehicles ("EVs") and more general Electrification of Transportation ("EoT"). Stakeholders identified some key drivers and barriers for EoT:

- Stakeholders ranked cost parity, range/convenience, increased charging opportunities, and cost of ownership/maintenance as top drivers in EV adoption.
- Stakeholders expected actual adoption of EVs to be fairly mixed but near the proposed reference case.
- Stakeholders noted that national studies show that people who adopt PV are also adopters of EV. Inverters are being built with EV charger compatibility in mind. Permitting is getting more complicated for EVs as higher amperage chargers are requiring higher rated house electric panels.
- Increasing charging on the grid increases load, which leads to conditions allowing more PV without curtailment or batteries. Hawaiian Electric noted that the model for EV adoption recognizes that there is a correlation between PV and EV adoption. The number of PV systems are included in the Bass Diffusion model, which is a model that describes how new technology is adopted by a population over time.
- Stakeholders were asked about the future market saturation of EVs, defined as the percentage of all light duty vehicles in operation that will be EV. On O'ahu, adoption saturation is expected to be low due to unknowns in the market such as use in tourist industry (only a few charging locations at hotels currently, difficulties in high rise residencies and associated charging locations). Stakeholders noted higher adoption on Maui perhaps due to no high rise barriers similar to that seen on O'ahu. The JumpSmart Maui initiative lead to an increased EV adoption but the business side of maintaining the chargers is a current challenge.

Feedback gathered during the sessions was used to validate or update Hawaiian Electric's assumptions. The EV questions were used to validate the drivers of the EV saturation model.

During other FAWG and SEOWG meetings, stakeholders also asked a number of questions about the specific assumptions used to drive Hawaiian Electric's EoT forecast and Hawaiian Electric provided responses:

- **Does the EV forecast take rental vehicles into consideration?**

  Yes, it is included in the commercial fleet assumptions.

- **Stakeholders were interested in the impact of a recently introduced bill to possibly ban gas vehicles.**

  Bills introduced in the Legislature that have not yet passed are not in the model, but could be a driver of potential sensitivity analyses.

- **Stakeholder asked will Hawaiian Electric show scenarios with managed charging? When the charging study was first done for the EoT team, it was just for unmanaged charging**.

  Managed charging will be examined during the Grid Needs Assessment as a base assumption. Unmanaged charging and lower adoption of EV managed charging TOU rates can be considered through sensitivity analyses.

- **Why is the assumption that EV charging will occur in the evenings? Is it due to customer behavior? Rate design? No workplace charging during the middle of the day? Are there any assumptions about how rates are going to change over time to modify this EV charging behavior? What about medium and heavy duty vehicles? What are their assumed charging patterns?**

  Most of the EVs are personally owned vehicles and assumed to charge at home when it's convenient after coming home from work or school in the evening. Although data on charging behaviors is limited and more recently impacted by the effects of COVID, this is assumed to be a reasonable, typical behavior. The Companies had pilot time-of-use rates for EV charging, however most EV owners did not sign up for the rates. The forecast includes a share of workplace charging; however, it remains fairly small compared to unmanaged charging. The forecast includes medium size vehicles such as crossovers, SUVs, and light duty trucks. Except for buses, which make up a small share of the EoT, it does not include heavy duty vehicles. The bus charging profiles are based on discussions with operators of bus fleets and assume the commercial electric bus charging facility pilot tariffs would be utilized. A managed charging sensitivity will be evaluated in the planning analysis downstream of the forecast.

- **Is Hawaiian Electric considering data for EV adoption on a geographic basis?**

  Geographical information on EVs are hard to obtain as the data contains Personally Identifiable Information (PII). The location of where the vehicle is registered is not as important as where it is charged and when. Hawaiian Electric is working internally with T&D planning who will be looking at EV charging using LoadSEER to try to get down to geographic area.

- **What are the forecasted EV % saturation numbers? Are the EV saturations consistent with carbon neutrality in Hawai'i by 2045?**

  Although EV saturations were not specifically consistent with carbon neutrality in Hawai'i by 2045, they are consistent with State and County goals for achieving 100% renewable energy fueled vehicles by identified years.

- **Hawaiian Electric used historical kWh per mile using the weighted average fuel economy of registered electric vehicles by island. For Lāna'i and Moloka'i, the fuel economy from a predominant electric vehicle represented each island's average. What was the vehicle used?**

  For Lāna'i and Moloka'i, the fuel economy from the Nissan Leaf represented each island's average.

- **The CA's Comments at pages 7-8 recommend that assumptions related to electrification of transportation should be modified (*i.e.*, the Consumer Advocate recommends that Hawaiian Electric's low case also be included as a sensitivity within the IGP planning process) but the base forecast is a reasonable starting point.**

  There is a great deal of uncertainty regarding the adoption of electric LDVs (light duty vehicles) that will occur over the next few decades. However, vehicle electrification is widely understood to be a key pillar of decarbonization. Some jurisdictions have adapted clear goals for EV adoption, such as California Governor Jerry Brown's goal to have 5 million EVs on the road by 2030 and Governor Gavin Newsom's subsequent order to phase out the sale of gasoline powered cars in 2035.

  In this perspective, Hawaiian Electric's baseline forecast of 51.6% EV LDV adoption by 2045 could be viewed as conservative. Given the uncertainty, it would be reasonable to consider both a Low EV Adoption sensitivity as well as a High EV Adoption sensitivity in addition to the baseline forecast.

  Some recent studies have suggested that EVs may be driven less than conventional cars. This is an interesting argument and, if true, would have important impacts for electric system planning. However, other work suggests that these results are erroneous and may reflect early, short-range EVs and/or early-adopter households with older drivers, retirees, or multiple vehicles.[23] Ultimately, changes in VMT are more likely to reflect whether new homes and new jobs are located close together as well as assumptions regarding public transit access in the future.

  The EV managed charging load shapes were developed using E3's EV Load Shape Tool. This Tool is based on detailed trip data from the National Household Travel Survey and it optimizes charging to minimize charging costs while ensuring that each vehicle has enough charge to make all needed trips. In other words, the managed charging shape reflects customers who save money without having to change or delay any intended trips. The use of managed charging shapes in the baseline forecast reflects two assumptions. The first assumption is that, in the near future, technology will make it simple for customers to manage charging against their home and workplace charging costs. For example, a customer's EV would know the distance of their commute as well as the rates they pay at home and at work and could optimize their charging accordingly. The second assumption is that customers will face a price signal that encourages managed charging, in this case time-of-use rates in the workplace.

[23] https://its.ucdavis.edu/blog-post/no-electric-vehicles-arent-driven-less-than-gas-cars/

Conclusion

- A percent reduction on the base EV forecast may be included in the lower bound bookend sensitivity to reflect uncertainty in EV adoption.
- Similarly, the Companies will consider a higher EV adoption rate (*i.e.*, a percent increase over the base EV forecast) in the upper bound that could be spurred by technology advancement, policies, or incentives.
- Managed charging profiles will be included in the base case.
- Future residential TOU rates may also be added and considered alongside increased managed charging.

3.2.2.5 DER Modeling and Incorporation of Pricing and Programs

The Companies wish to further elaborate and clarify the Integrated Solution Sourcing step discussed in the Updated Workplan as stakeholders have raised questions. The IGP process as was originally designed and subsequently refined is based on a sequence that starts with identifying resource, transmission, and distribution needs in reference to a baseline forecast and plan. This establishes the opportunity for all types and combinations of resources to fill these needs. The Joint Parties are clear in their strong preference for pricing and programs instead of procurements. The IGP process from the outset recognized the need for alternative sourcing methods. The Company maintains its unwavering commitment to source grid services through pricing, programs, and procurement opportunities for all resources. Customers that attended the public meetings expressed an interest in electric vehicles and community solar. These and other programs are prominent components of the Companies' long-range plans and aligned with performance based regulation outcomes.

For instance, the Companies are incorporating price signals for EV charging through the use of managed and unmanaged charging profiles. New DER programs could be solved for through the selection of the DER aggregator resource option in RESOLVE. Additionally, the Companies, as discussed in this Report, will incorporate a TOU load shape as part of high and low bookend sensitivities.

However, there is also a fundamental need to address affordability for all customers. This necessitates the consideration of cost-effectiveness of solutions sourced under these three methods, including the potential to achieve competitively priced solutions, as has been the direction of the Commission over the past decade. Pricing and programs must be carefully considered within the overall context of actual Grid Needs in a least-cost, best-fit manner.

Front loading conceptual pricing and program designs into a forecast that is in turn used to determine grid needs, neither supports the identification of the actual gap between a baseline and future state, nor the value of such a gap. There is no clearer recognition of this than the Joint Parties' request for a zero DER growth forecast to use as a value determinant which the Company provided.

Taking it a step further and adjusting forecasts, by creating unfunded conceptual DER programs, defeats two key aspects of the planning process. First, it eliminates the potential to determine the cost-effectiveness of any pricing alternative or program design. Further, pre-loading DER pricing and programs into forecasts that are not funded by the public surcharge, potentially create a non-competitive sourced allocation of ratepayer funds. Second, the RESOLVE model is only one of several analyses conducted to assess Grid Needs and most importantly it does not model system stability or reliability. Front loading program designs that have not been informed by these critical needs only exacerbates the challenges ahead to reach 100% renewable goals.

The IGP process is designed to inform the development of pricing and programs so that they address specific needs cost-effectively to the benefit of all customers and that Hawaii's goals may be realized. This is how system planning is done in the US and internationally, leveraging innovation and market competitiveness to address well defined Grid Needs identified through a cyclical structured rigorous process. The IGP process is a cyclical process that is intended to iterate over time and as such opportunities for incorporating the outputs of other dockets or inform other dockets is expressly a goal. In this regard, it is not clear why there is a need to predetermine the set of DER programs that supposedly will optimize the system – when the full GNA is not yet complete.

- **Joint Parties' Comments at pages 5-6 state that customer-based or bottom-up approach to planning is needed and that resource procurements are siloed. Further elaborating that there are no opportunities to understand how load growth stresses the system.**

  Future RFPs are intended to be technology agnostic so DER could participate in meeting grid needs. The Companies proposed procurement approach allows all resources to be evaluated on an equal footing. If DER or a DER Program (*i.e.*, through an aggregator) can cost effectively provide the services that are needed, services that include bulk system and distribution, then the Companies are agnostic to the type or technology. Competitive procurements also provide a cost effectiveness test through the evaluation step that would analyze the system benefits of DER compared to other proposals.

  Without this cost effectiveness test in a procurement, services provided by DER to meet grid needs must be properly valued to be cost effective as a program and continue to deliver system benefits. Therefore, it is appropriate to continue to consider DER at the system level so that it can be examined alongside other supply side and demand side options and alternatives to meet grid needs. As transmission needs and distribution needs are determined through their respective planning steps, DER can also be examined as a potential solution to serve some or all of those needs. However, to be clear, customer choice remains a programmatic option as customers can always choose to adopt DER and realize benefits through self-consumption.

In Figure 1.1 of the draft GNA shared with stakeholders in June 2020, which was developed over the course of several working group meetings in the SEOWG and CPWG, the Companies proposed to integrate the NWA opportunity evaluation within the broader solution sourcing process. Transmission and distribution needs would be evaluated for their fit in either a procurement, program, or traditional investment. The local grid needs were proposed to be procured alongside system needs in the Updated Workplan[24] in an integrated way. Similar to what is contemplated in the community based renewable energy procurements where the Companies have identified system needs and local distribution needs to encourage developers to site projects in certain locations to reduce future T&D infrastructure needs. These projects are given credit through non-price evaluation criteria and may be afforded partial or full credit in the price evaluation depending on how the resource may meet the local distribution needs.

As mentioned in the Non-Wires Opportunity Evaluation Methodology provided in the DPWG in June 2020, longer term needs beyond 5 years could be addressed through a targeted program since there is sufficient runway to build up capacity.

Conclusion

- A DER aggregator as a resource option will be made available. This incremental DER above the market forecast would be able to export and participate in grid services. The DER aggregator as a resource option is costed as a paired residential solar and residential BESS with a 10% adder for programmatic/customer acquisition cost.
- Pricing and Programs are not excluded from the GNA, and are an important part of the portfolio. For example, managed charging, future DER programs, the CBRE program, among others are included in the modeling inputs.
- Programs and Price signals should also undergo some form of a cost-effectiveness test to ensure affordability for customers.

3.2.2.6 Resource Cost Forecast

Most of the Stakeholder feedback received, either during meetings or as direct written comments on the I&A Report were related to clarification of the underlying assumptions used to develop the forecast. Some representative feedback and Hawaiian Electric responses are provided below.

- **In the I&A Report, a Stakeholder asked about the Grid Services RFP, specifically about O'ahu variable renewable, storage and grid resources and if these grid**

[24] *See* Updated Workplan at 10, which states, "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)."

services have already been procured and if so, what accounts for the long timeline presented in the I&A Report?

The grid services procured under the RFP have a partial in-service date of 2021 and ramp to their full capacity by 2023. This is done to reflect the implementation of aggregated grid services.

- **A stakeholder asked about the offshore wind costs presented in the I&A Report. The report states that Hawaiian Electric applied the annual percent change from the NREL ATB for floating offshore wind in 2033–2050. Hawaiian Electric's nominal offshore wind capital costs fall by 27% from 2033 to 2050. However, in the NREL ATB 2020, floating offshore wind costs in this period fall by about 21% in real dollars, which would be an 11% rise in nominal dollars, assuming 2%/year inflation. Using a similar calculation, in the NREL ATB 2019, floating offshore wind falls by only 15% in nominal dollars in 2033–50. Can Hawaiian Electric explain why their offshore wind costs fall much faster than NREL ATB offshore wind costs? Are there total project price differences in Hawaii compared to US mainland coastal states that have continental shelves or European sites that have basically shallower seas? If so, are those costs higher? What impact would these costs, if higher, have on the offshore wind project development costs?**

  The offshore wind costs have been updated to include federal ITC changes passed in December 2020, update to the 2020 NREL ATB, and correct for real $ costs (instead of nominal $ costs) in the source NREL study. The I&A Report and Workbook have been updated to reflect this information. Separately, NREL is working with BOEM and Hawai'i State Energy Office to conduct a Hawai'i specific offshore wind study that will provide more specific costs to use in this or future updates to the Grid Needs Assessment.

  PHOW's Comments at 5 notes that the offshore wind costs are a reasonable starting point but should be updated as better information becomes available, *i.e.*, the on-going NREL study with BOEM.

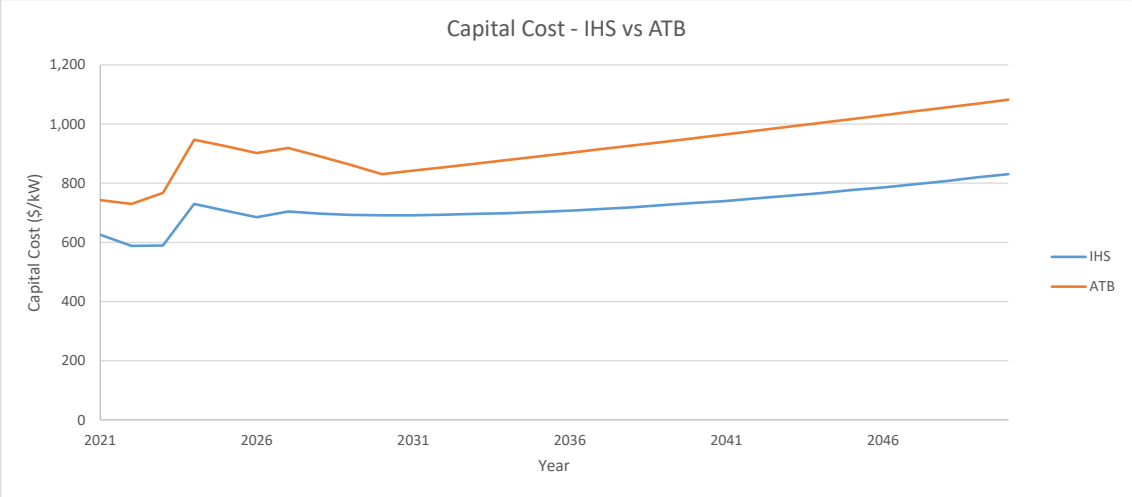
- **A stakeholder asked about the statement in the I&A Report that referred to several new projects will be coming on line in the near future that will also add storage to the resource mix, paired with solar or as a stand-alone resource and wanted to know if these resources are assumed to be online in the RESOLVE and PLEXOS models, or is the model allowed to optimize these as potential resources along with other solutions?**

  These resources are assumed to be online in the RESOLVE and PLEXOS models by the start of the planning horizon in 2025. These resources are either existing resources that are currently online or have had an application submitted for their approval (Stage 1 and 2 RFP projects).

- **Ulupono Initiative[25] asked why Hawaiian Electric used IHS Markit for the cost forecasts for the main utility-scale generation and storage technologies, instead of a public source such as the NREL Annual Technology Baseline? The IHS Markit forecast differs significantly from NREL ATB; is there reason to expect it to be better? There should be a preference for publicly available data.**

  IHS provides much more granular data for the resource costs. For PV this includes breakdowns of the module, inverter, balance of system, installation and development costs for fixed tilt and single axis tracking systems. For storage, similar category breakdowns are provided along with cost streams for multiple duration systems. The category breakdowns are also helpful for estimating cost reductions for co-locating paired PV+BESS systems. This allows the Company to create resource costs for paired solar and storage projects where components for standalone solar and storage may be shared. Figure 1 compares the nominal capital costs of the IHS and ATB forecast for single axis tracker solar with the same "Hawaii" factors applied as noted in the Inputs and Assumptions Report. The IHS costs track lower than ATB's forecast.

Figure 1: Nominal Capital Cost Comparison For Hawai'i Adjusted Single Axis Tracking PV



- **Clarifying the forecasts that differ between the September 25, 2020 I&A Resource Costs report and the February 18, 2021 I&A Workbooks.**

  In Ulupono's Comments at 7, there is a discrepancy between the most recent Inputs & Assumptions Workbook and the September 25, 2020 I&A Report. The difference is the September 2020 used IHS' 2019 forecast and February 2021 I&A Workbook used IHS' 2020/2021 forecast. IHS rebuilt their forecasting models from the bottom up, updated their learning curves to accelerate near term price declines and incorporated the latest financial data from Sunrun, SolarCity, and other developers to account for increases in

[25] Ulupono's Comments at 7.

customer acquisition costs. The I&A Report will be updated to reflect the latest information.

- **A stakeholder asked if Hawaiian Electric has consulted with pumped hydro developers, e.g., Pacific Hydro, about the likely cost for pumped hydro storage? We have heard estimates about 20% lower than the ones shown in the I&A Report.**

  Hawaiian Electric did not consult with pumped hydro developers in developing the PSH estimate. The PSH costs are based on the 2016 PSIP which used an average of costs from past PSH studies. However, if a need for long duration storage was identified, a PSH developer could bid into a future procurement to meet that need. The purpose of the GNA which will use these cost inputs is not to specify specific technologies but rather identify Grid Needs and allow various technologies to compete to meet those needs.

- **Ulupono offered comments that the NREL Solar and Wind potential study underestimates the solar potential on Oʻahu, and also provided suggestions to adjust certain assumptions to reflect a more appropriate solar potential (*See* Ulupono's Comments, at 4 and Exhibit 2).**

  Hawaiian Electric agreed to re-engage with NREL to run an additional scenario that reflects the suggestions provided by Ulupono. A high solar sensitivity can be modeled to test how higher solar development potentially shifts the plan. However, the Companies note that on balance, we have received feedback from other stakeholders that the resource potentials developed by NREL and shared in the August 18, 2020 Stakeholder Council meeting are too high due to property already earmarked for housing, State and Federal owned lands that are less likely to be developed for energy projects, zoning that makes the land unaffordable for a solar project, proximity to existing housing, and too small of a parcel size. Stakeholder feedback suggested about 1,000 MW of grid-scale PV potential remains on Oʻahu, much of it not located near existing transmission, which may add significant cost.

  The Companies also received numerous public comments through its public engagement meetings[26] related to the community impacts of renewable energy development and energy/social justice. It's clear that community acceptance will be an important part of the process. To that end the Companies are committed to discussing this issue further with the Stakeholder Council to find ways to improve the process of developing renewable projects. 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. The Companies will continue to engage the public as the IGP process progresses.

[26] *See* Public meeting questions and comments attached as Exhibit C, Appendix E, Meeting Materials to the Updated Workplan.

Conclusion

The resource costs assumed for the various candidate options were updated for several changes in 2020:

- The Federal ITC schedule for grid-scale PV, distributed PV, onshore wind, and offshore wind was updated in December 2020.
- Updated forecasts were provided by IHS Markit in December 2020 for grid-scale and distributed PV, onshore wind, and in January 2021 for utility and distributed storage.
- The latest 2020 Annual Technology Baseline ("ATB") was used to update the source data for geothermal, biomass, offshore wind, and concentrated solar power as well as the future trendlines for combustion turbines, internal combustion engines, municipal solid waste, and synchronous condensers.
- NREL is working with the Bureau of Ocean Energy Management and Hawaii State Energy Office to conduct a Hawai'i specific offshore wind cost modeling study. The study was introduced through a kickoff meeting in the SEOWG and Stakeholders were supportive of using the specific costs established by the study in IGP.

The Company will re-engage NREL to model an additional solar potential scenario that increases the solar potential over the initial, updated solar and wind potential study by NREL. This higher potential will be factored into the sensitivity analyses for O'ahu.

3.2.2.7 Cost Assumptions

Stakeholders provided several questions and comments on Cost Assumptions presented in the I&A Report:

- **Hawaiian Electric presented resource capital costs in a table in the I&A Report. Why are all technology costs increasing over time? We note that in Appendix A of the report, costs seem to be declining over time.**

  The figure was updated to correct the offshore wind cost. Appendix A shows costs increasing over time for all resources except for offshore wind. This appears to match the trend shown in the figure. Resource costs were updated and presented to SEOWG stakeholders in the February 26, 2021 webinar.

- **What input did stakeholders provide for Hawaiian Electric to consider in developing resource costs for offshore wind and how was that input incorporated in the I&A Report?**

  Stakeholders provided the reference NREL study to use as the basis for offshore wind resource costs which was used by Hawaiian Electric.

- **Hawaiian Electric noted in the I&A Report that the capital costs for BESS balance of system and modules were converted to Hawai'i costs (location adjustment) using a**

32% EIA factor. Is this adjustment applicable for both distributed and grid scale BESS?

The location adjustment factors for grid-scale storage were applied to distributed storage due to limited data for location adjustments for residential PV and BESS. The Companies are open to further stakeholder input to modify this assumption as may be appropriate.

Conclusion

- The forecast for offshore wind costs were modified to be based on the NREL reference provided by stakeholders.

3.2.2.8 Other Comments

- **Joint Parties recommend that the Commission order the Companies to determine conventional generation unit life expectancy and develop retirement plans.**

  The Companies agree that retirement plans for existing generation is required as part of the IGP process. The Companies' previously stated that this was under development and would be part of the next update to the I&A Report. The Companies have completed further analysis and run various retirement scenarios (*i.e.,* by age, unit flexibility, retiring Waiau Power Plant, etc.). The difference in net present value of those plans are within a few precent of each other and do not significantly change the cost of those various scenarios. Therefore, the Company will propose a unit retirement plan to be used in the base case based on age in the next update of the I&A Report.

- **Joint Parties recommend that the Commission order Hawaiian Electric to conduct sensitivities with and without biomass and biofuels.**

  While the Companies can certainly conduct these scenarios, the Companies wish to reiterate the intent of the GNA and the output of RESOLVE. The initial RESOLVE and PLEXOS modeling that will inform the solution sourcing step is a proxy meant to solely identify the needs, and allow the market to determine the technology and price that best fits those needs. For example, if RESOLVE selects a biomass resource to provide energy, regulation, and capacity, those services will be quantified and characterized in a procurement or program. That does not imply that there's a preference for biomass or the Companies would specifically seek a biomass unit in a procurement; rather if DER or another resource can provide those services in a least cost, best fit manner relative to other candidate resources or bids, then that is the resource that the Companies may select. Because the grid needs would be identified by service, rather than by resource, the evaluation step in a competitive procurement is helpful to identify the best fit proposals. The selection of a biomass unit by the model during the grid needs assessment helps to determine the grid needs and contributes to the avoided cost or valuation of the grid service.

- **CA's Comments at 13 recommend that an RFI step be inserted into the process for a 2-step, RFI-RFP process.**

  The Companies initially proposed this idea as part of the IGP process but after discussions in the competitive procurement working group, including developers, the stakeholders felt that it would take too long to complete an RFI and RFP process and the time between those two steps wouldn't necessarily add value. It was decided that it would be more efficient to have a single procurement step that allows a developer to continue to develop a project right away, if awarded. An RFI step can be reintroduced into the procurement process, but additional time will be needed by the utility and RFI respondents for the procurement process to incorporate this additional step. While the Companies remain neutral on either approach, there are several tradeoffs that should be considered. An RFI first process would provide indicative pricing and project locations earlier in the process that could enable an indicative ranking of projects to be developed to then inform earlier community engagement on proposed project sites and allow additional time to begin preliminary assessments of interconnection requirements. However, because the information provided in the RFI is not binding, developers could choose to change their project configuration, location, or pricing prior to the RFP which would negate some of the usefulness of the RFI.

Conclusion

- A fossil generation retirement plan will be provided for O'ahu to mitigate the risk of an aging generation fleet and to assess the impact of accelerating renewable resource development as generating unit utilization declines.
- The Companies are open to a no biofuel and biomass sensitivity but do not believe it is necessary for the GNA since the intent of GNA is to identify Grid Needs using proxy resources to inform a technology neutral solution sourcing step.

3.2.2.9 General Edits or Format

Stakeholders provided numerous written comments on the I&A Report that suggested ways that the information being presented could be made clearer or correct for formatting errors that improved readability. Hawaiian Electric thanks stakeholders for pointing out these items and has adopted most of the suggestions offered.

3.3 IGP GNA REPORT FEEDBACK

3.3.1 Overview

A majority of the feedback received (both verbal and written) were questions and requests for clarification, which have been addressed either in the working group forums or have been

logged and responses developed and presented in the detailed stakeholder feedback provided in Appendix B of this Report.

Feedback on the GNA Report consisted of more than 260 distinct comments, suggestions, questions, and edits which were grouped into 15 categories as shown in Table 7.

Table 7: GNA Report: Stakeholder Feedback Categories & Responses

No.	Category	Clarification	Incorporated	Total
1	Edit or format suggestions to improve clarity	9	43	52
2	Grid Services Definition Methodology	39	11	50
3	Sensitivity Analysis	26	4	30
4	Grid Services	20	7	27
5	Model Mechanics	13	7	20
6	GNA Modeling Process	12	5	17
7	Transmission Needs	12	5	17
8	Resource Characteristics	12	2	14
9	Avoided Cost of Service	10	3	13
10	IGP Solution Sourcing Process	3	1	4
11	Modeling Inputs	3	1	4
12	Solution Evaluation Method	3	1	4
13	Stakeholder Feedback	3	1	4
14	Solution Evaluation Methodology – Avoided Cost Screen	4	0	4
15	Grid Services Scenario Analysis	1	2	3

In Table 7, "Clarification" means stakeholder feedback that was provided either as a question or a comment and was responded to for clarification only. This feedback may not have been directly reflected in the GNA report. "Incorporated" means stakeholder feedback resulted in either a direct change to the GNA report, and/or the feedback resulted in a direct change or modification of an analysis or assumption which modified a forecast, which then informed the GNA Report.

3.3.2 Selected Comments and Responses

The following sections present some of the key themes, comments, suggestions, and questions associated with the GNA Report. A full listing of all the stakeholder feedback received and the responses provided is presented in Appendix B.

3.3.2.1 Grid Services Definition Methodology

The majority of the stakeholder comments were requests for clarification on a topic or for expanded discussion to provide additional context or rationale for the approach proposed.

Some key questions and comments from stakeholders and Hawaiian Electric's responses are provided below.

- **Hawaiian Electric stated that "the reason for the different time-intervals (for regulating reserve) was due to the different generator characteristics on the different islands. The change was then divided by the aggregated installed capacity, or the peak load, to normalize it". What does this mean? What is done for Molokai/Lanai? Are these supposed to be the same things (aggregated installed capacity vs. peak load)? Or different ways to calculate?**

  Different islands consist of different types of thermal generators with different characteristics. Hawai'i Island, Moloka'i, and Lāna'i have faster generators, and therefore, a 20-minute window was used for these islands. O'ahu and Maui have slower generators, and therefore, a 30-minute window was used. The change in renewable energy was normalized by dividing it by the aggregated installed capacity. The change in load was normalized by dividing it by the peak load. The GNA Report was modified to make this issue clearer.

- **With respect to Regulating Reserves, Hawaiian Electric states that "by grouping of the minutely data into positive and negative values, the positive changes in generation (negative changes in load) represent a need for downward regulation. Negative changes in generation (positive changes in load) represent a need for upward regulation." This is a seemingly reasonable approach for reserves. 3-sigma maybe a rather tight objective. Is the rationale for that given somewhere? It is unclear that adequate consideration is given to the well-behaved down capability of utility connected solar PV and wind.**

  The GNA Report was modified to add the rationale for using 3-sigma. The methodology is similar to what is used by ERCOT, and while ERCOT uses the 95th percentile when calculating their reserve requirement, given our islanded system and high renewable penetration, a more stringent requirement was used. The intent was to cover most needs but not all, which lead to a 3-sigma requirement. Sensitivity analyses were performed to examine less stringent requirements at 1- and 2-sigma. The GNA Report was modified to add the rationale for using 3-sigma.

- **Hawaiian Electric stated that it is better to calculate the reserve required due to each resource separately. Why is this better?**

  The reserves were calculated for each resource separately to ensure that as the portfolio changes, the reserve requirement represents the unique volatility and reserve needs that are associated with the various resources. Because the volatility in one resource may not be coincident with the volatility of another, defining the requirements as an aggregated portfolio may result in a lower requirement for the current portfolio of resources but may not be valid when the portfolio mix in the future skews specifically toward one resource e.g. solar dominant portfolio in 2045. The GNA Report was updated to make this clearer.

- **Hawaiian Electric stated regarding resource diversification and regulation time intervals, "To capture both the regulation needed by our operators to bring units**

online, as well as, the regulation needed to manage short-term fluctuations associated with variable renewable generation, it was decided that for O'ahu and Maui, requirements based on both the 1-minute and 30-minute interval would be used. For Hawai'i Island, requirements based on both the 1-minute and 20-minute interval would be used." Stakeholder asked that more explanation would be helpful.

The GNA Report was modified to address this comment. The 1-minute requirement would ensure that there is enough generation on the system to meet any short-term fluctuations in variable energy, while the 20 & 30-minute requirement would ensure that there is enough reserve for our operators to bring units online if needed.

- **A stakeholder asked if the avoided cost for Load Build and Load Reduce change over the 5-year period? Is this granular enough to be used as capacity value?**

  The planning horizon for RESOLVE was revised to be annual over the next 10 years from 2025, then every 5 years thereafter. For PLEXOS every year from 2021 through 2050 will be modeled. The years prior to 2025 are not modeled in RESOLVE because we are assuming that the first year that a PV, battery, wind, or synchronous condenser resource can be reasonably in service is 2025. Thermal and offshore wind resources may take a bit longer to develop so we are modeling 2028-2030 as the earliest they can be built. Given these initial assumptions, the planning horizon could be moved earlier if certain resource can be built sooner.

- **A stakeholder about where the transmission thermal limits come from? Additional background and context would be helpful.**

  The thermal limits of equipment (transformers, wires) are based on manufacturer ratings of equipment with consideration for engineering installation standards. This is consistent with industry practices. The actual thermal limits will depend on the size and type of wire that is installed in the field. These limits (as-built conditions) are reflected in the models.

Conclusion

- Several clarifications will be made to the GNA Report regarding grid services. The Companies continue to work with the TAP to vet the reasonableness of the grid service definitions and rules.

3.3.2.2 Grid Services

Stakeholder comments were mainly requests for clarification on a topic, suggestion for modifying the definitions of what resources could provide what services or for expanded discussion to provide additional context or rationale for the approach proposed.

Some key questions and comments from stakeholders and Hawaiian Electric's responses are provided below.

- **Generators serving their load with additional export capacity could provide voltage support service and FFR/Storage Load Under Control services.**

  The GNA Report was modified to reflect these changes.

- **A stakeholder noted that for Energy Efficiency could be considered for Load Control grid services because Energy Efficiency is a possible NWA resource option.**

  The Grid Services table in the GNA report was updated to include Energy Efficiency.

- **A stakeholder asked how Hawaiian Electric plans to incorporate FFR in PLEXOS (and RESOLVE) and how it relates to other Spinning Reserves and Inertia Constraints. Inertia can (and probably should) be included in PLEXOS.**

  The GNA Report was modified to add more detail in Appendix C. Inertia constraints, which are provide in the I&A Workbook, will be modeled in PLEXOS to ensure a minimum amount of inertia is maintained for frequency stability. Ulupono's Comments at 9 also recommended that Hawaiian Electric modify the current assumptions for batteries and curtailed renewables to provide virtual inertia as not to bias RESOLVE toward selecting synchronous condensers.

  First, the idea of virtual inertia, which is a capability currently being reviewed as part of the Stage 2 renewable projects that have grid forming inverters, is a nascent technology and an area of research in the industry. The Companies are testing its efficacy and determining to what extent it can be a substitute or complementary capability to physical mechanical inertia provided by conventional generators and synchronous condensers. The Companies are making modest near-term investments in synchronous condensers as these newer technologies continue to mature.

  The Companies also note that as part of a system security assessment, other services that synchronous condensers provide will be evaluated such as short circuit current and voltage support. These are currently available in a limited fashion through grid forming inverters; and may necessitate a synchronous condenser.

  Based on TAP review and feedback, Table 8 illustrates the various resource/technologies that can provide certain grid services. This table will be updated in the GNA Report.

Table 8: Grid Service Capability by Technology

Service by Resource	Inertia	Fast freq. response	Primary freq. response	Regulating Reserve	Energy Reserve Margin	Transmission Capacity	Distribution Capacity	Energy	Load Reduce	Load Build	Short-circuit current	Volt. Support	RPS	Grid Forming[5]
Conv. Therm.														
PSH					3									
GS BESS					3						1			
Paired Wind					2						1			
Paired GS PV					2						1			
Standalone Wind					2	*	*				1			
Standalone GS PV						*	*							
Dist. BESS				4	3						1			
Dist. PV				4	2	*	*			*	1			
Load Control				4										
Energy Efficiency														
Sync. Cond.														

Legend	Not Capable	Partially Capable or Technology in Transition	Fully Capable

1. Requires grid forming inverter capability; 3-5+ years away (Technology in transition)
2. Contribution to ERM limited by hourly dependable capacity
3. Contribution to ERM subject to change as resource portfolio changes
4. Requires controllability/communications for frequent dispatch signals (*i.e.*, AGC)
5. Area of research; however, in general there's an emerging consensus that something is needed to provide very short-term voltage stability (*i.e.*, form the voltage waveform) in high inverter-based systems.

* Partially capable following stakeholder feedback

- **Renewables (with headroom/curtailed) could provide FFR but do not appear in GNA Report Table 6 presenting grid services?**

  Variable generator was added to Table 8, see table above.

- **Can Hawaiian Electric document assumptions and/or references that were used to develop the Grid Service Capability by Technology as presented in the GNA report?**

  Grid Service Capability by Technology was developed with stakeholder feedback provided in the SEOWG and TAP, see table above.

- **Ulupono's Comments recommend that the Companies eliminate the proposed energy reserve margin ("ERM") calculation and reserve margin.**

  The Companies note that resource adequacy for high renewable systems is a current topic of discussion in the industry.[27] The Companies view the ERM criteria as something that may evolve over time as it gains operational experience with the new paired solar projects and as more data is acquired and analyzed. The Companies will work with the TAP to continue to evaluate this issue and benchmark reliability criteria against other methods being developed in the industry and may make appropriate changes in future IGP cycles.

  Simulation models like RESOLVE and PLEXOS assume the system can be perfectly balanced with perfect unit commitment and dispatch of resources to serve load and maintain operating reserves like a mathematical formula with left hand and right hand side variables. However, this solution does not account for sudden changes in the system that can occur in real life where generating units are suddenly unavailable on forced outage or unplanned maintenance is required.

  The energy reserve margin also provides a criterion to add new generation to the system, especially as thermal units are retired, and load growth continues. This criterion accounts for the contributions of variable renewables and storage toward meeting reliability and can ensure that reliability needs are met in all hours rather than just at the peak. Without this criterion to help govern the addition of new resources, the profiles and availability of resources on the system will need to precisely defined and difficult to do through 2050.

  Through stakeholder, public meetings, and TAP discussions that reliability of the electrical system is a key outcome and of utmost importance to customers and businesses, and a performance based regulation outcome that our plans need to achieve. The suggestion that a reliability planning criteria like ERM be removed, that poor weather conditions should not be considered as part of reliability criteria, and that balancing constraints and operating reserve defined in RESOLVE and PLEXOS are sufficient to ensure generation adequacy is contrary to the way that almost any other jurisdiction plans for reliability and incongruent with conversations with the TAP. Removing the ERM criteria will make future renewable plans unreliable and less resistant to natural disasters, forty consecutive days of rain, and climate change. The recent events in Texas where extreme weather lead to a shortage of available generation to serve demand and recognizing that the Electric Reliability Council of Texas ("ERCOT") does not have a forward capacity market to procure additional

[27] *See* https://www.esig.energy/five-principles-of-resource-adequacy-for-modern-power-systems/

capacity ahead of its delivery day, there is additional risk that must be understood when planning without any forward looking capacity margin.[28]

Conclusion

- Incorporated several comments from stakeholders and TAP members related to technologies that can provide certain grid services (see Table 8). This is critical for the model to determine which resources have the capability to provide certain services.
- The ERM criteria represents a reasonable starting point for this IGP cycle, which improves on previous methods by evaluating energy and capacity needs at every hour and providing "credit" to variable renewable resources to meet the hourly requirement.
- The TAP and the Companies have agreed to continue to evaluate the ERM criterion over the course of its work together. For example, the Companies' resource plans using ERM could be benchmarked against the plans using other reliability criteria in the industry (new and traditional).

3.3.2.3 Sensitivity Analysis

The majority of the stakeholder comments were requests for clarification on a topic or for expanded discussion to provide additional context or rationale for the approach proposed. In general, most stakeholders were supportive of using the sensitivity analysis approach to evaluate impacts due to changes in underlying assumptions and better understand which assumptions have the greatest potential to change the modeling outcomes.

Some key questions and comments from stakeholders and Hawaiian Electric's responses are provided below.

- **A stakeholder recommended that Hawaiian Electric 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.**

  The suggested approach was adopted, and Appendix E was added to the GNA Report to provide more detail on the sensitivities performed. In the CA's Comments (at 5), the Consumer Advocate acknowledges the complexity of this task given the multitude of layers and technologies, further stating that this and the process as a whole is a continuously improving process but supports the concept of establishing bookends.

- **The CA's Comments at 11 highlight that energy efficiency should play a greater role in planning Hawai'i's energy future by including information such as developable potential, cost, and hourly load shape, would enhance the exploration of energy efficiency deployment beyond the annual plan submitted by Hawaii Energy.**

[28] *See* https://www.utilitydive.com/news/the-great-capacity-market-debate-which-model-can-best-handle-the-energy-tr/440657/

As stated in the Companies' Updated Workplan, the Companies are supportive of incorporating this concept into the IGP modeling; however, in order for the Companies to model energy efficiency on a basis comparable to other supply-side resources, the following information would need to be developed by Applied Energy Group ("AEG") or Hawaii Energy as modeling inputs:

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

FAWG stakeholders also felt that the energy efficiency forecast may be too aggressive (*i.e.*, overstating what's achievable).

The TAP recommended that, "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."[29]

- **A stakeholder supported the approach of using a "DER Freeze" scenario to cap DER adoption at 2020 levels to better understand the impact of the market DER uptake assumed in the core scenarios.**

  An Appendix E was created to list the various sensitivities that will be analyzed, and one of the sensitivities is the "Market DER" sensitivity, which will analyze the value of the forecasted DER uptake.

- **A stakeholder recommended that Hawaiian Electric 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. Also, when Programs that emerge from the DER docket (like a TOU) they would be modeled as a sensitivity. You won't be building in TOU in the base case?**

  This analysis will tie to what comes out of DER docket for TOU rates and be incorporated in the modeling as described in the I&A Report on Electrification of Transportation. When TOU programs are adopted, the model will be modified to reflect those program parameters. A managed EV charging profile will address TOU for EV. Also, as discussed above, the Companies may incorporate a "best guess" of TOU adoption for DER in the absence of any final decisions made in the DER docket.

- **Regarding the TOU profile for EV charging, are the details going to be shared**

[29] *See* Updated Workplan, Exhibit A.3 at 4.

Yes. The I&A Workbook for O'ahu has been made available to stakeholders on the Companies' website.

Conclusion

- Bookends will be evaluated as a sensitivity around the reference forecast, to establish a plausible set of assumptions for each of the layers within the load forecast to define a cumulative high forecast and cumulative low forecast. An initial proposal for the bookends is provided below. In sum, the low and high bookends, labeled as Slower Customer Technology Adoption and Faster Customer Technology Adoption respectively, represent a deceleration and acceleration of customer adoption of distributed energy resources, electric vehicles, energy efficiency, and time-of-use rates which are all key drivers of the load forecast.

Table 9: Proposal for Bookends Sensitivity

Assumption	Slower Customer Technology Adoption	Base	Faster Customer Technology Adoption
DER	• Market Forecast • DER aggregator as a resource option	• Market Forecast • DER aggregator as a resource option	• Increase DER layer in market forecast by 30%, capped at the technical potential established by NREL • DER aggregator as a resource option
Electric Vehicles	• Reduce electric vehicle layer in market forecast by 30%	• Market Forecast	• Increase electric vehicle layer in the market forecast by 30%, capped at the same market saturation levels in the Market Forecast
Energy Efficiency	• Reduce energy efficiency layer in market forecast by 30%	• Market Forecast	• Increase energy efficiency layer in market forecast by 30%
TOU	• Market Forecast (no assumed TOU)	• Managed EV TOU • Managed DER TOU	• Higher Managed EV TOU adoption • Higher Managed DER TOU adoption

3.3.2.4 Model Mechanics

Stakeholder comments on Model Mechanics were mainly requests or suggestions for modifying or correcting information presented in Appendix A, Table 10 regarding model input definitions. Additional feedback included requests for clarification or greater context around the proposed definitions.

Some key questions and comments from stakeholders and Hawaiian Electric's responses are provided below.

- **A stakeholder suggested that Fuel Blend and Must Run / Must Commit a Load Following Reserve could all be run in PLEXOS.**

  Hawaiian Electric agreed and modified the GNA Report to reflect this.

- **A stakeholder asked if PLEXOS was limited for grid services like Ancillary Service Capability/Regulation Reserve and Frequency Response?**

  For clarity, PLEXOS can model the other grid services by applying minimum requirements for each respective service that must be met as the model solves for the least-cost dispatch to serve demand.

- **A stakeholder asked for a little more background on the adding of Optional DER on top of the DER layer.**

  Hawaiian Electric is testing methods to model DER as a resource option. One of the ways to accomplish this is to model a DER aggregator as a resource option that is costed as a paired residential solar and residential BESS with a 10% adder for customer acquisition cost. In sensitivity analysis where grid-scale resources are more limited, we may see that RESOLVE selects the aggregated DER for the portfolio. The resources that result from the RESOLVE modeling are not prescribing specific resources but are used as a proxy for the least-cost grid services that would be needed in any given year. RESOLVE is trying to select resources that meet the grid needs. The resource represents the specific need that the resource can provide (*e.g.*, energy, capacity, or other ancillary services). In reality, those services may be obtained from a different resource in the sourcing process.

- **Does Hawaiian Electric consider different periods of the year with materially different weather behavior?**

  Hawaiian Electric intends to address this issue through sensitivity analysis.

- **A stakeholder suggests that due to rapidly changing climate, use of a narrower range for back casting may be more appropriate. Longer-term history may not be the best representation of what is coming in the future.**

Hawaiian Electric recognizes that changes in the way we use historic data as basis for creating a forecast will change. The FAWG did consider a warming trend based on FAWG stakeholder feedback.

Conclusion

- Several clarifications will be made to the GNA Report regarding grid services. And as mentioned above aggregated DER export will be made available as a resource option.

3.3.2.5 GNA Modeling Process

The majority of the stakeholder comments were requests for clarification on a topic or for expanded discussion to provide additional context or rationale for the approach proposed in the grid needs assessment modeling.

Some key questions and comments from stakeholders and Hawaiian Electric's response are provided below.

- **In looking at the GNA process chart, a stakeholder suggested that some aspects of system security should be pulled forward and evaluated at the same time as the other services, rather than after. This has a major impact on how the synchronous machine fleet is handled. For instance, grid needs like voltage support/short circuit current/inertia that are not identified in PLEXOS/RESOLVE and show up later in system security could lead to must-run or sub-optimal commitment and dispatch of resources.**

  The GNA process graphic was updated to show the feedback loop from the System Security analysis to PLEXOS, if there are any changes that are needed in the plan to ensure reliability.

- **A stakeholder commented about the way Hawaiian Electric has proposed to use the RESOLVE model and the PLEXOS model to identify and verify the system needs. Limitations of tools will limit the identification of system needs – these tools will not identify system stability needs like inertia, grid strength, or the spec of FFR.**

  RESOLVE will produce a resource plan that will meet the various Grid Needs. This plan will be run through PLEXOS and other models to ensure system reliability and calculate the system cost. The GNA Report was modified to add this additional clarification.

- **In reviewing the Grid Service Needs Identification Modeling Process proposed methodology a stakeholder commented that there needs to be some assessment of Resource Adequacy and capacity value of renewables and energy limited resources (storage & DR). Otherwise it will be hard to know if portfolios are reliable.**

  Additional detail about the new Capacity Planning Criteria (Energy Reserve Margin or ERM) being proposed in the IGP was added to the Appendix. The ERM requirement is added to RESOLVE as a constraint to ensure adequate capacity/energy is being built.

Full reliability will be assessed through PLEXOS which will model 8760 annually over the planning horizon.

Conclusion

- While much of the discussions have revolved around RESOLVE, other tools will be used for an integrated GNA. The ecosystem of models used in the GNA (RESOLVE and PLEXOS models for the resource needs, PSS/E, PSCAD, and ASPEN for transmission and system security needs, Synergi and LoadSEER for distribution needs) will use a modeling framework with an iterative modeling approach taken within the system security step to fully address grid needs between these models.

3.3.2.6 Transmission Needs

The majority of the stakeholder comments were requests for clarification on a topic or for expanded discussion to provide additional context or rationale for the approach proposed on transmission needs modeling.

Some key questions and comments from stakeholders and Hawaiian Electric's responses are provided below.

- **A stakeholder recommended that Hawaiian Electric should acknowledge that the PLEXOS and System Security work may illuminate new transmission needs. How did Hawaiian Electric identify these needs? Are there other services identified that aren't needed? Can Hawaiian Electric document assumptions?**

  Hawaiian Electric acknowledges that PLEXOS and system security work may illuminate new transmission needs. Edits were made in the GNA Report to describe the feedback loop with system security. The transmission services identified are ones that Hawaiian Electric is currently evaluating to meet the transmission planning criteria. There could be other services identified in the future. The assumptions used as part of the system security study will be identified once a resource plan is decided on to run system security, so this will come later in the process. However, the Transmission Planning criteria does identify planning events that we will model and plan for. The I&A Workbook also has assumptions for identifying minimum inertia and FFR requirements at a high level in the RESOLVE and PLEXOS model.

- **A stakeholder asked how does the analysis and identification of transmission needs interplay with distribution needs?**

  The GNA Report modified to show that transmission needs and distribution needs feed into the RESOLVE modeling to determine the Grid Needs, as depicted in GNA Report Transmission Needs section.

- **A stakeholder suggested that an Appendix containing more background and other information on the work Hawaiian Electric is doing in developing Renewable Energy Zones would be very helpful.**

A footnote was added in the GNA Report to point to the document from NREL titled "Renewable Energy Zone (REZ) Transmission Planning Process: A Guidebook for Practitioners".

- **A stakeholder requested that more information be provided about Hawaiian Electric's high level evaluation of grid stability requirements and services, including citations to relevant sources. Hawaiian Electric must provide clearer explanation of their grid services requirements and that the analysis provides sufficient depth of results to identify the degree and causality of limitations.**

  Hawaiian Electric has made a change to the document to make it clearer that the high-level evaluation is for inertia and FFR using algebraic formulas in RESOLVE and PLEXOS. The assumptions used are available in the I&A Workbook. A more detailed analysis will be completed during the system security analysis. The intent to use a proxy for inertia and FFR in RESOLVE/PLEXOS is to limit the number of iterations by identifying those needs as part of the initial resource planning models.

- **Several stakeholders asked how Hawaiian Electric is modeling transmission constraints, specifically upgrade and interconnection costs.**

  The transmission system is not specifically modeled in RESOLVE, but reflects potential transmission upgrades as part of the resource costs. If the model decides to build out more resources in a given area, the resource costs are higher to reflect the higher transmission interconnection costs. Resource costs are increased as a constraint on the amount of capacity that can be built in a given renewable energy zone.

- **Regarding transmission constraints and renewable energy zones, a stakeholder asked for expanded discussion on how transmission constraints are determined, how much capacity is available and where this will all be documented?**

  Hawaiian Electric is using the NREL solar potential data to determine where potential renewable energy zones might be located, evaluating the current capacity of the transmission and distribution system. Hawaiian Electric will evaluate the current remaining capacity in these high potential areas then determine major transmission upgrades needed to interconnect up to the potential of a given renewable energy zone. These transmission costs will be attached to the cost of building solar in certain regions, and will be reflected regionally within the RESOLVE model. Some zones are large and Hawaiian Electric will need to model what scale would trigger transmission upgrades. This work is in-progress and will be completed as part of the transmission needs analysis. Assumptions and outputs of this analysis will be provided as it is completed.

- **The CA's Comments at page 12 offer suggestions, as previously offered in other dockets, to accelerate the procurement process, reduce overall cost of renewables, reduce risk for developers, and mitigate community concerns.**

  The Companies have been actively pursuing various forms of the CA's suggestions. For example, as part of the community based renewable energy procurements, the

Companies have proposed to remove the risk of interconnection facilities from developers by constructing and putting those facilities into rate base. The Companies have also offered land/sites in various procurements (*i.e.*, Waena, Molokaʻi, and Lānaʻi).

In future procurements, the Companies plan to be more prescriptive on available and feasible points of interconnections to streamline the process.

As part of the Transmission Needs analysis, the Companies will identify renewable energy zones as noted above to develop major transmission upgrades needed for future renewable energy projects in areas where high solar and wind potential exists. This concept used in Australia, Texas, and other places may attract future development in Hawaiʻi.

Conclusion

- System Security needs will be informed by Stage 2 interconnection requirements studies that are evaluating extremely high inverter-based scenarios, on-going electromagnetic transient studies with NREL evaluating 100% inverter-based generation on Maui, among others. Where these studies identify future work, additional System Security analyses will be completed as part of the GNA.
- Renewable energy zones, solely from a technical perspective, are being developed using the NREL Resource Potential Study to determine existing transmission capacity and major transmission upgrades needed to interconnect additional resources in high potential areas. REZs have the potential to attract project development, streamline interconnection, and take advantage of economies of scale. The transmission upgrade costs for each REZ will be reflected in the RESOLVE and PLEXOS models. The Companies will share this analysis upon completion of the Transmission Needs step.

3.3.2.7 Resource Characteristics

The majority of the Stakeholder comments were requests for clarification about information presented in Appendix B of the GNA Report. There were a number of questions on the capabilities for specific resources and Stakeholders asked for clarification on a topic or for expanded discussion to provide additional context or rationale for the approach proposed.

Some key questions and comments from stakeholders and Hawaiian Electric's responses are provided below.

- **A stakeholder asked for clarification about the assumptions used for the retirement of existing resources in the context of planning for future capacity needs given the limited contribution for load build/curtail services that are envisioned to be provided.**

  Retirement assumptions are being developed. Initially, the Companies wanted to see what retirements RESOLVE would choose as part of the optimization but will now evaluate sensitivities to look into different retirement plans. As noted earlier in this

Report, the Companies will present a retirement assumption in the next update of the I&A Report.

- **Regarding the location of resources, a stakeholder asked if Hawaiian Electric was characterizing a resource's ability to reduce T&D constraints? Expanded discussion would be helpful.**

  The GNA Report was modified to clarify what the "location of resources" means in terms of Resource Operating Characteristics. The Location of Resources refers to transmission/distribution constraints such as interconnection limits, as well as, additional transmission and distribution costs to interconnect additional resources. The intent is to consider limits such as export limits at the point of interconnection due to the location of a project.

- **Referring to a statement in the GNA report that defined Resource Operating Characteristics as minimum/maximum capacity, variable operations and maintenance (O&M) cost, fixed O&M cost, heat rate and ramp rate, a stakeholder asked if this was an exhaustive list of just exemplary list?**

  Hawaiian Electric has provided a fully detailed listing of Resource Operating Characteristics used in modeling are available in the I&A Workbook.

- **A stakeholder asked if the Reserves listed in Appendix B in addition to spinning reserve for 100% of largest generator? Is there a possibility for a new wind/solar project being the largest contingency?**

  The minimum requirement used in the PSIP was also used in the regulating reserve rule being proposed. For O'ahu, the minimum was based on the largest generator. It is possible that a new solar or wind project may become the largest unit contingency.

Conclusion

- The I&A Workbook clarifies many stakeholder questions regarding resource operating characteristics.

3.3.2.8 Other

- **PHOW's Comments state that PHOW is supportive of the long-term RFP concept proposed in the Updated Workplan and recommends the Commission direct the preparation of a long-term RFP in the next 1-2 years.**

  The Companies support a long-term RFP concept as a pathway to integrate other technologies into the resource portfolio other than solar and storage that will enhance the reliability and resilience of the system through resource diversification.

3.3.2.9 Edit or Format

Stakeholders provided numerous written comments on the draft GNA Report that suggested ways that information being presented could be made clearer or corrected formatting errors that improved the readability. Hawaiian Electric thanks stakeholders for pointing out these items and has adopted most all of the suggestions offered.

Appendix A. Detailed Feedback – Inputs & Assumptions

1. SPECIFIC FEEDBACK

This appendix presents a detailed listing of the comments, questions, suggestions and specific edits provided by Stakeholders that informed the IGP I&A Report, with the exception of the comments from Parties filed on the First Review Point Report, which were specifically identified in the body of this report.

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Stakeholder Comment Summary

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Item No	Sec	Sub Section	Draft Text	Question, Comment or Suggested Edit	Topic Category	Response, Status or Action Actually taken	Response Category
1	MISC			Please explain how the ERM service is represented in RESOLVE.	AS Requirements	See May 22, 2020 SEOWG meeting materials here: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200522_wg_seo_meeting_presentation_slides.pdf	1
2	MISC			Why doesn't HECO envision obtaining virtual inertia from batteries, wind turbine mass or curtailed renewables? Omitting these possibilities will skew the model in favor of unneeded thermal capacity or synchronous condensers.	AS Requirements	RESOLVE has requirements for both inertia and FFR. BESS, wind, and PV are partially capable of providing FFR. For system security purposes, physical mechanical inertia is still required, and the Company has developed minimum inertial requirements that are part of the modeling in RESOVLE and PLEXOS. These requirements will be confirmed in PSS/E and PSCAD once a resource plan is determined. Physical inertia does not need to be provided by fossil fuel generators but can be provided from synchronous condensers, including repurposing fossil fuel generators that are no longer needed. The Company notes that new grid forming technologies are also currently being studied as part of Stage 2 projects to determine whether virtual inertia contributions can be counted from grid forming inverters. Regardless of physical or virtual inertia, synchronous condensers will still be needed to provide other services such as short circuit current for system protection.	1
3	MISC			Please explain how targets were selected for ERM, contingency reserves, regulating reserves and inertia, for use in RESOLVE and PLEXOS. Do these vary depending on weather conditions or the amount of solar, wind, BESS and thermal capacity installed?	AS Requirements	See May 22, 2020 SEOWG meeting materials here for additional detail on ERM: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200522_wg_seo_meeting_presentation_slides.pdf See January 23, 2020 SEOWG meeting materials here for additional detail on regulating reserve: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200123_wg_seo_meeting_presentation_materials.pdf See June 30, 2020 SEOWG meeting materials here for additional detail on FFR, inertia: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200630_wg_seo_meeting_presentation_materials.pdf	1
4	3	Figure 11	IGP Resource Capital Costs	Why are all tech costs increasing over time? (Appendix A seems to show costs declining over time.)	Cost Assumptions	Document was modified. The figure was updated for a correction to the Offshore Wind cost. Appendix A appears to show cost increasing over time for all resources except for offshore wind. This appears to match the trend shown in the figure. Also see slides 15 and 16 in the I&A Discussion PowerPoint deck of February 23, 2021 for the latest capital costs in nominal dollar terms.	2
5	3	3.4	Offshore Wind: The source data for the offshore wind estimate was developed in collaboration with stakeholders	What input did stakeholders provide on this assumption and how was it incorporated?	Cost Assumptions	Stakeholders provided the reference NREL study to use as the basis for offshore wind resource costs.	2
6	3	3.4	Battery Energy Storage - Location Adjustment: The capital costs for balance of system and modules were converted to Hawai'i costs using a 32% EIA factor	Is this applicable for both distributed and grid scale?	Cost Assumptions	The location adjustment factors for grid-scale storage were applied to distributed storage due to limited data for location adjustments for residential PV and BESS. We're open to further stakeholder input to modify this assumption as needed.	1
7	5	Tables		Tables 32–38 show outage rates for Waiau 3–10, Kahe 1–6, CIP-CT, Airport DSG and Schofield 1–6, H-POWER and Kalaeloa for 2021–2050. Does this mean HECO thinks these plants can stay in service this long? Please specify the capital and O&M expenditure that would be required if each plant is retired in each year between 2021 and 2050 (e.g., What would be required to keep Kahe 5–6 in service until 2030? What would be required to keep them in service until 2040?). Please also provide similar data for plants on other islands.	Cost Assumptions	Maintaining thermal units that are only getting older is a challenge. The Company is currently looking into the long term economics of maintaining these units but as of now do not have firm numbers.	1

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Item No	Sec	Sub Section	Draft Text	Question, Comment or Suggested Edit	Topic Category	Response, Status or Action Actually taken	Response Category
8	3	3.1.1		How much DER PV and distributed BESS is currently in place on each island? How much DER PV and distributed BESS does HECO forecast to be added in 2020, 2021 and 2022? How does this compare to additions in 2018, 2019 and early 2020? If the forecast is much different from recent experience, why is that so? What is the basis for each of these forecasts?	DER Forecast	The I&A document was updated to provide details: As of Jun 30, 2020 the cumulative installed DER PV is as follows: HECO 702MW, HELCO 105MW, MECO 128MW. According to the forecast, HECO incremental installed capacity is approximately as follows: 2021 30MW, 2022 36MW See page 21 of the IGP Inputs and Assumptions doc. •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) 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. This information forms the basis of any resulting differences between actual additions in 2018, 2019, and early 2020 versus forecasted additions in 2020, 2021 and 2022. •Longer term are model based. 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.	2
9	3	3.1.1		Do you consider the possibility of customers producing more power from DER than they need, and selling it back to the utility? If not, why not? If HECO is concerned about land area available for utility-scale solar, then they should prioritize strategies to get the most solar from customer rooftops, which would include the option of customers producing more power than they consume.	DER Forecast	The market forecast was not changed in response to these comments. Sensitivities around the DER forecast in the resource plan analysis can address this. Pricing and services that can be provided by DER would be needed to model DER as a resource. Or, the incremental DER potential (difference between NREL and market uptake forecast) can be modeled as a resource. The market forecast does not include an assumption for compensation of customers' excess DER generation beyond their own annual energy needs. Future export compensation and exact tariff structure resulting from new DER tariffs and ARDS is not available at this time 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.	1
10	3	3.1.1		It would be more appropriate to use DER capacity factors from the actual sample days (referenced in 2.1), rather than monthly DER capacity factors, which may overstate the amount of DER production on low-sun days.	DER Forecast	Day selection accounts for DGPV profiles in the weighting and profiles tie to the selected days.	1
11	3	3.1.1		Why were residential properties excluded from DER if they were not owner-occupied, had more than four units, or needed less than 3 kW to meet their own needs? What fraction of residential roof area was excluded based on each of these filters? (63% of all residential customers were excluded in Oahu, which seems unrealistic.). Note, we understand that renters can't normally add PV on their own, but there are, in fact numerous rental properties that do have solar. Does "residential" include residential condominiums which have solar PV systems on parking area roofs and standalone solar installations? If not, why not? If not, how much added DER could be aggregated on each island?	DER Forecast	Questions were answered as detailed below. These types of uncertainties in the forecast assumptions are addressed by sensitivities around the DER forecast in the resource plan analysis. See January 29, 2020 FAWG meeting materials: https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents The criteria for the residential class market size estimate are based on analysis of customer adoption from 2001-2019. These criteria were chosen because they represent the most likely pool of potential PV adopters based on historical adopters. On one hand, there are some rental properties that have PV, which might suggest an upside to this market size estimate, on the other hand, demographic factors, such as income level, that likely play a role in limiting the pool of adopters were not applied to the market size estimate. The Community Based Renewable Energy program also provides the rental market segment with opportunities to access the benefits of renewable energy. Reasonableness of these criteria was discussed at multiple FAWG meetings. FAWG feedback included suggestions that programs or mandates could change in the future to expand the residential market. The market size estimates are not based on nor do they provide a precise accounting of all available rooftop square footage. Therefore, a percentage of rooftop included or excluded from the market size estimate is not available. However, the NREL rooftop potential study that was recently completed does provide an estimate of the PV generation associated with total available rooftop space. This could provide a high-level comparison between market and total technical potential. Condominiums that have commercial rate schedule accounts that could support common area PV systems were included in the commercial DER potential, not residential.	1

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12	3	3.1.1		Why were structures greater than six stories excluded from DER? What fraction of commercial roof area did this include? What threshold was used for consumption and why?	DER Forecast	Questions were answered as detailed below. These types of uncertainties in the forecast assumptions are addressed by sensitivities around the DER forecast in the resource plan analysis. See January 29, 2020 FAWG meeting materials: https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents The commercial customer market size is more challenging to assess than the residential class as historical adoptions are significantly lower and commercial customers have a different set of barriers and motivation factors to consider. Roof area was not available for this analysis. The exclusion of greater than six story buildings was meant to simplify the identification of the number of high-rise buildings that may not have enough rooftop space to install a PV system as many of these buildings have other equipment that compete for space or are possibly in the shadow of nearby tall buildings on O'ahu. This criteria eliminated less than 30% of commercial buildings on O'ahu, less than 2.5% on Maui and 0% on Hawai`i, Lāna`i and Moloka'i. If the number of floors were missing for a building, the building was included in deriving the market potential. The threshold for identifying customers who have consumption that is high enough to make reducing their electric bill a priority relative to all of their other business expenses varied by island, commercial rate and sector. It was based on reviewing the consumption of customers who installed PV systems as of 2018, deriving energy usage into quintiles within each sector by island and rate. Customers with usage below the first quintile within each sector by island and rate were excluded from deriving the percentage of the addressable market. If there were less than 5 customers within a grouping 500 kWh/month and 5,000 kWh/month was used for small and medium commercial customers respectively. Reasonableness of these criteria was discussed at multiple FAWG meetings. FAWG feedback did not include suggestions to expand the commercial market. The market size estimates are not based on nor do they provide a precise accounting of all available rooftop square footage. Therefore, a percentage of rooftop included or excluded from the market size estimate is not available. However, the NREL rooftop potential study that was recently completed does provide an estimate of the PV generation associated with total available rooftop space. This could provide a high-level comparison between market and total technical potential.	2
13	3	3.1.1		Why is the 2045 Oahu DER forecast in the IGP 17–23% lower than HECO's forecasts from the PSIP, June 2018 and March 2020? How should the difference between actual DER installs and forecasted DER be reconciled if the DER does not materialize?	DER Forecast	The DER forecasts in IGP are based on market potential. Previously, the PSIP DER forecasts assumed a high potential where all single family residential customers and 20-25% of total commercial sales were included. These types of uncertainties in the forecast assumptions are addressed by sensitivities around the DER forecast in the resource plan analysis.	1
14	3	3.1.1		Comparing Oahu distributed BESS in the IGP and HECO's June 2018 forecast, why is the 2020 IGP forecast 50% lower? Why is the 2045 IGP forecast 31% lower? What is measured/included in calculating the amount of distributed BESS - single family residential? multifamily residential? residential apartment and condominium projects?	DER Forecast	The distributed BESS in both the June 2018 and IGP forecasts are driven by the number of DER systems installed. The number of distributed BESS is therefore using the same assumptions for the forecasts of DER systems. The June 2018 forecast was developed early in 2018 and relied on data available through the 1st quarter of 2018 and through discussions with program administrators on their experience with application activity. The short-term forecast (2018 – 2022) was derived using existing applications submitted for the NEM, CGS and CSS programs. The CGS+ (GSP), Smart Export (ISE), and NEM Plus (NMP) programs were under development and expected to begin installations by the 4th quarter of 2018.	1
15	3	3.1.3		Comparing Table 10, column A and Table 12, column B, why does the capacity factor for DER fall from 19.9% in 2025 to 18.5% in 2045?	DER Forecast	See page 22 of the IGP Inputs and Assumptions doc. A degradation factor of 0.5% a year was applied to the sales impacts to recognize that the DER system's performance degrades over time.	1
16	Slide	14		HECO should be considering the possibility of higher levels of DER and should include the customer's cost of DER in the total optimization, so it doesn't look like customers are getting something for nothing. However, we note this is not a cost to the utility or ratepayers, and the economics of rooftop PV will drive adoption.	DER Forecast	Additional sensitivities could examine higher levels of DER adoption above the market forecast for IGP.	1
17				How is demand response included in the forecast?	DER Forecast	DR is considered a resource and is included downstream of the forecast development in resource planning as a resource.	1

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18				Are disposal fees considered? What are the project costs for large storage? If battery prices continue to drop will people defect from the grid?	DER Forecast	Capital costs - excluding any estimate of disposal fees - for BESS are in INPUTS	1
19				Stakeholder pointed out that the Federal commercial tax credit can be taken by companies that lease DER systems to residential customers.	DER Forecast	This was not taken into consideration and will be researched to possibly implement or consider in sensitivity. Some questions would have to be answered such as how much of the credit goes to the developer versus the customer.	1
20				Stakeholder raised concerns over whether or not forecasting is addressing the technical limits that is currently limiting adoption of non-controllable programs on Moloka'i.	DER Forecast	The current limitations on Moloka'i are reflected in which programs new installations occur in the near-term forecast.	1
21				Installs used owner occupied properties as past records have indicated that renters have a more difficult time enacting permanent projects and are less likely to do so. Stakeholder suggested that could change in the future if new developments of single-family and multi-family housing is built with PV.	DER Forecast	A sensitivity to assume a higher addressable market in the future could address this.	1
22				How are you modelling the tax credit? Are you still modelling it ending in 2024? Would that make much of an impact?	DER Forecast	Assumptions are the same as was presented and discussed in the January 2020 and August 2019 meetings. Federal tax credits start ramping down after 2019 and follows the current law. State tax credits start ramping down later as there is no definitive future plan and are based on proposed legislation that did not pass however provides an insight into what legislators are considering.	2
23				Is there an assumption regarding more battery storage to absorb more of the PV generation during the midday period? Why wouldn't the BESS discharge patterns be against the peak period?	DER Forecast	The pairing of PV and BESS in the forecast was done from evaluating the customer's own needs. The BESS does discharge during the evening peak period as can be seen on the peak forecast charts. Additional battery storage that is not driven by individual customer needs could be evaluated in the resource planning analysis.	1
24				Rental homes and changes in the market may impact the forecast. What if you relax the number of stories and apply a higher market percentage to account for new customers and all new developments which will already have PV installed?	DER Forecast	This can be addressed with a higher DER sensitivity	1
25				Does any of the battery storage include retrofitting existing systems and does it include standalone batteries?	DER Forecast	Battery storage was included in NEM+ systems. The forecast did not include standalone batteries as it could be picked up in the demand response analysis.	1
26				Drivers and barriers of solar PV with storage adoption: cost savings is the main driver; cost of storage is a barrier; expect steady adoption of PV paired with storage over the next many years, but not boon years like NEM. There is financial merit, although it is challenging right now. Expectation is for it to become more and more viable as costs decline or PPAs free customers from having to justify up front capital costs; and resiliency at sites that value resiliency, like disaster recovery, may become a more important driver over the next 5-10 years.	DER Forecast	This stakeholder input is reflected in the assumptions for the DER uptake modeling, specifically that all residential and small and medium commercial PV is paired with batteries.	2
27				New Homes are being built to make it easier to adopt PV in the future: fire codes for batteries are well established making the permitting process easier; Battery Energy Storage Systems are available to be added to a newly purchased house as part of the mortgage making it easier for home buyers to adopt renewables; and built with conduit lines into them to minimize the cost of adopting PV in the future	DER Forecast	Developers are balancing total initial cost of the home versus measures that have an up-front cost, but provide savings over time. Future savings over time don't help first time or affordable home buyers get over the hurdle of the initial cost of home ownership.	1

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28				Drivers for DER rapid growth: Lower technology cost (PV price down 80-90% over last 8-10 years and projections are sensitive to real estate costs, natural gas prices and enacted policies); Technology advancements (better communications and control capabilities, compatible with Demand Response programs, and further adoption in grid management, more tech firms to manage DERs); Economics alone are not sole factor for adoption (values and beliefs such as environmental reasons, social influence (e.g. friends, neighbors, coworkers), and wanting to have the latest technology); Headwinds for DER growth (Solar+Storage still expensive for residential customers, rate design solutions are complex, and involve an increasingly complex electrical system, and competition between DER resources (e.g. storage vs. demand response)); and Consumer (consumers demand more choice, more engagement in how they use their energy, overall costs of solar and batteries, energy storage in residential space still expensive, and complexity of designing rates and managing more complex systems)	DER Forecast	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion provided insights which was considered and incorporated into the either the forecast development or in the qualitative consideration for interpreting the results which are summarized in the I&A document	2
29				Solar sales in Hawaii are much lower than they were from 2011-2015 while electricity costs today are at 2007 levels (cost of PV+BESS today is at 2007 levels for PV) Estimating 6-18 months before the capacity caps on the Customer Grid-Supply Plus and Smart Export programs will be reached on Hawai`i Island Stacking services will be the value stream to drive DER adoption (80-90% of PV systems now include batteries) NEM – only 30% of the energy produced by the PV system is used by the customer. 70% of the energy is used at another time. Having a battery allows that energy to be stored and used at another time…virtual NEM. Try to solve the problem of using the assets smarter to the benefit of all rate payers. Will run out of space trying to reach the renewable energy goals. DERs will be in the mix and need stability in the market Pricing signals - what is the true market value of DER? Hawaiian Electric must find mechanisms to incentivize customers to allow the use of part of their storage for grid functions. Currently BESS's value is to offset their own usage, leaving little energy available for grid services. It's a challenge with the various options to make it simple for customers to understand. There are a lot of tariffs.	DER Forecast	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Some of this stakeholder input is reflected in the assumption for the DER uptake modeling that all residential and small and medium commercial installations are PV paired with storage.	2
30				Q: What are the drivers for adoption? A: PV and storage installed costs, tax credits/rebates/incentives, and program structure/rates design are all important because they interplay to affect pay off period, which is the driver: Solar developers provide the price point based on these factors combined; as cost comes down, tax credit impact reduces; if you don't have a tax liability, don't benefit individually; and studies show that tax credits can benefit all indirectly CBRE: Setting small program sizes can dampen build out; cap is a spiraling problem; need tariff programs that are simple to understand and big enough to stimulate the market; and pricing is complicated More Comments: On-going costs are very important Increases adoption for DER/storage, e.g., CA announced shutdown of transmission lines during high wind Commercial backup – PV & storage or diesel/CHP generators? TX gen due to cost (fuel much cheaper). Rates (TOU, rate arbitrage) may be motivating storage.	DER Forecast	The feedback on cost drivers is reflected in the uptake model, which is driven primarily by the payback on investment. Comments on program simplicity and CBRE shared with colleagues working on the CER docket.	2

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31				Q: What are the barriers for customers? A: Participants agreed that lack of home ownership was a major barrier to adoption while shared roof space, low consumption/low bill, low income, roof integrity, and lack of financing options were all possible barriers to adoption for residential customers. Participants stated that lack of roof ownership, limited space, and short lease on property were major barriers to adoption while lack of financing options, building aesthetics, and roof integrity were possible barriers for commercial customers. Townhome PV hard on Oahu, easier in Maui and Hawaii Counties If income is low, then saving means something Roof space, efficiency in W/square feet has gone up, which helps with this Residential customer education is poor Low incentive for rentals Business priorities are important factor/barrier Need entire policies and regulation process that incentivizes rather than blocking Grid constraints are another barrier Environmentally conscious may still adopt regardless of their bill If 80% of your income is going to housing and groceries, you aren't going to pay thousands for a PV system Roof integrity not necessarily a barrier; may impact timing HOA type rules may affect ability to install Some "historic" homes have installed PV on side of roof facing away from	DER Forecast	Feedback on home ownership and low consumption/low bill reflected in residential market size estimate for uptake modeling of DER. Feedback on commercial lack of roof ownership and limited space reflected in commercial market size assumptions. Other barriers to adoption indirectly included in the uptake modeling by using local historical adoption rates that have these barriers embedded in the historical adoption.	2
32				Qs: What would it take to see major growth? What is the future market saturation? A: Participants stated that system prices and new incentives would be very important in driving major growth in DER adoption while new technologies would possibly be important. Participants stated that the DER market will be partially saturated but still room for growth within the next 5 years and 10 years depending on incentives. By 2045 they expect little to no growth as replacement construction and new technologies may provide that growth. Also stated that tariff design/compensation for grid services along with tariffs that are simple and attractive would create major growth. Cost assumptions – why not use other sources like NREL and GTM Research? Pricing Keep incentives simple, make them sexier Marketing innovation Partnerships – how to bundle things together to improve quality of life Internalization of cost of carbon Unlimited NEM Create market where whole value chain is winning Policies that line up incentives Historically to hit the top third of the adoption curve you would need policy to dive it People are holding off on adoption, waiting for technology improvements/price reductions	DER Forecast	Stakeholder feedback on saturation was used to validate DER forecast uptake over the timeline. Feedback on tariff design and compensation received was provided to the team working on advanced rate design and Customer Energy Resources group.	2

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33				Q: What happens to existing DER systems after they degrade or the lease ends? A: Participants stated that residential customers are most likely to replace or extend lease of DER systems and are generally unlikely to remove or do nothing with systems; similar expectation for commercial customers Hearing that legacy systems are being replaced with more efficient technology If original system was a cash purchase, then replace. If lease, then extend the lease If lease can be extended at the same rate, then it will be chosen since electricity prices are going up Wouldn't extend the lease if the systems output is degraded People don't even change the filters for their HVAC; not going to do anything about an old PV system "Transfer" as an option as it may be used for another purpose later Degradation is considered by planners. How to track replace/expansion/updating of systems under discussion because unless the customer updates paperwork, it isn't trackable. Inverter replacement visibility? Replacement with smart inverters, no visibility?	DER Forecast	Stakeholder feedback was used to validate forecast assumptions used in the DER forecast.	1
34	3	3.1.1	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**	If forecast assumptions are changed—even in a relatively minor way—does that require all the models to be run again for each island? And would this extend the timeline for some of the products in the IGP process?	DER Forecast	Stakeholders suggested and HECO agreed that developing sensitivity analysis would be a good way to examine impacts due to changes in selected assumptions. The resource plan analysis includes sensitivities around the DER forecast, so if assumptions are changed then outcomes should be covered by the range of sensitivities.	2
35	3	3.1.1	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** .	What was the threshold?	DER Forecast	Document was modified. Inputs and Assumptions document was updated to address this question by including a more detailed explanation of how thresholds were set for commercial consumption.	2
36				Is load shifting included in hourly shapes?	DER Forecast	No, demand response load shifting is not in the hourly shape forecasts, but considered in possible resource impacts. Load shifting from batteries paired with a PV system is included in the hourly shapes.	1
37				Impacts of renewable project adoptions: Policies could require measures that would dramatically increase housing prices making it harder for first home buyers and the lower demographic.	DER Forecast	Comment acknowledged.	1
38				Batteries: There will be an impact of Battery prices due to tariffs with China. The cost of batteries are dropping due to EVs. We're at the beginning stages, need scale. The short-term trend for battery prices is going up. More manufacturers are handling the battery disposal (out of 250,000 customers, Sunrun recycled about 30 systems). Reusing batteries for applications that require less efficiency will help to drive down battery prices. The price for individual cells are decreasing however the power electronics are not at a scale in which the prices can go down. Commercial will most likely not adopt batteries as much of their load coincides with solar generation (limited 3 Phase batteries are also a barrier to entry for the commercial industry)	DER Forecast	The cost projections for batteries reflect a decline in costs over the forecast period. This stakeholder input is consistent in the assumptions for the DER uptake modeling, specifically that all residential and small and medium commercial PV is paired with batteries, while large commercial PV systems are not.	1

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39	3	3.1.1	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**.	Is there a specific percentage associated with "most future systems"? And is this true across all distributed generation and other solar resources?	DER Forecast	Document was modified. Inputs and Assumptions document updated with more specific details on the percent of systems paired with storage and size pairings.	2
40	3	3.1.1	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	How would this threshold change if storage is incorporated as it's expected to be in most new installations? Is this the assumed size for residential customers? If not, what is the assumed system size per customer?	DER Forecast	I&A document was updated to address these questions by including a more detailed explanation of why the 3kW PV system size was used to determine the customer use threshold to exclude customers with low consumption. System size assumptions were also added to the document.	2
41	1		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.	An Executive Summary might help make this document more readable. The Executive Summary could be as simple as bullet point statements, with the details explaining the bullet points left in the respective sections.	Edit or Format	Document was modified. High-level bullet points were added listing the assumptions being presented.	2
42	2	Fig 1	O'ahu Net Load Duration Curve Comparison	What does the Y axis represent in this Figure 1? What is "Value"?	Edit or Format	Document was modified. Figures were changed to define the y-axis.	2
43	2	Fig 1	O'ahu Net Load Duration Curve Comparison	What units are used for the Y axis in Figure 1? Shouldn't this be MW?	Edit or Format	RESOLVE Day Sampling: The data in Figure 1 is normalized by annual load (Hourly Load / Annual Load).	1
44	2	Fig 2	O'ahu Net Load Distribution Comarison	What does the x-axis represent in this figure? Are there units for the numbers on the x-axis?	Edit or Format	Document was modified. Figures were changed to define the x-axis.	2
45	2	Fig 9	Lana'i Net Load Duration Curve Comparison	Adjust x-axis to be 0 to 100% like other graphs	Edit or Format	Document was modified. Figures were changed to fix the x-axis scale.	2
46	3	Table 6	Input Data Sources for Underlying Forecast	Can specific source references be hyperlinked/footnoted? For example, which UHERO data on visitor arrivals was used – was it updated post-COVID data or older?	Edit or Format	Date of the UHERO forecast used in the underlying forecast prior to adjustments for COVID is provided in the tables of drivers in Appendix C of the Inputs and Assumptions document. Appendix C has also been updated to include explanation of COVID adjustments to the forecasts, including the date of the post-COVID UHERO forecast used to inform the COVID adjustments.	2
47	3	Table 10	Cumulative Distributed PV Capacity (kW)	Unclear whether the scale of this data is kW (as the title of the table indicates) or MW (as this row indicates)	Edit or Format	Document was modified. Document was corrected to read kW	2
48	3	Table 11	Cumulative Distributed BESS Capacity (kW)	Unclear whether the scale of this data is kW (as the title of the table indicates) or MW (as this row indicates)	Edit or Format	Document was modified. Document was corrected to read kWh	2
49	3	3.2	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[1] and March 9, 2020[2] FAWG meetings .	Please include the value for the loss factor here.	Edit or Format	The loss factor is unique to each island's system and is accounted for in both the sales and peak forecasts. The net-to-system factor used to convert customer sales to system level load is calculated as equal to 1/(1-loss factor) and includes company use. The loss factors are included below: - Oahu: 4.43% - Hawaii: 6.38% - Maui: 5.17% - Lanai: 4.39% - Molokai: 9.07%	2
50	3	Table 18	Electric Vehicles - Hawai'i	In this table, by 2050, EVs are accountable for 50% of the system peak.	Edit or Format	Agreed	1
51	3	Table 19	Electric Vehicles - Maui	Why is this such a large number in later years? Is this unmanaged peak contributions? Why is the peak contribution from EVs so high?	Edit or Format	Although multiple charging profiles are used which include charging during the day, the assumption is that that most EV's are personally owned vehicles that are charged when it is most convenient for the owner resulting in most vehicles being primarily charged during the evening peak. Refer to January 29, 2020 FAWG meeting slide deck. Developing assumptions for managed EV charging which will allow shifting to off peaks and will be done in the resource planning stage. Maui customers have demonstrated to be early and more aggressive adopters of renewable and energy efficient technologies such as solar water heaters, DER systems and electric vehicles resulting in a higher adoption of electric vehicles when compared to the other islands over most of time horizon.	1
52	3	Table 25	Resource Cost Data Sources	Can specific references be provided?	Edit or Format	Links were added for the data from DOE, NREL, and IHS. There is no link for the HECO data, GE data, or Siemens data.	2

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53	3	3.4	Distributed Wind: The capital and fixed O&M source data for distributed wind was provided by the **Department of Energy's 2017 Distributed Wind Market Report**. The average installed small wind costs were used from the report	Is a 2018 distributed wind report available? If so, why is HECO using legacy reports when updated data are available?	Edit or Format	Document was modified. Footnote was added to state that while there is an updated report in 2018, resource costs for distributed wind were last provided in the 2017 report. Noted the correction to the capital cost and the update to the O&M cost.	2
54	3	3.1.3	Light Utility Electric Vehicles - 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.	What are the forecasted EV % saturation numbers? Are the EV saturations consistent with carbon neutrality in Hawaii by 2045?	Electrification of Transportation	Although EV saturations were not specifically consistent with carbon neutrality in Hawaii by 2045, they are consistent with State and County goals for achieving 100% renewable energy fueled vehicles by identified years.	1
55	3	3.1.3	Historical kWh per mile was obtained using the weighted average fuel economy of registered electric vehicles by island. For Lāna'i and Moloka'i, the fuel economy from a predominant electric vehicle represented each island's average.	What are these predominant vehicles?	Electrification of Transportation	For Lāna'i and Moloka'i, the fuel economy from the Nissan Leaf represented each island's average.	2
56	3	3.1.3		Could HECO provide the inputs to their "Annual kWh per vehicle" calculation by year, as well as their estimate of the number of EVs on Oahu each year? For 2045, HECO previously reported that they expect 54.4% of vehicles to be electric. As of May 2020, there are 643,299 vehicles on Oahu; multiplying these gives 349,955 EVs on Oahu in 2045 (based on 2020 vehicle count). Using 9011 VMTs per vehicle (2018 DBEDT data) and 0.31 kWh/mile gives 2793 kWh per vehicle per year. Multiplying this by 349,955 EVs gives 977 GWh/year of sales for light duty vehicles, which is much lower than the 1,297 GWh that HECO estimates for light duty vehicles (excluding buses) in 2045 in the Oahu Sales and Peak Forecast (EXCEL) file (8/31/20) at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents. Does HECO use different estimates of VMTs, EV adoption or light-duty fleet size?	Electrification of Transportation	See: FAWG January 29, 2020 meeting materials, the IGP EoT Forecast (EXCEL) linked here: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/EoT_forecast_IGP.xlsx	1
57	3	3.2	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.	Does this forecast assume that EV's will be charged during the daytime on-peak period? It seems likely that there will be incentives baked into rate designs and programs for EV charging to occur off-peak, which would significantly decrease the peak forecasts going through 2050. This could have a significant impact on the necessary generation going forward and this peak forecast.	Electrification of Transportation	Although multiple charging profiles are used which include charging during the day, the assumption is that that most EV's are personally owned vehicles that are charged when it is most convenient for the owner resulting in most vehicles being primarily charged during the evening peak. Refer to January 29, 2020 FAWG meeting slide deck. Developing assumptions for managed EV charging which will allow shifting to off peaks and will be done in the resource planning stage.	1
58	3	Table 17	Electric Vehicles - O'ahu	Why is this such a large number in later years? Is this unmanaged peak contributions? Why is the peak contribution from EVs so high?	Electrification of Transportation	Although multiple charging profiles are used which include charging during the day, the assumption is that that most EV's are personally owned vehicles that are charged when it is most convenient for the owner resulting in most vehicles being primarily charged during the evening peak. Refer to January 29, 2020 FAWG meeting slide deck. Developing assumptions for managed EV charging which will allow shifting to off peaks and will be done in the resource planning stage.	1
59				Stakeholder asked about recently introduced bill to possibly ban gas vehicles.	Electrification of Transportation	Bills that have not yet passed are not in the model but could be potential sensitivities.	1
60				Stakeholder asked if we have geographic adoption.	Electrification of Transportation	Geographical information on EV's are hard to obtain as the data contains PII data. The location of where the vehicle is registered is not as important as where it is charged and when. Working with T&D planning who will be looking at EV charging using LoadSEER to try to get down to geographic area.	1
61				Stakeholder asked about unmanaged charging and will we show scenarios with managed charging? When the charging study was first done for the EoT team, it was just for unmanaged charging.	Electrification of Transportation	Managed charging will be examined in the resource planning stage.	1
62				Do you see any reduction in mileage driven due to walkable spaces and increase in public transportation?	Electrification of Transportation	Mainly increase in miles driven. But rate of growth is decreased due to services like ride sharing.	1
63				Does the EV forecast take rental vehicles into consideration?	Electrification of Transportation	Yes, it is included in the commercial fleet.	2
64				Why is the assumption that EV charging will occur in the evenings? Is it due to customer behavior? Rate design? No workplace charging during the middle of the day? Are there any assumptions about how rates are going to change over time to modify this EV charging behavior? What about medium and heavy duty vehicles? What are their assumed charging patterns?	Electrification of Transportation	Most of the EVs are personally owned vehicles and assumed to charge at home when it's convenient after coming home from work or school in the evening. The company had pilot time-of-use rates for EV charging however most EV owners did not sign up for the rates. The forecast includes a share of workplace charging however it remains fairly small compared to unmanaged charging. The forecast includes medium size vehicles such as cross overs, SUVs and light duty trucks. Except for buses, which makes up a small share of the EoT, it does not include heavy duty vehicles. The bus charging profiles are based on discussions with operators of bus fleets and assume the commercial electric bus charging facility pilot tariffs would be utilized. A managed charging sensitivity will be evaluated in the planning analysis downstream of the forecast.	2

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65				National studies show that people who adopt PV are also adopters of EV. Inverters are being built with EV charger compatibility in mind. Permitting is getting more complicated for EV's as higher amperage chargers are requiring higher house BUS. Increasing charging on the grid increases load leading to allowing more PV without curtailment or batteries.	Electrification of Transportation	Model for EV adoption recognizes that there is a correlation between PV and EV adoption. The number of PV systems are including in the BASS Diffusion model.	2
66				Lyft has a Green mode allowing customers to choose EV for their ride. Roberts Hawaii is implementing hydrogen and 100% EV vehicles (tariffs are a big factor in adoption). For electric buses, energy cost should be about 40% less than fuel, but the O&M costs are still unknown. Barriers for Renewable Fleet Adoption: Infrastructure for large fleets is not available and the largest barrier to EV adoption. Lyft utilizes contractors for their services. Many local contractors do not own EV (they are creating a program that would provide contractors with vehicles allowing for the possibility of more EV's. Electric buses are not close to the economies of scale and are very expensive (decreasing bus ridership creates more forecast uncertainty and hesitation in future investments). Multi-modal transportation is not as effective in rural areas, which includes much of Hawaii	Electrification of Transportation	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion provided information that was used to develop or validate assumptions used to develop the forecast.	2
67				Charging connectors are relatively standardized and are not a barrier to adoption. Mobile charging is for emergency only and not viable for regular everyday charging. Barriers to adoption: Lack of dependable and central charging infrastructure (need to provide tax abatements or some incentive for places of work to accommodate charging and no successful business model for Level 3 charging) Laws currently in place are not being enforced (SB 1000 states that places of business must have a certain amount of EV charging stalls for X amount of regular stalls) Locational Demand Charges (Example of demand charges causing the price for an EV charging station to $2/kWh and smarter demand charges need to be established to avoid high rates) Lack of data to determine what is happening to EV's after their end of life expectancy	Electrification of Transportation	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion was mainly about extracting information that could be used to develop or validate assumptions used to develop the forecast. The pace of EV adoption is related to the ability to have places to charge so information such as this were used to validate EV uptake over time.	1
68				Key Drivers for Adoption: Models forecast EV's reach cost parity with traditional ICE vehicles by late 20's early 30's; future societal trends, i.e. large or small vehicles; incentivize customers to charge during the daytime PV peak; if charging at home, EV charging cost will be around 60% compared to charging at the pump; regulation such as a ban on ICE vehicle sales; Europe car trends tend to dictate American car trends Barriers to adoption: Trucks with long routes will have longer trip times due long charge times for a large battery; lack of infrastructure for charging; range anxiety regardless if the consumer does not actually drive that far; market demand for vehicles; customers in Hawaii love trucks; military usually bring their cars with them whenever they move	Electrification of Transportation	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion was mainly about extracting information that could be used to develop or validate assumptions used to develop the forecast. The pace of EV adoption is related to the ability to have places to charge so information such as this were used to validate EV uptake over time and the types of vehicles to consider.	1
69				Clustering of adoption causes problems to specific distribution networks (people of similar socio-economic status tend to live in the same area; adoption of PV and/or EV tend to trend in areas) Value must be assigned to both smart (during peak PV) and "dumb" (coincident with nighttime peak) charging of EV's. Forecasts based on historical data and do not consider trends from the next generation Innovation in how existing technology is used can bring down cost of EV charging (using batteries in areas with high demand charge can bring down costs; in some pilots, rates reduced to 50 cents per kWh; not much synergy between PV and DC Fast Chargers) Potential resiliency issues at 100% renewable	Electrification of Transportation	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion was mainly about extracting information that could be used to develop or validate assumptions used to develop the forecast.	1

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70				Q. What are the drivers that are needed to support these goals by increasing EV adoption and reaching higher saturations of total light duty vehicles? Participants ranked cost parity, range/convenience, increased charging opportunities, and cost of ownership/maintenance as top drivers in EV adoption. Refer to feedback https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20190827_wg_fa_breakout_questions_group_1.pdf https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20190827_wg_fa_breakout_questions_group_2.pdf https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/forecast_assumptions/20190827_wg_fa_breakout_questions_group_3.pdf	Electrification of Transportation	Breakout sessions to gather input on forecasting assumptions as well as intake assumptions were held during the August 27, 2019 FAWG meeting. Feedback gathered during the breakout sessions were used to validate or update assumptions presented during the first half of the meeting. The EV questions were used to validate the drivers of the EV saturation model.	1
71				Q. What is the future market saturation of EVs as a percent of light duty vehicles? Using the EoT Roadmap as a guide, most participants expected actual adoption to be fairly mixed but generally near the reference case Feedback: Oahu: Low due to unknowns in market – use in tourist industry, high rises, etc.. Noticed hotels only have a few charging ports Backbone study recently filed by HECO; forecasts a big need for chargers Maui: Group noted higher adoption on Maui – no high rise barriers like on Oahu JumpSmart Maui program let to increased EV adoption, but now Hitachi is not longer servicing the program and business side of maintaining the program has been a struggle Hawaii: Group noted need for trucks, including hauling own garbage Highest percentage of low income residents	Electrification of Transportation	Breakout sessions to gather input on forecasting assumptions as well as intake assumptions were held during the August 27, 2019 FAWG meeting. Feedback gathered during the breakout sessions were used to validate or update assumptions presented during the first half of the meeting. The feedback on expected EV adoption was used to validate the current assumptions for adoption for the reference case and scenarios.	1
72				Q. What are the lower income populations, do they differ by county? Income a barrier?	Electrification of Transportation	Utility uses targeted approach for incentives. Carve outs for charger infrastructure for disadvantaged communities because less infrastructure investment in those communities historically. Also, limited secondary markets in those communities.	1
73				Q. What influences a customer's decision when to charge their vehicle? Feedback: Participants stated that it is very important for personally owned customers to charge their vehicles at their own convenience Also stated that it's very important that charging be available at home but slightly less important for workplace charging or public charging For commercially-owned vehicles, participants stated it was very important to charge when it fits the business' operations and that there was accessibility to a charger regardless of cost All location items (home, workplace, etc.) have to be "Very Important" to get to reference or high scenarios. Consensus that cost doesn't matter when you're running on empty. Demand for gasoline is inelastic, and do expect similar behavior here.	Electrification of Transportation	Breakout sessions to gather input on forecasting assumptions as well as intake assumptions were held during the August 27, 2019 FAWG meeting. Feedback gathered during the breakout sessions were used to validate or update assumptions presented during the first half of the meeting. The feedback on a customer's decision when to charge their vehicle was used to validate the charging profiles for personally and commercially owned vehicles. And the importance to develop scenarios.	1
74				"Some stakeholders think changes in demographic behavior should be analyzed For example, newer generation anecdotally drives less than older generations"	Electrification of Transportation	Comment acknowledged.	1

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75				Is home automation (i.e. smart homes) factored in? What is the impact of EE on the peak? Has ratio changed over the last 10 years?	Energy Efficiency Forecast	Currently, the forecast derives a simple ratio of the historical energy impacts to historical peak impacts then applies to the forecasted energy impacts. Considers the type of equipment installed in the historical periods to find an appropriate time frame. Looking forward to receiving the EEPS potential study. The ratio of EE will need to change for the future because the "low-hanging fruit" i.e. replacing light bulbs will be unavailable and getting higher EE's will be more difficult. The ratio can vary by year depending on changes to the programs however; using a blended average over multiple years smooths that out. Newer modeling uses load profiles of sectors to shape efficiency. The illustrative EE forecast will be replaced with AEG's forecast when available.	1
76				How much of the savings are "hard to reach"?	Energy Efficiency Forecast	The limited income and not limited customers could be used as a proxy to determine how much is "hard to reach". Some commercial sectors would also be considered, for example restaurants do not usually participate in programs.	1
77				Suggestion to consider sensitivities similar to DER for energy efficiency.	Energy Efficiency Forecast	The EE forecast will be provided by AEG. They provided a "Business as Usual Case" and will provide a "High Potential" Case. May need to do something simple for a lower case.	1
78				EE Forecast looked too aggressive based on Stakeholder's own experience with their organization and running EE projects.	Energy Efficiency Forecast	Sensitivities may address this.	1
79				What's the reality of the impact due to EE being greater than the impact of more PV? Is there that much EE potential regarding existing structures, buildings and homes? We have to push kind of hard to get 1% of annual energy sales to be reduced by EE measure adoption. What's the potential trade-off between EE and PV? We pushed for EE measures when we provided incentives for solar PV and didn't see much uptake if any. Customer behavior seemed to convey the notion that solar PV had a better economic outcome than EE, which can have high upfront costs.	Energy Efficiency Forecast	The impacts of energy efficiency on sales have been greater than PV and are assumed to continue being greater based on the results from the Statewide Market Potential Study. The EE forecast include impacts from codes and standards in addition to interventions from energy efficiency programs.	1
80				Stakeholder said the business as usual EE achievable potential forecast was too aggressive. He was speaking from experience trying to do EE projects. He didn't want to raise it in the meeting but wanted us to know what he thought coming from someone with planning/installation experience.	Energy Efficiency Forecast	In its updated work plan filed on 1/19/21, the Company asked for additional information from AEG to model EE as a resource including the developable potential, load shape, cost and operational limits. Modeling EE as a resource would allow it to economically compete against other available candidate options.	1
81				LED lighting is an easy way to reduce energy consumption in existing structures via retrofits or in new construction: longer lasting LED lights require changing less often decreasing maintenance costs in the public and private sector; without much effort, commercial customers can get 20-30% energy savings with LED retrofits. With more effort and controls, can get 60-70% savings. Sensors, controls, manufacturers and products are continuing to evolve and mature in this space; and LED lighting is standard in new homes.	Energy Efficiency Forecast	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion was mainly about extracting information that could be used to develop or validate assumptions used to develop the forecast. Not directly applicable to the forecast process or outcome.	1
82				Key Drivers for Adoption: Ease of certain projects and immediate impacts; quick return on investment (example is LED retrofit); rebates are a big driver for customers Barriers to Adoption: For military, projects take about 2-3 years to be implemented. In that time, energy prices go up and it is hard to justify the efficiency project upon completion when utility bill is still higher than previous (have to explain that the bill would have been larger if not for the efficiency upgrades); hard to change people behaviors (military frames it as saving on energy bills mean more money for bullets; for privatized housing, a baseline was established that would determine a family's nominal usage; families would start using even more energy to increase their baseline); in the senior sites, behavior is sometimes dependent on the resident leaders; policies with an adverse effect (in section 8 housing, tenants are given a fixed amount per month for energy and that is decreased if efficiency measures are implemented; in some cases, the decrease was more than the efficiency causing the customer to pay more than they previously did); in the retail sector, certain colors are needed for displays that were not available as LED's; adopting PV would not make financial sense without tax credit; and HUD requires an energy conservation plan	Energy Efficiency Forecast	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion was mainly about extracting information that could be used to develop or validate assumptions used to develop the forecast. Not directly applicable to the forecast process or outcome. Energy efficiency forecast used is from AEG. AEG attended this meeting.	1

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83				Policies and Codes: May have an upward effect on pricing, possibly negating a downward trend in price (policies tend to increase demand thereby increasing prices); a cheap and effective efficiency measure; are locked in place and cannot be weakened by a future policy or code (3 Potential Code Adoption Scenarios: IECC adopted within two years of code's publication date; wait 3-years after publication, like CA, wait for technology to catch up; or adopt every-other published IECC, starting with 2018 IECC); Hawaiian Electric should factor in the adoption scenarios of codes into its forecasts Barriers to Adoption: Complexity and difficult for customer in obtaining requested information (undertaking the whole building will be needed going forward, vs simple lighting retrofits); on boards that discuss energy efficiency, the most knowledgeable usually have normal day jobs that prevent them from participating in ALL the meetings; consumers do not understand the different interconnection types (everyone thinks their bill is going to be like the NEM customer bills)	Energy Efficiency Forecast	Panel discussions in the May 22 and 23, 2019 FAWG meeting covered the main drivers and barriers for adopting distributed energy resources, energy efficiency and electric vehicles from the customer, industry, program administrator and consultancy perspectives. Trends in the respective industries and visions of future technologies and programs were also discussed. Stakeholder discussion was mainly about extracting information that could be used to develop or validate assumptions used to develop the forecast. Not directly applicable to the forecast process or outcome. Energy efficiency forecast used is from AEG. AEG attended this meeting.	1
84	3	3.3	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	How does this regression compare to current futures pricing for these products, or from a forward curve forecast?	Fuel Forecast	A comparison between the regression and the current future pricing is unavailable.	1
85	3	3.3		Are the fuel price forecasts in Tables 22–24 specified in nominal dollars or real dollars?	Fuel Forecast	The fuel prices in Tables 22-24 are in nominal dollars.	2
86	3	3.3		Why did HECO use a forecast of Brent crude prices from Facts Global Energy (FGE) instead of a public source such as the US EIA's Annual Energy Outlook (AEO)? Does the Facts forecast differ from the AEO 2020? We have a preference for publicly available data.	Fuel Forecast	Hawaiian Electric chose to use a Brent forecast based on Facts Global Energy (FGE) because it provides a more accurate reflection of Brent relative to the EIA data.	1
87	3	3.3		Why does the price margin between biodiesel and diesel in the HECO forecast rise from $16.73/MMBtu in 2020 to $21.88/MMBtu in 2045?	Fuel Forecast	The price forecast is a linear regression based on the historical prices and Brent. The slope for diesel and biodiesel are different and the forecasted prices are in nominal dollars.	1
88				Stakeholder was apprehensive about relying on biodiesel to get to 100% renewable generation	Fuel Forecast	Some biodiesel may be required to achieve 100% renewable generation, especially after considering the technical potential to develop new resources and community impacts of developing new resources.	1
89				A stakeholder commented that it is inconsistent that resource planning uses worst case scenarios while planning and forecasting uses averages	Fuel Forecast	Both the forecasting and resource planning processes make assumptions in the development of the respective forecasts and resource plans. This can include assumptions on whether certain scenarios do or do not occur like a worst case scenario or typical average scenario.	1
90			TAP 24AUG20 Meeting - Review of FAWG work products	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.	Load Forecast	Please see the latest draft of the SEOWG deliverable.	1
91	3	3.1	Load Forecast	Consideration should be given to the recent PUC order providing guidance e.g., in regards to how energy efficiency and EVs are considered in the load forecast	Load Forecast	The SEOWG GNA report addresses this issue through proposed sensitivity analysis. Please see the latest draft of the SEOWG deliverable. For EVs specifically, right now the forecast assumes unmanaged charging, planning to develop a managed-charging profile to account for EVs being on TOU rate.	2
92	3	3.1	Multiple methods and models were analyzed to develop the underlying forecast as presented in the July 17, 2019 FAWG meeting.	Additional information on the stakeholder feedback on these methods and models and how it was incorporated in HECO's decisions in developing the underlying forecast should be clearly stated in this document or a subsequent deliverable that summarizes stakeholder feedback and how it was or was not incorporated and why.	Load Forecast	Stakeholder feedback is referenced where applicable in the I&A document and will be captured in the Stakeholder Engagement Summary (SES) report which is in development.	2
93	3	3.1	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**	What are the drivers specific to each customer class? Where are those described, and from what data sources? Please provide a table of data inputs for each customer class that is driving the sales forecast.	Load Forecast	I&A document modified. Appendix C provides a narrative and workbook attachments to the Inputs and Assumptions document have been updated to include this information.	2

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94			TAP 24AUG20 Meeting - Review of FAWG work products	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.	Load Forecast	Taken into consideration	1
95			TAP 24AUG20 Meeting - Review of FAWG work products	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	Load Forecast	Taken into consideration	1
96			TAP 24AUG20 Meeting - Review of FAWG work products	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.	Load Forecast	This issue was addressed in the GNA, as similar suggestion was received from SEOWG sessions. See GNA Appendix E	2
97			TAP 24AUG20 Meeting - Review of FAWG work products	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.	Load Forecast		1
98				How closely are you working with the Counties to receive information on new projects that could affect the load?	Load Forecast	Some information is obtained via public channels such as information made available by city and county. Information is also obtained from Hawaiian Electric's internal group that receives requests to provide power to new projects	1
99				Do we know what the forecast would look like if warming temperatures not included?	Load Forecast	Yes, would be slightly flatter with slightly lower growth.	1
100				What are we doing to account for changes in demographic? Losing younger generation, elders are becoming larger part of our population with different behaviors (e.g., take a bath by 5:00). Is that being considered at all?	Load Forecast	This is difficult to incorporate that type of behavioral change in forecast. We see the population reduction in UHERO's forecast, but not by age group. As we move forward, we'll look for ways to incorporate that.	1
101				If studies are based on 2018, how do we account for changes in volcanic activities?	Load Forecast	We'll apply some factors to adjust our forecast as needed while not affecting any future projection. For Hawai'i island we use net system profiles that were modeled based on 2015-2018 actuals. Models were assessed for reasonableness against actuals. Eruption impacts were largely loss of residential customers which would impact the level of sales under the shape more than the shape itself. No large commercial customers were lost.	1
102				Part of population impact is due to in/out migration from shifts in job opportunities. Next generation doesn't want to travel for work. Hawai'i island may be last place that is affordable to buy a home however it could be second homes.	Load Forecast	Stakeholder discussion was mainly about clarification and ideas. UHERO factors in in/out migration when deriving their population forecast and develops job forecasts by industry. Does not necessarily factor in generational changes to travel for work.	1
103				I thought the FAWG last week covered some very interesting topics, particularly as it focused on some of the items I've been digging into lately (the impact of lighting market transformation, DERs). The presenters did a good job outlining thought provoking issues, explaining your approach and the outputs, and at a high level, methodologically, these seemed reasonable. I don't find myself with any major bits of feedback to provide.	Load Forecast	Feedback was used to validate the approach to deriving the forecasts was reasonable.	1
104				Does the forecast take into account specific end-uses for factors such as an increasing aging population and increasing demand for dialysis that will require more medical equipment thus increasing the future load?	Load Forecast	The forecast does not take into account specific end-uses for factors such as an increasing aging population and increasing demand for dialysis that will require more medical equipment thus increasing the future load. Although, if the trend is occurring already, the forecast may account for it to some degree in the underlying trend. A review of the number of dialysis facilities over time and the impact to sales was conducted. The impacts were not significant enough to include as a line item in the way new large loads are included.	1

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105	3	3.2		What are the values of the loss factors used to convert loads from the customer level to the system level, as discussed on p. 30? Were these applied only to peak forecasts or also to GWh sales forecasts?	Load Forecast	The loss factor is unique to each island's system and is accounted for in both the sales and peak forecasts. The net-to-system factor used to convert customer sales to system level load is calculated as equal to 1/(1-loss factor). The loss factors are included below: - Oahu: 4.43% - Hawaii: 6.38% - Maui: 5.17% - Lanai: 4.39% - Molokai: 9.07%	2
106	3	3.2		Are the peak forecasts in Tables 17–21 reported at the system level (peak production by all resources, to serve load plus losses), while the sales forecasts in Tables 12–16 are reported at the customer premises (total consumption from electric utility or self-supply, not including losses)? Will RESOLVE be run with system-level values for both peak and total sales? (that is what we would recommend).	Load Forecast	Peaks are reported at system level while sales are reported at the customer level. RESOLVE is run using system level load.	1
107	3	3.2		The sales and peak forecasts reported in Tables 12–21 are also shown in the Oahu Sales and Peak Forecast (EXCEL) file (8/31/20) at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents. That spreadsheet also shows versions of the peak and sales forecasts looking back to 1996. However, when we compare the "Recorded" values shown in this spreadsheet for 2006–19 to the comparable values that HECO reported on FERC Form 714 for these years, the GWh sales in the spreadsheet are all about 7.5% below the Form 714 data, and the MW sales in the spreadsheet are all about 2.3% below the Form 714 data. Can HECO say why the backcasted version of these forecasts differ from the system load reported to FERC?	Load Forecast	The I&A workbook will have the load data that will address this comment. Regarding FERC Form 714, Hawaiian Electric units are reported in gross generation while IPPs are reported in net generation which may cause the data mismatch described in the comment.	2
108	3	3.2		Are the peak forecasts in Tables 17–21 reported at the system level (peak production by all resources, to serve load plus losses), while the sales forecasts in Tables 12–16 are reported at the customer premises (total consumption from electric utility or self-supply, not including losses)? Will RESOLVE be run with system-level values for both peak and total sales? (that is what we would recommend).	Load Forecast	Peaks are reported at system level while sales are reported at the customer level. RESOLVE is run using system level load.	1
109	3	3.2		The sales and peak forecasts reported in Tables 12–21 are also shown in the Oahu Sales and Peak Forecast (EXCEL) file (8/31/20) at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents. That spreadsheet also shows versions of the peak and sales forecasts looking back to 1996. However, when we compare the "Recorded" values shown in this spreadsheet for 2006–19 to the comparable values that HECO reported on FERC Form 714 for these years, the GWh sales in the spreadsheet are all about 7.5% below the Form 714 data, and the MW sales in the spreadsheet are all about 2.3% below the Form 714 data. Can HECO say why the backcasted version of these forecasts differ from the system load reported to FERC?	Load Forecast	The FERC Form 714 years 2006-2019 is a database that can be downloaded from the FERC's website here: https://www.ferc.gov/industries-data/electric/general-information/electric-industry-forms/form-no-714-annual-electric/data. I downloaded the database and saved it here: "S:\System Planning\Corporate Energy Planning\Integrated Grid Planning\Working Groups\SEOWG\Deliverables\Inputs and Assumptions\FERC Form 714 2006-2019 Database" Hawaiian Electric's ID Respondent ID#: 178 Respondent Name: Hawaiian Electric Company, Inc. eia_code: 19547	1
110				Some stakeholders think that a wider range in temperature and other variables should be used	Load Forecast	Warming trend was further increased following feedback during the breakout session during the August 27, 2019 FAWG meeting.	2
111				Is life expectancy taken into account? People are living longer and use more energy in their lifetime.	Load Forecast	Births and deaths are factored into the population forecasts. Birthrates have been slowing over the last decade. Current studies show that Oahu's population has been declining.	1
112				How is affordability incorporated into the economic forecasts? e.g. As water systems are privatized they get less affordable to those most in need.	Load Forecast	UHERO does not incorporate affordability into their economic forecasts aside from increased out migration of population as income can't keep pace with housing/other costs to live in Hawaii	1
113				Will climate change be a factor in population, i.e. will unfavorable weather in other locations cause migration to Hawai'i?	Load Forecast	Weather is immediate and short term; climate is longer term. The economic forecast does not account for possible effects of climate change on population projections however; the growth in population is slowing.	1
114				Are you adjusting your cooling degree days?	Load Forecast	We try to look for relationship between weather and hourly loads. Using the hourly models, we can vary the forecast weather (for example, typical year vs. extremes). Cooling degrees are based on temperature and as we include a warming trend, cooling degree days will also be adjusted.	2

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115				Visitor growth wasn't the only driver on Maui. Some of that growth, was also driven by support brought to the island from Senator Inouye and that is no longer the case.	Load Forecast	Yes, that funding and business development was a contributor. We do not see that type of impact going forward. For example, there has been a contraction in activity and occupancy in the Maui Research and Technology Park in Kihei.	1
116				Most participants agreed that the reference case assumption of a warming trend in average temperature was reasonable Consensus was that 1 degree F by 2050 was reasonable and could be higher Suggested sources for alternative warming trend assumptions: IPCC Report 2018, global (conservative) increase of 1.5°C by 2035-2052, have to review report to confirm total timeframe of the increase; city climate change commission provides sea level rise projection, which is based on an underlying temperature increase assumption; UH Sea Grant Range between highs/lows – will this change over time? Look at impact of increasing temperature correlated to PV production Humidity levels are important – more energy use, cooling equipment has to use more energy at higher humidity Wind/wind speed – strength, consistency of trade winds, declining number of trade wind days and strength of trade winds Why are you using Fahrenheit instead of Celsius given that most of the discussions I've seen to date discuss increase in climate temperature in Celsius? Maybe this is a moot issue given the conversion factor isn't that dramatic at 1 or 2 degree changes? Reasonable for use as a base case, scenario analysis could be useful to understand impact. Extreme weather days considered? Likely having non-linear effects, but not easily picked up in models due to	Load Forecast	Warming trend was further increased following feedback during the breakout session during the August 27, 2019 FAWG meeting.	2
117	2	2.1		Please provide hourly production potential for the sample days for existing and potential wind and solar facilities and explain how it was calculated.	Model Mechanics	RESOLVE Day Sampling: Hourly profiles are based on historical data or provided by the developer for the respective projects.	1
118	2	2.2		Does the PLEXOS unit commitment strategy match actual HECO practices? Can you tell us what unit commitment strategy you expect to use? This can be a significant driver of fuel use and renewable curtailment.	Model Mechanics	PLEXOS - Unit Commitment: Units are committed economically, subject to any constraints for system security.	1
119	MISC			Please share the complete RESOLVE inputs and model code; without those, it is impossible to judge the quality of the plan. At first glance, seeing all the "maxed" labels and all the discussion of biomass, it seems HECO may have excessively restricted the amount of solar available on Oahu, possibly defined some required services that can "only" come from thermal plants, and ended up with a very biomass-heavy result. We would welcome further thoughts and sharing of inputs and code to address this concern.	Model Mechanics	The inputs will be provided in the inputs workbook that we are currently putting together. The RESOLVE code, however, can not be provided. E3 says that the model is proprietary.	1
120	MISC			What role, if any, did the Technical Advisory Panel have in reviewing the assumptions, sources, and RESOLVE optimization constraints?	Model Mechanics	TAP provided comments on the Review Point deliverable	2
121	2	2.2	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.	Where are the actual inputs? The categories are informative, but it would help to verify the details (which should include sources i.e., for fuel costs, for contractual terms of generating units the numbers should tie to PBR modeling, etc.). They don't appear be in the appendices.	Modeling Inputs	Additional modeling inputs that are public will be provided in an input worksheet and posted to the website.	1

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122	3	3.1.1	Assumptions were made as to the structure of future DER programs for the long term after obtaining input and perspectives from program administrators/designers, industry and policy/consultancies. The future new DER tariff is assumed to have compensation for export[1] that is aligned with system needs and allows for controllability during system emergencies.	Do potential changes in rate design also factor into the assumptions for these models? For example, if we see a broader rollout of TOU rates or other advanced rates, that could change the load forecast's peaks and average load, as well as a range of other aspects of the load that will be important for resource optimization.	Modeling Inputs	Current rate design programs are reflected in forecast and does not incorporate or try to adjust for as-yet undefined future advanced rate design programs. As more information is known about advanced rate design and actual implementation to show response to new tariffs, forecasts can be updated.	1
123	3	3.1.1	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	How will the monthly DER energy production be adapted for PLEXOS? Will information on assumptions HECO uses to create hourly DER forecast be available in a separate document? Similarly, how are the monthly DER CFs adapted to fit with RESOLVE's representative 30 day structure?	Modeling Inputs	PLEXOS will use a full 8760 that is representative of the production from a distributed energy resource. RESOLVE will similarly use an hourly profile that ties to the 30 modeled days and is shaped such that the average capacity factor of the 30 modeled days matches the average capacity factor of the full 8760.	1
124	3	3.4	Location Adjustment: A 62% location adjustment factor for capital	This estimate is for utility scale generating units and not for small, local resources. It may not be appropriate to use the same adjustment factor for both	Modeling Inputs	We're open to updating this assumption. The 62% location adjustment factor was specific to utility scale resources and not distributed resources	1
125	2	2.1		Are the sample days selected to correctly match the joint distribution of wind, solar and load, or only to get the load distribution right? In high-renewable systems, low solar/wind days are more important than high-load hours, especially in Hawaii.	Model Mechanics	RESOLVE DAY Sampling: RESOLVE uses statistical sampling to downscale annual data to 30 representative days per year. These representative days are weighted based on historical data to best match the distribution of load, DGPV, wind, and solar.	1
126				What would the forecast look like without those layers? And what are the costs? Did you analyze the costs of different energy (Cost-benefit analysis) from the layers to better align programs and advance rate design with the needs of the grid? What is the full cost that will be required to achieve our goals?	Model Mechanics	Could be answered in the modeling phase. That is the reason why layers and sensitivities are provided to downstream planners.	1
127				Any plans to do sub-hour forecast?	Model Mechanics	Eventually, if it is needed for models and the sub-hourly data is available. It took a lot of work to get the hourly level shapes (data collection, filtering, cleaning, etc.).	1
128	2		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	Could HECO elaborate on what the outputs are of the two models, and how the outputs of RESOLVE can be verified in PLEXOS? It was helpful to see the high-level outline of optimized resources produced in RESOLVE during the most recent SEOWG meeting, but it's unclear what the output of PLEXOS will be given it is an 8760 model.	Modeling Outputs	RESOLVE will solve for the modeled grid services to ensure all grid needs are met through the portfolio optimization. However, because RESOLVE is only modeling 30 representative days that are weighted for a full year, service requirements for less typical, outlier days may not be fully captured. PLEXOS can model those days through the full 8760. PLEXOS will verify that the grid needs continue to be met when the planning horizon is expanded to 8760 hours per year for the full 30 years through 2050.	2
129	2	2.1	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	Does this mean to capture operational costs of each potential resource under most conditions? Which operational costs are weighted and which are inputs (as shown in appendix A)? The following tables and figures only show this sampling analysis for load, how does operational cost fit in?	Modeling Outputs	Operational costs and dispatch of resources will be weighted to represent a full year. Costs that are already input on an annual basis will be passed through (e.g. fixed O&M or capital costs for new resource builds) but costs that vary per MWh (e.g. fuel costs) will be weighted.	1
130				How will the privatization of electricity generation (i.e. each person has their own energy source and storage) affect those who are financially unable to defect. Will all the costs go on to them? Will the costs of defection be passed on to those that do not, and what will be the costs? How is affordability incorporated into the economic forecast?	Other	In developing the resource plans, we consider affordability and the resulting bill impacts of those plans. The modeling objectives and planned sensitivity analyses that will examine varying degrees of DER adoption are discussed in the Grid Needs Assessment deliverable.	1
131				Will there be engagement between the various working groups where intersections exist?	Other	Yes, likely some cross-over but not as much with this particular group. Some members of this group are already engaged in multiple workgroups	1
132				Hawai'i island population growth is locational, with future growth predominantly in Puna and Ka'u, where infrastructure is lacking. In order to address for changes in population, how are infrastructure upgrades factored into this?	Other	Any distribution needs to specific areas will be analyzed by distribution planning analysis.	1
133				Some stakeholders felt that the lack of monthly bill decreases could result in a decrease in public interest in renewable energy	Other	The resource planning will construct least cost plans that meet the RPS requirements as mandated by law. However, across all sensitivities, the plans may not always result in a bill decrease.	1
134				Will rising sea levels threaten utility infrastructure? If so, what will be the cost of retreating further inland?	Other	As part of the GNA, started to scope out a process to address resilience needs and the GNA addresses this in more detail.	2
135				Battery cost in assumption – how is lifespan, safety, and its effects on environment are factored into the cost? How are future substitute technologies considered in assumptions? How do future renewables (cheaper and more efficient) affect customer's decision to stay on the grid? Should there be an "actual" forecast that does assume that the utilities will hit the RPS goals? How will the projects accommodate current fire code? (i.e. "Camp" Fire where Lithium Ion batteries started a fire and local fire dept. were unprepared.)	Resource Cost Forecast	Modeling described in the GNA document where the modeling helps develop a resource plan that will consider future renewables including batteries with the objective of achieving RPS goals.	1

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136				Some stakeholders note that the inflation rate they have is less than what HECO used UHERO provides a forecast of Honolulu CPI, which could be used instead of GDPIP	Resource Cost Forecast	Escalation rate used by HECO is tied to the GDPIP.	3
137	3	3.4		Why did HECO use IHS Markit for the cost forecasts for the main utility-scale generation and storage technologies, instead of a public source such as the NREL Annual Technology Baseline? The IHS Markit forecast differs significantly from NREL ATB; is there reason to expect it to be better? We have a preference for publicly available data.	Resource Cost Forecast	IHS provides much more granular data for the resource costs. For PV this includes breakdowns of the module, inverter, balance of system, installation and development costs for fixed tilt and single axis tracking systems. For storage, similar category breakdowns are provided along with cost streams for multiple duration systems. The category breakdowns are also helpful for estimating cost reductions for co-locating paired PV+BESS systems.	1
138	3	3.4		Are interconnection and transmission costs included in the cost of the generation technologies shown in 3.4 and Appendix A? If not, can HECO say how much additional costs those could create?	Resource Cost Forecast	Interconnection and transmission costs were not included in the cost of the generation technologies.	1
139	3	3.4		What cost of capital did HECO use to convert capital costs to levelized costs for Figure 12?	Resource Cost Forecast	The after tax weighted average cost of capital used to develop the O'ahu revenue requirement factors was 7.032%. The specific revenue requirement factor used to levelize the costs varies by technology.	1
140	3	3.4		What lifetime does HECO assume for all the new-build technologies (renewable and thermal)?	Resource Cost Forecast	Renewable and storage technologies are both assumed to have a 20 year service life. Thermal technologies are assumed to have a 30 year service life.	1
141	3	3.4		HECO reports that they applied the annual percent change from the NREL ATB for floating offshore wind in 2033–2050. HECO's nominal offshore wind capital costs fall by 27% from 2033 to 2050. However, in the NREL ATB 2020, floating offshore wind costs in this period fall by about 21% in real dollars, which would be an 11% rise in nominal dollars, assuming 2%/year inflation. Using a similar calculation, in the NREL ATB 2019, floating offshore wind falls by only 15% in nominal dollars in 2033–50. Can you explain why HECO offshore wind costs fall much faster than NREL ATB offshore wind costs? Are there total project price differences in Hawaii compared to US mainland coastal states that have continental shelves or European sites that have basically shallower seas? If so, are those costs higher? What impact would these costs, if higher, have on the offshore wind project development costs?	Resource Cost Forecast	Document and workbook have been updated. The offshore wind costs have been updated to include federal ITC changes passed in December 2020, update to the 2020 NREL ATB, and correct for real $ costs (instead of nominal $ costs) in the source NREL study. Separately, NREL is working with BOEM and Hawai'i State Energy Office to conduct a Hawai'i specific offshore wind study that will provide more specific costs to use in the resource planning.	2
142	3	3.4		Has HECO consulted with pumped hydro developers, e.g., Pacific Hydro, about the likely cost for pumped hydro storage? We have heard estimates about 20% lower than the ones shown here.	Resource Cost Forecast	HECO did not consult with pumped hydro developers in developing the PSH estimate. The PSH costs are based on the 2016 PSIP which used an average of costs from past PSH studies. However, if a need for long duration storage was identified, a PSH developer could bid in to meet that need. The purpose of the grid needs assessment which will use these cost inputs is not to specify specific technologies but rather identify grid needs and allow various technologies to compete to meet those needs.	1
143	3	3.4		Why is distributed storage modeled as only having two hours of depth? Wouldn't 4–8 hours be more appropriate?	Resource Cost Forecast	IHS characterized residential storage as having two hours of depth as part of the resource cost assumptions. This is just for residential storage. In the resource model, when it optimizes around stand-alone storage, it can optimize around its capacity and its duration. The model will be able to choose to build longer duration storage with less peak output, or greater output with less duration based on least cost.	1
144	A	App A		The cost of a 153 MW combined cycle power plant reported in Table 76 is approximately double the cost reported for a 152 MW plant in the 2016 PSIP.	Resource Cost Forecast	Estimates for both the 153MW combined cycle power plant and the 55MW simple cycle CT included additional plant costs that were based on recent costs incurred by the Company to install similar sized units.	1
145		Table 78		Similarly, the cost of a 55 MW simple cycle CT in Table 78 is approximately double the cost of a 100 MW CT in the PSIP. Can HECO explain why this is?	Resource Cost Forecast	Estimates for both the 153MW combined cycle power plant and the 55MW simple cycle CT included additional plant costs that were based on recent costs incurred by the Company to install similar sized units.	1
146	6		In addition to the thermal generating units, Hawaiian Electric has a diverse range of variable renewable resources induding 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.**	Are these resources assumed to be online in the RESOLVE and PLEXOS models, or is the model allowed to optimize these as potential resources along with other solutions?	Resource Cost Forecast	These resources are assumed to be online in the RESOLVE and PLEXOS models by the start of the planning horizon in 2025. These resources are either existing resources that are currently online or have had an application submitted for their approval (Stage 1 and 2 RFP projects).	1
147	6	Table 65	O'ahu Variable Renewable, Storage, and Grid Service Resources: Grid Services RFP	Are these grid services already procured? If so, what accounts for the long timeline?	Resource Cost Forecast	The grid services have a partial in service in 2021 and ramp to their full capacity by 2023.	2
148	4	4.1		Please describe the land and roof exclusions being used in the NREL Solar and Wind Resource Potential Study.	Resource Potential	See the NREL report here: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/stakeholder_council/20200818_sc_heco_tech_potential_final_report.pdf	1

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149	Slide	10		Seem to be using a 20 year life for existing wind and solar, resulting in these retirement schedules. That seems short to us; the NREL ATB shows a 30 year life for these. Note that many HECO Cos. PPAs for wind and solar have 25-year terms (from COD).	Resource Potential	Existing wind and solar project service lives are based on their PPA term lengths.	1
150	Slide	48		Seem to be using a 20 year life for existing wind and solar, resulting in these retirement schedules. That seems short to us; the NREL ATB shows a 30 year life for these. Note that many HECO Cos. PPAs for wind and solar have 25-year terms (from COD).	Resource Potential	Existing wind and solar project service lives are based on their PPA term lengths.	1
151	Slide	13		It would be interesting to compare this to Ulupono's Scenario 2.1 in the PBR docket. We will do so if we have time. We are concerned about all the "maxed" notes, which indicate that HECO are putting low (probably excessively low) caps on available renewable resources. RESOLVE may be undershooting what we should do because of this.	Resource Potential	The RESOLVE models currently assume the resource potentials defined in NREL's study during the 2016 PSIP. We are soliciting stakeholder feedback on the reasonableness of the updated 2020 study and whether the resource potentials warrant further adjustments.	1
152	3	3.4	Investment Tax Credit	Has HECO considered including a sensitivity around extension of ITC	Sensitivity Analysis	Yes, see the latest draft of the SEOWG deliverable.	1
153			TAP 24AUG20 Meeting - Review of FAWG work products	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	Sensitivity Analysis	Taken into consideration. Will address the specific comments within the Appendix.	1
154			TAP 24AUG20 Meeting - Review of FAWG work products	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.	Sensitivity Analysis	To some extent this may be addressed in the sensitivity "bookend" analysis. HECO will manipulate the variables/layers that are available to test outcomes	1
155				Please describe the system security constraints in detail. How do they depend on the amount of renewable capacity or production? Do they include N-1 contingency rules? What types of reserves are allocated and what other rules are used to set the reserve targets? Are there any "must-run" or "baseload" units?	AS Requirements	The latest set of assumptions for O'ahu have been posted on our website at https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/working-groups/forecast-assumptions-documents under the September 25, 2020 meeting materials. In the index tab of the Draft Oahu Inputs Workbook 2 (EXCEL) (Updated February 18, 2021) file, the requirements for inertia, regulating reserve, and FFR are linked to their respective tabs.	1
156				The NREL capacity report estimates a (unrealistically) low amount of utility-scale solar on Oahu. If HECO uses these estimates and also applies the restriction described here—that distributed solar can only provide for on-site needs—they may erroneously conclude that large amounts of expensive biofuels are required to produce an adequate supply of energy. Why is HECO not considering purchase of distributed solar power for delivery to other customers, e.g., via a tariff with dynamic prices reflecting the hourly marginal value of power? This would allow full use of available rooftops, rather than restricting use to match on-site requirements.	DER Forecast	NREL will conduct an additional run to address the concerns raised by stakeholders in their review of the study assumptions. Contracting is currently underway to commence this work and preliminary feedback from NREL indicated that the study updates should be feasible. In the resource planning, DER will also be modeled as a resource option using the difference between the market forecast and technical potential as available capacity that could be further selected in the models. DER modeled as a resource would be able to export and participate in the provision of grid services. Further discussions with stakeholders may be needed to understand how to price this resource option within the capacity expansion modeling.	1
157				HECO's forecast in the EoT_forecast_IGP.xlsx file shows 30.0 VMT/day on Oahu in 2019, rising to 34.1 VMT/day in 2045. In contrast, DBEDT data show 8,706 VMT/year on Oahu in 2019, which is 23.9 VMT/day (see https://files.hawaii.gov/dbedt/economic/databook/2019-individual/18/181719.pdf). Please explain why HECO's VMT forecast begins 26% above the current levels reported by DBEDT and then rises to 43% above current levels. Does this seem realistic?	Electrification of Transportation	To develop the vehicle miles traveled assumption in the IGP forecast for O'ahu, the Company utilized the 2019 State of Hawai'i data book (https://files.hawaii.gov/dbedt/economic/databook/2019-individual/18/181719.pdf) and the Monthly Energy Trends report (https://dbedt.hawaii.gov/economic/energy-trends-2/) published by the Department of Business, Economic Development, and Tourism (DBEDT). The data presented in the data book include "both taxable and nontaxable vehicles and all military nonresident exempt vehicles" which include "passenger cars, buses, trucks, and motorcycles but exclude trailers and semi-trailers." Since some vehicles included in the data are not light duty vehicles, the Company utilized data provided in the Monthly Energy Trends report which included only registered and taxable passenger vehicles but did not include information regarding vehicle miles traveled. The data book did not break out the total vehicle miles traveled by vehicle type therefore light duty vehicle miles traveled could not be isolated. Thus, to be conservative, the Company used the vehicle miles traveled from the data book and the total passenger vehicles from the Monthly Energy Trends report to determine the daily vehicle miles traveled per vehicle assumption. Although this results in a higher average vehicle miles traveled per day, the result is within the scenario bookends.	1
158				Why does HECO use a 20 year life for renewable and storage technologies, when the National Renewable Energy Lab uses 30 year life for wind and solar plants and 15 year life for batteries? (https://atb.nrel.gov/electricity/2020/) Are HECO's estimates more accurate?	Resource Cost Forecast	Recent procurements have resulted in PV+BESS projects with 20-25 year terms. The Company is amenable to either changing the assumed 20 year service life for PV/Wind projects to 30 years or consider a lower cost replacement resource to be available at the end of the 20 year contract for an additional 5-10 years.	1

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159				This answer repeats the statement in the original assumptions document that the changes in offshore wind costs after 2033 are based on the NREL ATB. However, as noted in the original question, nominal costs for offshore wind rise by 11% between 2033 and 2050 in the 2020 NREL ATB or fall by 15% in 2033–50 in the 2019 NREL ATB. These both differ from HECO's forecast, which shows capital costs falling by 27% during this period. Can HECO explain why their forecast for the cost of offshore wind in 2033–50 does not follow the NREL ATB, even though they state that it does in their original assumptions and their answer to this question?	Resource Cost Forecast	Offshore wind costs are being updated for the development of a federal investment tax credit for offshore wind. Updates were also made to correct for the real dollar costs provided by the source NREL study, instead of nominal dollar costs, apply the State ITC, and update for the trends in the 2020 NREL ATB from the 2019 ATB.	1
160				Please respond to the our request. HECO's data and modeling methods must be transparent and must adapt in response to stakeholders' concerns. Without this, stakeholders and regulators cannot judge the prudency of the resulting plan. E3 has published RESOLVE inputs, outputs and code in proceedings before the California Public Utilities Commission and it is appropriate and necessary to do the same in this proceeding (see, e.g., https://www.cpuc.ca.gov/General.aspx?id=6442462824	Model Mechanics	The model can be shared under NDA, noting that E3 has begun to charge a license fee to access the model	1
161				Based on previous answers, the historical values of the "Peak Forecast" in the "Oahu Sales and Peak Forecast (EXCEL)" file should match the values that HECO reported on FERC Form 714 each year, i.e., they are both system level peaks. However, the peak values in this spreadsheet in 2006–19 are about 2.3% below the peak values in the FERC Form 714 filings for these years. Also based on answer 15, the "Customer Level Sales Forecast" for historical years should be 4.43% below the GWh load reported to FERC (customer level vs. system level). However, the historical sales values in this sheet are actually about 7.5% below the annual load reported on FERC Form 714. Can you explain why the historical values in the load forecast spreadsheet don't match the loads that HECO reported on FERC Form 714 in 2006–19?	Load Forecast	The mismatch may be due to the structure of the FERC Form 714 reporting. Hawaiian Electric units are reported in gross generation while IPPs are reported in net generation	1
162				What role, if any, did the Technical Advisory Panel have in reviewing the assumptions, sources, and RESOLVE optimization constraints?	Other	The TAP provided review of the load forecasts and its components over the course of several meetings. A summary of the TAP's review in Review Point 1 was provided in Exhibit A.3 of the IGP Work plan Update and Review Point that was filed on January 19, 2021 (pg. 200 of the pdf) and can be found here: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/dkt_20180165_20210119_HECO_IGP_updated_workplan_review_point.pdf	1
163				What are the drivers for the increases in Resource Costs shown in the updated cost curves presented during the I&A Discussion on February 23, 2021	Resource Cost Forecast	Some resource cost assumptions did decline. But, for residential PV/Storage is due to customer acquisition cost assumptions, off-shore wind is due to correcting earlier interpretation of source costs, and updating latest trends in ATV, storage due to some shifting of costs from the module costs to Balsance of System costs. There is some difficulty in providing details because the IHS forecast data is not public. HECO is following up with IHS to see what additional detail may be available to share more broadly.	1
164				If you were to convert the entire existing fossil-fueled transportation fleet in the state, how much additional electric capacity (mW) and energy (MWH) would that conversion represent, based on the amount of driving done in 2020? The question goes to how much build out of the grid would be needed to accomplish the EoT goals	Electrification of Transportation	HECO currently does not have that information. Would have to consider the pace of the conversion as well as how much (less than 100%) of the fleet is actual converted.	1
165				Did the Integral Analytics model for EV's represent a base, High or Low case assumption for EV growth	Electrification of Transportation	HECO did a reference case, as well as a high and low case to provide a bracketing. What is presented is the reference case. The high and low adoption cases were presented to the FAWG break out session for response and the reference case was adopted. The website for FAWG has all the information.	1
166				Does the EV forecast take into consideration any of the stated objectives of some major manufacturers that will be 100% electric by some future date? (2035)	Electrification of Transportation	HECO considered a broad range of information sources to inform the forecast assumptions. We did track the news releases and did take into consideration the manufacturers timeframes to take into consideration as a check on the adoption rates assumed.	1

Appendix B. Detailed Feedback – Grid Needs Assessment & Solution Evaluation Methodology

1. DETAILED FEEDBACK

The appendix presents a detailed listing of the comments, questions, suggestions and specific edits provided by Stakeholders that informed the IGP GNA Report with the exception of the comments from Parties filed on the First Review Point Report, which were specifically identified in the body of this report.

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3 - Question/Not adopted and reason provided

Item No	Sec	Sub Section	Draft Text	Comment or Suggested Edit	Topic Category	Response, Status or Action Actually taken	Response Category
1	1	1.1	This document describes how Hawaiian Electric plans to use a combination of the RESOLVE & PLEXOS optimization models, among others, in the Integrated Grid Planning ("IGP") Process to	After reading the document, what it describes is the Grid Needs Assessment which is a combination of modeling and analysis. See the comments on Resiliency, community impacts, etc. Together the modeling (and assumptions) and the qualitative (perhaps quantitative too) non-modeling assessment make up the Grid Needs Assessment (as a product)	Edit or Format	Added item #3 and revised the paragraph "The main body…"	2
2	1	1.1.1	"Grid Needs" and "Grid Needs Assessment"	This is capitalized later in the document which means it is a defined term – I assume this is supply resource and grid services?	Edit or Format	Supply side and demand side resource that can provide grid services	2
3	1	1.1.1	General	Create an Appendix for defined terms	Edit or Format	TBD. We will do it if we have time. Currently working on it.	2
4	1	1.1.2	Develop long-term resource plans to identify potential pathways for achieving the 100 percent renewable energy goal in 2045	Is there anything we can say about how you look at short term/near-term needs , that if broadened would start to address the longer-term needs? Perhaps this is an opportunity to talk about how you look at the modeling. Just don't want it to sound like these are two separate efforts?	Edit or Format	Document was modified. Removed "long-term" from the statement.	2
5	1	1.1	Resource options may include, but are not limited to, grid-scale resources, distributed energy resources ("DER"), such as, photovoltaic, demand response, electric vehicles, and utility tariffs and utility programs, subject to available modeling inputs. .	Suggestion to rewrite this PP.	Edit or Format	Document was modified. Paragraph in question was removed. Since this section of the report is giving a high-level overview of the report, this paragraph wasn't needed.	2
6	1	1.1	subject to available modeling inputs	Not sure what this means in the context of the rest of the sentence.	Edit or Format	Document was modified. Paragraph in question was removed. Since this section of the report is giving a high-level overview of the report, this paragraph wasn't needed.	2
7	1	1.1	as the methodology used to derive the Grid Needs . AND the Footnote: Grid Needs" means the specific grid services (including but not limited to capacity, energy and ancillary services) identified in the Grid Needs Assessment, including transmission and distribution system needs that may be addressed through a Non-Wires Alternative.	Don't grid needs go beyond the NWA process?	Edit or Format	The definition of Grid Needs provided in the footnote does not say that Grid Needs is only for NWA.	1
8	1	1.1	Hawaiian Electric worked extensively with the Solution Evaluation Optimization Working Group ("SEOWG"), the Technical Advisory Panel, and the Stakeholder Council throughout 2019 and 2020 to develop the methodologies	Just looking at this from a different angle. Did HECO develop the methodologies or did SEOWG? Not sure if you want to put the emphasis on SEOWG, not HECO as a whole.	Edit or Format	HECO developed the methodologies.	1
9	1	Fig 1.1	Figure 1.1	There are ongoing stakeholder working groups, but does this diagram need specific stakeholder input points (beyond PUC/TAP/IO)? E.g. would like to see interim results (inputs to, use of, and results from modeling) from HECO for review by all stakeholders.	IGP Solution Sourcing Process	As proposed in the IGP workplan update filed on 01/19/2021, a technical stakeholder working group will be formed once the existing set of working groups has completed their deliverables. This stakeholder working group will provide a venue for continued stakeholder feedback as the IGP process is commenced this year.	1

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10	1	Fig 1.1	Figure 1.1	This diagram also needs a key. What are the different colors/shapes? Can HECO use the same terminology they are using in this document in the diagram? E.g. Grid needs identification, scenario design, grid needs modeling, etc.	Edit or Format	Document was modified. Terminology was adjusted so the document and diagram should match. The shapes and colors were arbitrary, so there is no key	2
11	1	Fig 1.1	Figure 1.1	Need more narrative and/or diagrams upfront to understand the flow of the process & how the pieces fit together. (e.g. how do distribution needs inform bulk power needs and investment, etc.).	IGP Solution Sourcing Process	Document was modified. The figure was modified to make the process clearer.	2
12	1	Fig 1.1	Figure 1.1	Do we need PUC Review Points prior to RFP issuance and after Contract Negotiations?	IGP Solution Sourcing Process	The second review point will take place after the planning analyses for the Grid Needs Assessment are completed. The commission will have an opportunity to review the projects resulting from the RFP once the PPA applications are submitted following contract negotiations.	1
13	1	1.2	System Reliability (e.g. ., Adequacy of Supply)	Is this really an example among others or is this intended to be "i.e." ?	Edit or Format	Document was modified. The example was removed	1
14	1	1.2	Consideration will also be given to the following factors in the Company's Grid Needs Assessment as part of the goals for the IGP process.	Need more detailed descriptions of how the model considers these (in the descriptions below) recognizing that these attributes do not lend themselves to quantitative metrics	Modeling Inputs	Grid Resilience will be addressed in the modified process diagram. Further details are provided in App B of the IGP workplan update filed on 01/19/2021. Stakeholder feedback on community impacts and land use can help inform and modify certain planning inputs used in the modeling. As an example, one of the keys inputs into the modeling is the resource potential for onshore resources that define the maximum capacity of each resource that can be developed on each island. As part of the modeling input development, Hawaiian Electric engaged NREL to update the resource potential study they had conducted during the 2016 PSIP. Results of the updated analysis were shared with the IGP Stakeholder Council and posted to the Company website. See https://www.hawaiianelectric.com/clean-energy-hawaii/integrated-grid-planning/stakeholder-engagement/stakeholder-council.	2
15	1	1.2	RPS: The Grid Needs Assessment will seek to achieve and accelerate the State of Hawai'i's Renewable Portfolio Standards	Has HE committed to accelerating? Was it PUC mandated? Are the targets shown in Figure 1.2 the accelerated targets?	Edit or Format	What is written should be OK. PBR (Performance Based Regulation) has a PIM to essentially incentivize accelerating the RPS achievement.	1
16	1	1.2	System Reliability: Company is accountable for Adequacy of Supply	Is this a formal term? "Resource adequacy" or "Adequate Level of Reliability (ALR)" is more common in the industry, and implies that demand can be met with non-supply resources as well.	Edit or Format	Adequacy of Supply refers to a report that is filed with the PUC annually in accordance with paragraph 5.3.a of General Order No. 7 and describes whether generation capacity from utility plants and other sources is sufficiently large to meet reasonable expectations of service. See https://puc.hawaii.gov/reports/energy-reports/adequacy-of-supply/	1

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17	1	1.2	The resource plan will provide insight into resource procurement and system investment decisions needed to achieve the 100 percent renewable energy goal and inform new programs and procurements over the short-term as well as long-term horizon (20 -30 years).	Not sure if this is true, but suggest trying to address that the modeling covers the entire planning range.	Edit or Format	Document was modified. What was written looks OK.	2
18	1	1.2	Grid Resilience:	HECO is encouraged to include quantitative means to determine resilience impacts or include detailed explanation of any considerations made for resilience.	Modeling Inputs	Appendix B in the IGP workplan update filed on 1/19/21 has additional details on how resilience will be considered in the IGP process.	1
19	1	1.2.5	Grid Resilience:	May want to provide a little detail about how resilience is factored into the modeling and/or Needs analysis. If it is NOT a part of the model, then suggest you be clear about how it is addressed in the overall Needs assessment. Since this section is titled "Modeling Objectives" it would be cleaner to attribute topics here as they pertain to treatment in the model. If there are other things (like resilience) that are considered in the Grid Needs assessment, but OUTSIDE the model you might want to separate that out to keep things clear.	Edit or Format	Document modified	2
20	1	1.2	Grid Resilience: There are several ways of looking at grid resilience, the first being hardening of existing grid infrastructure (e.g., upgrades to utility poles, transmission and distribution line monitoring, transformers, etc.)	This is just a wording concern, but Isn't this just one way to achieve resilience, which seems to be defined in the second part of the sentence (e.g. rather than the two items listed being two different ways of looking at resilience)? As noted, The Resilience Working Group Report for IGP, issued 4/29/2020 includes detailed discussion and recommendations. Specific recommendations for the IGP process are provided in section 7.1 of that document. HECO should explain, in some detail, how the WG's specific recommendations will be of used to advise and adjust the "optimum" plan emerging from the RESOLVE, PLEXOS and other analyses.	Stakeholder Feedback	Updated document and addressed in the Stakeholder Engagement Summary report	2
21	1	1.2	Grid Resilience: Notably, this includes consideration of resilience enhancing microgrids to provide local, emergency power generation	Is this intended to point at the recent HECO Microgrid tariff and what it might provide for those that seek greater resiliency?	Edit or Format	Document was modified with additional edits to be clearer.	2
22	1	1.2	Grid Resilience: As outlined in the Resilience Working Group Report for Integrated Grid Planning , comments from first responders, other infrastructure owners, and other RWG participants will be used to inform transmission and distribution planning needs, priorities for resilience improvement, and options to achieve them .	What is "them."	Edit or Format	Document was modified	1
23	1	1.2	Grid Resilience: As outlined in the Resilience Working Group Report for Integrated Grid Planning , comments from first responders, other infrastructure owners, and other RWG participants will be used to inform transmission and distribution planning needs, priorities for resilience improvement, and options to achieve those identified planning needs and priorities them.	Revised language to address comment	Edit or Format	Modification made to address comment	2

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24	1	1.2	Community and Land Use	Same issue as resiliency - Evaluation overlay?	Edit or Format	Document was modified. Stakeholder Council feedback on community impacts and land use can help inform and modify certain planning inputs used in the modeling. As an example, one of the keys inputs into the modeling is the resource potential for onshore resources that define the maximum capacity of each resource that can be developed on each island. As part of the modeling input development, Hawaiian Electric engaged NREL to update the resource potential study they had conducted during the 2016 PSIP. Results of the updated analysis were shared with the IGP Stakeholder Council and posted to the Company website.	2
25	2	2	The following discussion summarizes the combined learnings from leading states and experts, and feedback from stakeholder discussions in the several SEOWG meetings held in 2019 and 2020.	This whole section appears to be brief. Would it be worth an appendix giving more detail on the survey findings & the WGs?	Stakeholder Feedback	A document is being developed to highlight the feedback received in the Working Groups.	1
26	2	2.1	Hawaiian Electric met with other utilities from the U.S. and Australia. At these meetings the other utilities discussed what did and did not work for them during their solution evaluation approaches .	Just solution evaluation or also needs assessment?	Edit or Format	Document was modified. It should be both.	2
27	2	2.1	Based on their experience they have all generally said that they improved their Request for Proposal ("RFP") process by providing more technical detail about what is asked of them. They also instilled the importance of complete and accurate proposals such that the proposals were more easily understood resulting in a faster evaluation.	Based on their experience they have all generally said that they improved the outcome of their competitive solicitation process by providing more operational and technical detail about what specific need was being addressed while still staying technology neutral as to the solution. More specific and clear requirements presented in the Request for Proposal ("RFP") process tended to result in more thorough and consistent responses from bidders. Bidders appreciated the additional detail, because it allowed them to make better decisions about solicitations to pursue where they felt their proposal could be most competitive. They also instilled the importance of preparing structured bid response forms as well as including pro-forma contracts that allowed bidders to prepare accurate and complete proposals that in turn were more easily understood resulting in a faster evaluation.	Edit or Format	Document was modified.	2
28	2	2.2	Stakeholder Feedback: Grid Needs	Grid needs defined as supply and services?	Edit or Format	Document appears to be correct. No change needed.	3
29	2	2.2	Stakeholder Feedback: During this process, stakeholders asked the Company to clarify multiple parts of the proposed process. The main changes include:	During this process, stakeholders asked the Company to clarify and capture in this methodology document suggestions and modifications to the initially proposed needs assessment and solution evaluation methodology and process.. The following is a high level summary of changes and modifications adopted:	Edit or Format	Document was modified	2

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30	3	3.1	An overview of the process flow is shown in Figure 3.1. Forecast Assumptions serve as the input assumptions into the Transmission and Distribution Needs assessment, which then inform the Grid Needs (Capacity, Energy & Ancillary Services) identification.	Figure hasn't changed. New section 3.2.4.1 (below) recognizes that some iteration back from system security may be necessary. Suggest figure and possibly language be modified to reflect that. Again- could this show stakeholder input/review points for iteration on results?	Edit or Format	The figure was modified to explicitly show the iteration that can occur after the system security step is completed. Stakeholder input was received on the inputs and assumptions that precede the grid needs analyses. Stakeholders will have an opportunity to review the planning results in the grid needs assessment.	2
31	3	3.1	Two models used to identify and verify the system needs are the RESOLVE model and the PLEXOS model. RESOLVE produces a proposed optimized resource plan of Grid Needs that is confirmed in PLEXOS as an hourly production simulation to capture the total system costs.	Is the model producing a resource plan or a grid needs assessment? Those seem like different things. This sentence suggests that confirmation is only PLEXOS. PLEXOS alone may not be sufficient. How will System Security analysis be used to refine the plan?	Edit or Format	Document was modified. RESOLVE will produce a resource plan that will meet the various Grid Needs. This plan will be run through PLEXOS and other models to ensure system reliability and calculate the system cost.	2
32	3	3.1	Two models used to identify and verify the system needs are the RESOLVE model and the PLEXOS model. RESOLVE produces a proposed optimized resource plan of Grid Needs that is confirmed in PLEXOS as an hourly production simulation to capture the total system costs.	This should be expanded to talk more about the Resolve Sensitivities and how that is fed into Plexos and WHY the sensitivities were developed. May cover in more detail later but need to at least introduce it here.	Edit or Format	Document was modified. The sensitivities will be used to stress test the proposed plan. Introduced the sensitivities here but further information on the sensitivities will be provided in Appendix E.	2
33	3	3.1	RFP are evaluated through another round of RESOLVE and PLEXOS modeling to create the optimal portfolio of solutions that the utility should procure, while maintaining system reliability at a reasonable cost. In addition, the modeling considers other IGP objectives described in Section 1.2.	How?	GNA Modeling Process	Document was modified: Section 1.2 was updated to highlight how the various objectives will be analyzed and how the non-quantitative fields are considered.	2
34	3	3.1	RFP are evaluated through another round of RESOLVE and PLEXOS modeling to create the optimal portfolio of solutions that the utility should procure, while maintaining system reliability at a reasonable cost. In addition, the modeling considers other IGP objectives described in Section 1.2.	May want to expand a little bit and describe . You take the results of the bids (cost and attributes) and put that back through the model to see what the best combination of solutions is? So that reflects ONLY the resource costs/attributes that you went out to bid for. How to you adjust the longer term elements of the model if only short-term resources were solicited? Does the long-term change?	Edit or Format	Document was modified to make clear that we take the bids and put them into the models to determine the portfolio of projects that best meets the objectives.	2
35	3	3.2.1	Forecast Assumptions: The forecasts and assumptions will be provided as part of Review Point 1	Put in footnote or something to clarify what this is and what it is a part of	Edit or Format	Document was modified. Footnote was added saying that the Review Point is a formal submittal to the PUC for review.	2
36	3	3.2.1.1	Forecast Assumptions: Fuel Price Forecasts: Fuel price forecasts will be vetted through the FAWG and SEOWG . These are based on a historical Brent correlation and Brent forecast provided by Facts Global Energy ("FGE"). FGE is an independent consultant that provides analysis on the oil & gas industry.	Do you want to use the term "FAWG" and "SEOWG" here? Asking as I'm assuming these WGs will only be around for the first year/cycle. Also, that could mean that non-HECO participants could have a say	Edit or Format	Document was modified. The results are presented and discussed with the FAWG and SEOWG.	2
37	3	3.2.1.2	Forecast Assumptions: Retail Sales Forecasts: Retails sales forecasts will be vetted through the FAWG. The FAWG will produce a deliverable that will have more details regarding the sales forecast.	Do you want to use the term "FAWG" and "SEOWG" here? Asking as I'm assuming these WGs will only be around for the first year/cycle. Also, that could mean that non-HECO participants could have a say	Edit or Format	Document was modified. The results are presented and discussed with the FAWG and SEOWG.	2
38	3	3.2.1.3	Forecast Assumptions/DER Adoption Forecast: Based on stakeholder feedback, the Company clarified that incremental DER would be available as a resource option in the model to be economically selected. We proposed that the cost of DERs available for selection could be based on a combination of residential PV and residential battery energy storage to approximate the cost of a DER Aggregator..	Agree the model should be able to select, though there are numerous customer drivers that lower the cost of these resources and should be modeled as such. DER's are betting our conventional and IFM resources with some capacity markets in the mainland, which would not be possible if this assumption was reasonable	GNA Modeling Process	The capabilities of DER to provide certain grid services has been discussed through the SEOWG and TAP. However, if available, the Company would like further information from stakeholders on the costs of a DER aggregator.	1

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39	3	3.2.1.3	We proposed that the cost of DERs available for selection could be based on a combination of residential PV and residential battery energy storage to approximate the cost of a DER Aggregator..	Could use a definition for DER Aggregator	Edit or Format	Document was modified. Footnote was added to define a DER aggregator (work in progress definition) A DER aggregator is a third party that consolidates the function and capability of multiple DER systems	2
40	3	3.2.1.3	We proposed that the cost of DERs available for selection could be based on a combination of residential PV and residential battery energy storage to approximate the cost of a DER Aggregator..	Where will these costs come from? Can we point at a process, or stakeholder input? Would like more detail on how these sensitivities are used w/in the process flow. Can you/should you describe HOW the sensitivities are being applied or is that better done in 3.3?	GNA Modeling Process	These cost are provided in the Inputs and Assumptions document under the Resource Cost.	1
41	3	3.2.1.3	The SEOWG and FAWG worked to identify sensitivities for the forecast assumptions with further input from stakeholders. See Section 3.3 for discussion of sensitivities that have been proposed by stakeholders.	Would like more detail on how these sensitivities are used w/in the process flow.	GNA Modeling Process	The sensitivities are discussed in Section 3.3.	1
42	3	3.2.1.3	The SEOWG and FAWG worked to identify sensitivities for the forecast assumptions with further input from stakeholders. See Section 3.3 for discussion of sensitivities that have been proposed by stakeholders.	Can you/should you describe HOW the sensitivities are being applied or is that better done in 3.3?	GNA Modeling Process	Document was modified by addition of more details to 3.6	2
43	3	3.2.1.3	Resource cost assumption from public data sources	Was there stakeholder feedback on these costs	Stakeholder Feedback	Will be addressed separately in the Input and Assumptions document	1
44	3	3.2.2	Planned Resource Builds & Retirements	It's really not clear how you intent to retire and are planning for capacity needs. This is really important given the limited contribution for load build/curtail services that are envisioned to provide.	Resource Characteristics	Retirement assumptions are still being developed internally. Initially we had wanted to see what retirements RESOLVE would choose as part of the optimization but will now look at sensitivities to look into different retirement plans. The Companies' previously stated that this was under development and would be part of the next update to the inputs and assumptions. The Companies have done further analysis and run various retirement scenarios (i.e., by age, unit flexibility, retiring Waiau Power Plant, etc.). The NPV of those plans are within the margin of error of one another and does not significantly change the cost of those various scenarios. Therefore, the Company will propose a unit retirement plan to be used in the base case based on age in the next update of the I&A document.	2
45	3	3.2.3	Resource Operating Characteristics: • Operating characteristics (e.g., minimum/maximum capacity, variable operations and maintenance (O&M) cost, fixed O&M cost, heat rate, ramp rate)	Is this all the operating characteristics or is this an exemplary list?	Resource Characteristics	The characteristics used in our modeling are more fully detailed in the inputs assumptions workbook that is currently being developed.	1
46	3	3.2.3	Resource Operating Characteristics: • Assumptions on ability to provide different services (duration)	What are the temporal windows for these? Hourly?	Resource Characteristics	Primarily hourly in that the modeling where these characteristics will be used is hourly.	1

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47	3	3.2.3	Resource Operating Characteristics: • Location of resources (transmission/distribution constraints	What does this mean here- is HECO characterizing a resource's ability to reduce T&D constraints?	Resource Characteristics	Document was modified. Location of resources refers to transmission/distribution constraints such as interconnection limits, as well as, additional transmission/distribution costs to interconnect additional resources. The intent is to consider limits such as export limits at the point of interconnection due to the location of a project.	2
48	3	3.2.4	Transmission Needs	HECO should acknowledge in this section that the PLEXOS and System Security work may illuminate new transmission needs. How did HECO identify these needs? Are there other services identified that aren't needed? Can HECO document assumptions?	Transmission Needs	HECO acknowledges that PLEXOS and System security work may illuminate new transmission needs. Edits were made to describe the feedback loop with System Security. See Section 3.1 The transmission services identified are ones that we are currently looking at to meet the transmission planning criteria. There could be other services identified in the future. The assumptions used as apart of the system security study will be identified once a resource plan is decided on to run system security, so this will come later in the process. However the Transmission Planning criteria (Transmission Planning Assessment section) does identify planning events that we will model and plan for. The Inputs and Assumptions workbook also has assumptions for identifying minimum inertia and FFR requirements at a high level in the RESOLVE and PLEXOS model.	2
49	3	3.2.4	Transmission Needs: the output of the transmission needs analysis will serve as inputs to the RESOLVE model.	How does this interplay with distribution needs?	Transmission Needs	Document was modified. Figure 3.1 shows that transmission needs and distribution needs feed into the RESOLVE modeling to determine the Grid Needs.	2
50	3	3.2.4	Transmission Needs: renewable energy zone concept	An appendix on this survey would be very helpful. Want to know more about this.	Transmission Needs	Document was modified. Footnote was added to point to the document from NREL titled "Renewable Energy Zone (REZ) Transmission Planning Process: A Guidebook for Practitioners"	2
51	3	3.2.4	Transmission Needs: Fig 3.2: 2) Identify the injection capacity available at each transmission substation to prioritize favorable locations for renewable energy injections into the system.	Seems like there would be a lot of other factors that go into a site being favorable for RE injection capacity. Are those considered in this process (e.g., land availability, community engagement)?	Transmission Needs	The other factors that may make a region favorable for RE injection capacity are being considered when determining the resource potential. As discussed in Section 1.2, the resource potential developed by NREL was shared with the Stakeholder Council for feedback. The amount of land available for development will be constrained based on the NREL study and feedback from stakeholders.	1

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52	3	3.2.4	Transmission Needs: 6) High-level evaluation of grid stability services .	Where do these come from? Can we link to/cite something? HECO must provide clearer explanation of their grid services requirements. In addition, it is essential that the analysis provide sufficient depth of results to identify degree and causality of limitations.	Transmission Needs	Document modified. Made a change to the document that the high level evaluation is for inertia and FFR using algebraic formulas in RESOLVE and PLEXOS. The assumptions used here are available in the Inputs Assumptions workbook. A more detailed analysis will be completed during the System Security Study. The intent to use a proxy for inertia and FFR in RESOLVE/PLEXOS is to limit the number of iterations by identifying those needs as part of the initial resource planning models.	2
53	3	3.2.4	Transmission Needs: Short circuit current and voltage support will not be incorporated into RESOLVE, but rather assessed as part of the system security assessment described in Section 3.2.4.1, along with a validation of the inertial and frequency response requirements identified in the RESOLVE modeling	Analysis or Study a better word? Probably best to go with one of these words and use that word throughout? Based on how it is used in Section 3.2.4.1.	Edit or Format	Document was modified. Term used is System Security Analysis.	2
54	3	3.2.4.1	System Security: • Evaluation of weak grid issues and development of a "weak grid" definition for each of the island grids	Could this be defined generally here? May have been defined elsewhere, maybe later, in this document.	Transmission Needs	As stated in the document, we acknowledge the need to develop a "weak grid" definition for each island grid.	1
55	3	3.2.4.1	It is important to note that currently there is no universally accepted definition of grid forming technology	May be worth a few sentences describing what "grid forming" is all about and why it is important. This jumps right into issues with inverters and lack of synchronous inertia. A more generic context setting might be helpful to readers.	Edit or Format	Document was modified. Term added to Glossary	2
56	3	3.2.4.1	If significant system security deficiencies exist on the selected PLEXOS long term resource portfolio, then there may need to be an additional iteration between the system security and RESOLVE and PLEXOS modeling.	What is significant? Do the standards mentioned earlier detail this?	Edit or Format	Any violations of the transmission planning criteria provided in Appendix E will need to be resolved. There's somewhat of an engineering judgement call whether certain violations warrant another iteration with PLEXOS/RESOLVE or whether those issues can be resolved at a later time. Regardless, all violations of criteria need to eventually resolved.	1
57	3	3.2.5	Distribution Needs: Refer to DPWG deliverables, NWA Opportunity Evaluation and Distribution Planning Methodology	Provide a link	Edit or Format	Document was modified. Footnote was added to provide a link to the DPWG website.	2
58	3	3.2.6	Grid Needs: Inclusive of the inputs and analyses described above, the following Grid Services have been identified as defining the Grid Needs RFP	Is this correct?	Edit or Format	Document was modified. It should be Grid Needs, not Grid Needs RFP.	2
59	3	3.2.6	The definitions are provided in Table 3.3 and the types of properties needed to characterize each service are shown in Table 3.4, Table 3.5, and Table 3.6.	If there is no real narrative around the information presented in these tables, suggest placing in Appendix	Edit or Format	Document was modified. Stated that the columns represent where in the process each service is analyzed.	2
60	3	3.2.6	Table 3.3 - Grid Service Definitions	Do we need more detailed definitions here? Additional temporal details?	Edit or Format	The information presented in the Table was presented to the Working Groups and there was no explicit feedback requesting the information to be modified.	1
61	3	3.2.6	Table 3.3: "Represented in PSSE/PSCAD/ASPEN	Could we have more narrative of how these two columns work together to consider all of the grid services?	Edit or Format	Document was modified. Stated that the columns represent where in the process each service is analyzed.	2
62	3	3.2.6	Table 3.3: Load Reduce	Can a generator provide load reduce	Grid Services	Yes, a generator can provide load reduce.	1
63	3	3.2.6	Table 3.3: Load Reduce	Maybe related, but should we explicitly also say aggregators can provide?	Grid Services	Accounted for as part of generators and storage.	1
64	3	3.2.6	Table 3.4: Capacity, Energy, Ancillary Services Grid Service Properties for Modeling	Hard to follow the table. May be worth some narrative and an explanation of the colors The color coding in these two tables is not clear to me	Edit or Format	Document was modified. Colors didn't represent anything and were removed.	2

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65	3	3.2.6	Table 3.4: Property	Will the basis for the different properties be explained in the appendices? Should the table be specific for some properties, such as duration, delivery timeframe, etc.? Ex: for capacity services, how many hours duration is required? Why? Ex: for FFR1, why is availability specified as 12 cycles or less?	Grid Services	The table of properties provided are representative of the kinds of information we will need to define Grid Needs. The planning analysis will determine the specific properties.	1
66	3	3.2.6	Table 3.4: Number of Service calls/Load Build	Based on what and does this not limit how these resources work in concert with RR on a daily basis?	Grid Services	In order for Load Build and Load Reduce to provide Regulating Reserve, they need to respond to frequent dispatch signals	1
67	3	3.2.6	Table 3.4: Regulating Reserve Type/Reg Res Svc: 1-minute or 20-30 minutes	How did we end up combining the two types of regulation reserve into the one reserve slot in RESOLVE	Grid Services	Only the longer timeframe regulation was incorporated. RESOLVE was not able to directly accommodate the 1-minute reserve. It will be used in PLEXOS.	1
68	3	3.2.6	Table 3.4: Ramping Capability	How does load reduce and build compliment or work with RR needs	Grid Services	In order for Load Build and Load Reduce to provide Regulating Reserve, they need to respond to frequent dispatch signals	1
69	3	3.2.6	Table 3.4: Service Source/Market Service	Is this a planning criterion or a market service? If market service, how will it be procured?	Grid Services	This is a market service. It will be procured through an RFP and/or a program.	1
70	3	3.2.6	Table 3.4: Service Source/Market Service	Program too?	Grid Services	Yes, market service refers to an RFP and/or program	1
71	3	3.2.6	Table 3.4: Resource Type/Voltage Support	Generators serving their load with additional export capacity could provide this service.	Grid Services	Document was modified. Variable generator was added to the list.	2
72	3	3.2.6	Table 3.4: Service Source/Market Service	And programs?	Grid Services	Yes, market service refers to an RFP and/or program	1
73	3	3.2.6	Table 3.5: Resource Type/FFR Service/Storage Load Under Control	Generators serving their load with additional export capacity could provide this service.	Grid Services	Document was revised to add variable generator.	2
74	3	3.2.6	Table 3.5: Service Source/Market Service	And programs?	Grid Services	Yes, market service refers to an RFP and/or program	1
75	3	3.2.6	Table 3.6: Service Source/Market Service	And programs?	Grid Services	Yes, market service refers to an RFP and/or program	1
76	3	3.2.6.1	Grid Service Capability by Technology: Based on feedback from the TAP	And stakeholders	Grid Services	Document was modified. "Stakeholders" was added.	2
77	3	3.2.6.1	Grid Service Capability by Technology: A representative technology from each of these resource categories will be input into RESOLVE based on cost to allow the portfolio selection to solve in a timely manner	This sentence seems a bit off (or could be just me). What is the portfolio section trying to solve? Based on cost or costs?	Grid Services	The least-cost representative technology from each of these resource categories will be input into RESOLVE to allow the portfolio selection to solve in a timely manner.	1
78	3	3.2.6.1	Table 3.7: Grid Service Capability by Technology	Can we document assumptions and/or references here	Grid Services	The table was developed with stakeholder feedback provided in the SEOWG and TAP.	1
79	3	3.2.6.1	Table 3.7: Grid Service Capability by Technology: Load Control	EE is not considered here, but if EE is a possible NWA resource option, should probably be included?	Grid Services	Revised the table to add Energy Efficiency.	2
80	3	3.2.6.1	Table 3.7: Grid Service Capability by Technology: Legend Format	Maybe separate the legend from the table?	Edit or Format	Document was modified. Legend was separated.	2
81	3	3.3	Scenario Design for Grid Service Needs Identification: The inputs and grid service definitions described below will be used to develop scenarios and sensitivities to capture a reasonable the range of potential futures relevant for the Company's planning.	Is this the right word? Outcomes?	Edit or Format	Document was modified. Both were OK, but updated with outcomes.	2
82	3	3.3	Scenario Design for Grid Service Needs Identification: The inputs and grid service definitions described below will be used to develop scenarios and sensitivities to capture a reasonable range of potential outcomes relevant for the Company's planning.	May be worth some description of how you determine which sensitivities to explore (there are many)	Grid Services Scenario Analysis	Document was modified to provide additional clarity	2

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83	3	3.3	Scenario Design for Grid Service Needs Identification: To date, stakeholders have proposed numerous sensitivities on topics such as:	Have you selected which ones? Doing all these? Others?	Grid Services Scenario Analysis	Document was modified. EV charging behavior was removed since that will be considered in the EV docket.	2
84	3	3.3	Scenario Design for Grid Service Needs Identification: • DER uptake up to and exceeding the market forecast • Higher levels of energy efficiency • Removal of the State ITC for PV • Limiting onshore grid-scale resource development • Extended periods of low renewable generation • Electric vehicle charging behaviors	Recommend additional sensitives are planned with DER market track and will fold into this process depending on outcomes.	Grid Services Scenario Analysis	What comes out of the DER market track will be folded into the IGP.	1
85	3	3.4	Grid Needs Assessment Modeling Process	The amount of grid services that are actually represented in RESOLVE and PLEXOS, per table 3.3, should be come out of this work. However, the other dynamic services not represented in RESOLVE and PLEXOS show up downstream in the system security. There needs to be explicit recognition that there may be need to challenge, iterate and refine the mix of these dynamic services in that work. These efforts will further advise the efforts of 3.5, avoided cost of service. But only partly. That work (page 24, 25) only addresses the timing (i.e. from PLEXOS) of the need, not the intricacies of the function. How will HECO use the system security step to confirm the adequacy of those grid needs?	GNA Modeling Process	As shown in Figure 3.1, the System Security analysis will be performed after PLEXOS. If there is any shortfall, the plan will be adjusted and rerun through PLEXOS to address it.	1
86	3	3.4	Grid Needs Assessment Modeling Process : Within this process, the Company expects large resource and grid service procurements to occur once per cycle, while utility programs and Transmission and Distribution ("T&D") NWAs will be evaluated on an annual basis to address rapidly evolving local needs.	Not reflected in the latter 12 months in Figure 1.1 ("Updated IGP Solution Evaluation & Sourcing Process Diagram").	GNA Modeling Process	The Transmission and Distribution NWAs are not shown in the figure but will be reflected as part of the resource needs process step.	1
87	3	3.4	Grid Needs Assessment Modeling Process : Based on guidance provided by the Commission , Hawaiian Electric will expand the role of the Technical Advisory Panel ("TAP") to provide independent evaluation of the Grid Service Needs Identification.	Is this just for the first cycle? If so, what happens after? Do we want third parties involved? I think no but not sure what was agreed to. Or is this what is stated in the next cycle? Not that clear.	GNA Modeling Process	There will continue to be some technical review going forward by some entity, TAP or otherwise	1
88	3	3.4	Grid Needs Assessment Modeling Process: Preferred Procurement Scenario: Should there be any shortfalls in any of the grid services on an hourly basis that were not met by RESOLVE's reference portfolio, Hawaiian Electric may determine that adjustments need to be made to the RESOLVE constraints and rerun or that adjustments can be made manually to the reference portfolio without requiring additional modeling.	Needs to be reworded. ..., Hawaiian Electric may determine that a rerun is needed by making adjustments to the RESOLVE constraints or... Is a rerun also required here? Can't tell. "Rerun" is used before but possibly "modeling" is used here. Not sure on the terminology use.	Edit or Format	Changes were made in the document	2
89	3	3.4	Grid Needs Assessment Modeling Process: Preferred Procurement Scenario: The comparison of the various resource portfolios and the determination of Hawaiian Electric's Preferred Procurement Scenario will be shared with stakeholders at the second PUC Review Point shown on Figure 1.1. During this review point, the TAP and the Commission may ask Hawaiian Electric to perform feasibility checks on additional scenarios if the additional analysis is deemed prudent to make a final determination during Commission review.	Okay but why not stakeholders?	Stakeholder Feedback	Stakeholders are asked to provide review throughout the process through the various Working Group meetings.	1

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90	3	3.5.1	Avoided Cost of Service: Given that the Final Procurement Portfolio represents Hawaiian Electric's best estimate at a least cost portfolio that meets all these Grid Services, this portfolio will set a baseline for the expected quantity, timing, and avoided cost for each of the Grid Services. See Table 3.4 for more details.	Are these marginal? Correct the Table reference to 3.8	Edit or Format	These are marginal. The cross-reference was fixed.	2
91	3	3.5.1	Table 3.8: Energy Reserve Margin (ERM)	Should the quantity units and avoided cost units match? I.e., MW, $/MW-year or MWh, $/MWh Does this value tell you the "cost" of providing the ERM? Or the value of ERM to the system? Or something else?	Avoided Cost of Service	ERM quantity is MW by hour. The avoided cost for ERM is informed by the cost of the resource needed to meet the ERM shortfall, derated by its hourly dependable capacity. ERM needs will be met with the least cost resource unless a higher cost resource with greater availability is needed.	1
92	3	3.5.1.1	Quantity: Forecasted load and load shape determines determine the amount of energy that needs to be generated on an hourly basis to meet that load.	And capacity	Avoided Cost of Service	Document was modified. "Capacity" was added.	2
93	3	3.5.1.1	Quantity: For some Grid Services, such as Regulating Reserve, the requirement will be modeled on an hourly basis and is dependent on the installed capacity of variable energy resources.	Do we have formulas for all grid services?	Avoided Cost of Service	The requirements for the grid services will be provided in the input workbook.	1
94	3	3.5.1.1	Quantity: RESOLVE takes this and similar dependencies into consideration when calculating the least-cost resource portfolio.	What is "this"?	Avoided Cost of Service	Document was modified to make clearer.	2
95	3	3.5.1.2	Timing: The timing of Grid Needs is captured in RESOLVE and PLEXOS through these modeling constraints.	Are there important differences in Resolve or Plexos that affect how the timing of Grid Needs gets determined?	Avoided Cost of Service	RESOLVE uses a beginning of year, January 1 date for resource in service or retirement dates. PLEXOS can model more granular dates which may shift the timing of some grid needs. Additionally, PLEXOS will model the full 8760 so the timing of grid needs can be more detailed.	1
96	3	3.5.1.3	Avoided Cost:	This section and the graphics are not really clear to me. I think I know where it is trying to go, but not sure the examples are really helping. Found it hard to follow and confusing as to what the main points are.	Avoided Cost of Service	Document was modified to make clearer.	2
97	3	3.5.1.3	Avoided Cost: Shadow prices are a fundamental output of constrained optimization problems like those used in RESOLVE and PLEXOS	Could just be my lack of knowledge, but this seems off. Do RESOLVE and PLEXOS use this/these things?	Avoided Cost of Service	The document is correct as written.	1
98	3	3.5.1.3	Avoided Cost: This approach to calculating and using avoided costs is similar to the one proposed by the California Public Utilities Commission (CPUC) Integrated Distributed Energy Resources (IDER) proceeding, as shown in Figure 3.5.2	What are the differences?	Avoided Cost of Service	While the CPUC IRP needs analysis informs the subsequent planning effort by each Load Serving Entity ("LSE") in California, the procurement evaluations do not use RESOLVE. Rather, proprietary bid and portfolio evaluation models are used that may or may not have the same assumptions as the statewide RESOLVE cases. See Hawaiian Electric's Response to June 25, 2020 Commission Questions and June 15, 2020 Letter from DER Parties filed on July 2, 2020 in Docket No. 2019-0323	1
99	3	3.5.1.3	Avoided Cost: Figure 3.5.2	Figure reference is wrong	Edit or Format	Document was modified. Cross-reference was fixed.	2
100	3	3.5.1.3	Avoided Cost: In California, the Integrated Resource Planning (IRP) proceeding produces a Reference System Portfolio	Again, could just be me. But a "proceeding" produces a Reference System Portfolio?	Edit or Format	Document was modified. "Process" was used.	2

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101	3	3.5.2	Other Modeling Inputs: In addition to the Grid Services identified above, the modeling can provide additional information:	1 and 3 does not appear to be information, but rather commentary/options. Whereas 2 appears to be information.	Edit or Format	The document should be OK as written.	1
102	4	4.1	The Solution Evaluation phase comes after the Grid Needs Identification phase and after resource options have been returned via the Grid Needs RFP, NWA RFPs, and development/deployment/uptake of utility programs	I ask this because the solicitation process is controlled by HE and program adoption (or adoption assumptions) take place over a number of years	Solution Evaluation Method	The document should be OK as written.	1
103	4	4.2	Solution Evaluation Modeling Process: As with the Grid Needs Assessment phase, Hawaiian Electric acknowledges stakeholder feedback and will engage an Independent Observer to oversee the resource option ranking and portfolio development process.	What is this? Are we acknowledging that stakeholders provided feedback on the proposed methodology or that stakeholders suggested and HE agreed to adopt an IO for the evaluation? Not clear to me.	Solution Evaluation Method	As with the Grid Needs Assessment phase, Hawaiian Electric acknowledges stakeholder feedback to have independent oversight of the IGP process and will engage an Independent Observer to oversee the Grid Needs RFP process similar to how the TAP provides oversight of the Grid Needs Assessment process.	1
104	4	4.2	Solution Evaluation Modeling Process: As in the Grid Needs Assessment phase described above, the Company will then rank the potential resource portfolios based on the Modeling Objectives described in Section 1.2. The goal of this ranking and selection process is to select least-regrets options for the final portfolio, which we will be called the Action Plan.	Better define what you mean by "least regrets". Lowest cost/best fit, most diverse; best risk adjusted chance of success, etc.....	Solution Evaluation Method	Document was modified to address the question	2
105	4	4.2	Solution Evaluation Modeling Process: We propose two Solution Evaluation processes to identify the Action Plan:	How does this approach compare to current RFP evaluation process? Do we need additional documentation about the plan here?	Solution Evaluation Method	Current RFP evaluation process is closed so can not provide details AND the evaluation criteria will be specific for each RFP.	1
106	4	4.2	Solution Evaluation Modeling Process: We propose two Solution Evaluation processes to identify the Action Plan:	I read this as a step one and step two type thing. But I think it is one or the other. If one or the other, how is it decided which to use? Also, I think this is getting at identifying (finalizing) the Action Plan. However, #1 says it "aims" to screen out resources. If it only "aims", does it do the job? And #2 says it "evaluates" the effects. If only "evaluates", does it do the job?	Edit or Format	Document was modified. Initially, these were separate processes that we were considering to use to develop the Action Plan. Currently, we are thinking of doing both.	2
107	4	4.2	Solution Evaluation Modeling Process: 1. The first approach aims to screen out resource options to ensure that Hawaiian Electric is making efficient use of the 5-month evaluation window.	Suggested Rewording: The first approach will use an avoided cost-based screening process to evaluate resource options, which has the advantage of less time consuming than extensive modeling analysis .	Edit or Format	Document was modified to address the question	2
108	4	4.2	Solution Evaluation Modeling Process: Once applications for resources from the Action Plan have been submitted for approval, they will become input assumptions into the next IGP cycle.	Are these applications mentioned in Section 4?	Edit or Format	Document was modified. Also included programs established.	2
109	4	4.2.1	Avoided Cost Screening Approach:	This is still all hourly, which is mostly satisfactory. But there's a likely need for at least some sub hourly analysis, to mitigate risk of unnecessarily expensive results. Is this included here?	Sol Eval Meth - Avoided Cost Screen	The Grid Needs Assessment will include some subhourly modeling through the way certain requirements are defined like the regulating reserve and through the iteration between System Security and the PLEXOS modeling.	1
110	4	4.2.1	Avoided Cost Screening Approach: A tradeoff of this quick approach is that we will not be able to capture the interactive effects of multiple resources in a portfolio	Is this important to do? What are the implications of "not capturing" these effects?	Sol Eval Meth - Avoided Cost Screen	This is the primary reason why we are now considering doing both the Avoided Cost Screening Approach and the Optimal Portfolio approach.	1

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111	4	4.2.2	Optimal Portfolio Approach: Hawaiian Electric also proposes also to rerun RESOLVE to select optimal portfolios of resource options based on the cost and operating characteristics, using the same Modeling Objectives described earlier in this document (primarily least-cost).	In addition to the screening approach?> I thought these were two different approaches being proposed? Are they sequential or complimentary	Edit or Format	Document was modified. Clarification was made that initially we had proposed a couple different processes that could be used to determine the Action Plan, but currently, we are considering both approaches.	2
112	4	4.2.2	Optimal Portfolio Approach: This approach will use the models and inputs already set up for the Grid Needs Assessment process but will replace the generic resources used in the Grid Needs Assessment process with specific resource cost and performance characteristics.	Should this be done in Plexos as well, or instead?	Edit or Format	Document was modified. Added clarification that the portfolio developed in RESOLVE would then be run through PLEXOS. PLEXOS will be used here as well, similar to the Grid Needs Assessment, to validate the portfolio.	2
113	4	4.2.2	Optimal Portfolio Approach: Due to computational limitations, it may not be feasible to include all the resource options received in the solicitation process to be evaluated together in RESOLVE and PLEXOS.	Ok. Based on this, it sounds like you are proposing a 2-step process to rank viable proposals, select most viable from the screening and then use model runs to evaluate portfolio cost? This needs to be clearer AND provide some explanation as to why this approach makes sense.	Edit or Format	Document was modified. Clarification was made that initially we had proposed a couple different processes that could be used to determine the Action Plan, but currently, we are considering both approaches.	2
114	4	4.2.2	Optimal Portfolio Approach: In this situation, we propose to use the screening analysis described in Section 4.2.1 to help reduce the number of resource options being analyzed together based on the resource options that the screening analysis determined to provide highest benefit/cost to the system.	Makes sense to focus attention on most promising resources, but also don't want to exclude things from the analysis if they can help improve cost/performance. How much visibility do we have into this process?	Sol Eval Meth - Avoided Cost Screen	The analysis and portfolio development will be overseen by the Independent Observer.	1
115	A	A.2	Modeling Inputs: Ancillary Service Capability/Reg reserve and frequency response	Is the Plexos capability limited for grid services? Do not match grid services	Model Mechanics	PLEXOS can model the other grid services through constraints.	1
116	A	A.2	Modeling Inputs: Operation Inputs	How is weather modeled? Does the "weather" change each year? Plexos not able to model a curtailable DER?	Model Mechanics	Document was modified. PLEXOS is able to model curtailable DER. Weather is not explicitly modeled in RESOLVE or PLEXOS.	2
117	A	A.2	Modeling Inputs: Under DER - Optional DER & PLEXOS inputs	What does TDB mean? Need additional detail	Model Mechanics	Document was modified. Added Optional DERs, which consist of Flexible Load and Demand Response.	2
118	B	B.1	Model Input Definitions : 1. DEFINITIONS FOR VARIOUS MODEL INPUTS	Does this list match the text in the main body of the document. Are there any other inputs or outputs that will be utilized? Can the full list be documented	Model Mechanics	Excel workbook is being developed to fully detail the applicable inputs and outputs and will be made available with the next version of the GNA	2
119	C	C.1.1	Current Planning Criteria: Hawaiian Electric's capacity planning criteria for the island of Oahu consists of one rule and one reliability guideline. Capacity planning criteria for the islands of Maui and Hawaii Island consist of one rule, with consideration given to maintaining a reserve margin of approximately 20 percent.	20% can be of any resource type or grid service capable of providing?	Grid Services Definition Methodology	Historically this is met by firm resources and demand response.	1
120	C	C.1.1	Current Planning Criteria: The total capability of the system must at all times be equal to or greater than the summation of the following:	How does this get incorporated into the RESOLVE and Plexos models? Can the models tell you how many times the criteria are violated, and by what amounts? Can the model run and keep track of violations but not actually constrain things?	Grid Services Definition Methodology	RESOLVE solves for ERM as part of the optimization. If RESOLVE is unable to meet all ERM shortfalls (due to limited resource availability), the model will time out. The model does identify the modeled hours where a shortfall occurred and the amount. The model can run without an ERM requirement.	1
121	C	C.1.1	Current Planning Criteria: However, with the increasing quantities of variable renewable wind and solar resources, and future energy storage additions to the system, Hawaiian Electric's current planning rule and guidelines does not account for the dynamic nature of variable resources and limited duration storage.	What about ERM? Limited duration storage providing programmatic of solicitation based services?	Grid Services Definition Methodology	RESOLVE will account for storage as part of the optimization to meet the ERM.	1

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122	C	C.1.1	Energy Reserve Margin: However, to plan for adequate generating capability and to provide for reasonable emergencies, the loss of the resource that can generate the most energy in a day needs to be planned for with the energy reserve margin.	How does this account for location of the largest generating unit?	Grid Services Definition Methodology	Location is not accounted for under the capacity planning criteria.	1
123	C	C.1.1	Definitions: Normal Net Capability Rating: (N1, N2, N3... NN) - For applicable firm capacity units such as steam units, combustion turbines, and internal combustion engines, this is the maximum net load the units are capable of carrying continuously on a day-to-day basis. This is the maximum net load to which the unit is normally dispatched.	Does this take into account forced outage rates?	Grid Services Definition Methodology	Forced outage rates and their impact on available capacity are accounted for through the proposed ERM percentages.	1
124	C	C.1.1	Definitions: Hourly Dependable Capacity: The Hourly Dependable Capacity ("HDC") is the minimum expected capacity from variable generation resources based on empirical data. The HDC (MW) is calculated for each hour as follows:	Do we have adequate empirical data for all resources (e.g. could this apply to storage)?	Grid Services Definition Methodology	Currently, there are no grid scale storage resources on the system so there is no historical data to reference.	1
125	C	C.1.1	Definitions: Energy Reserve Margins - 60% For Lana'i	What is the empirical/analytical basis for these percentages? Is this approach better than other possible planning criteria that incorporate probabilistic methods as opposed to straight 30/60% reserve margin? How do we appropriately balance between a modeling constraint like planning criteria and letting model procure grid services to provide capacity or other needs?	Grid Services Definition Methodology	The margin is applied to all hours so in effect multiple loads and renewable profiles are considered, similar to a probabilistic analyses that only studied the peak load.	1
126	C	C.1.1	Definitions: Energy Reserve Margins - The size of generating units on each island are contributing factors to energy reserve margin targets. For instance, on Molokai and Lanai, the largest generating units on the island have the capability to produce roughly 60% of each island's average daily energy usage. For comparison to the current planning criteria described above, which is to meet the peak load with the loss of the largest available unit, the 60% energy reserve margin target for Molokai and Lanai is to plan for resources that can generate enough energy throughout the day to meet the island's energy load without the largest available unit.	Understanding that Hawaii has unique circumstances, this is still a high energy reserve margin compared to national averages. This is just so high. Can HECO use storage (as noted as a future possibility above) to reduce and save money for customers?	Grid Services Definition Methodology	Yes, storage will be considered as an eligible resource to meet the ERM.	1
127	C	C.1.1	Definitions: Planning Considerations for an Energy Reserve Margin - Although several utilities use a loss of load expectation ("LOLE") criteria for capacity planning, the probabilistic analyses to support a robust LOLE calculation with very high quantities of variable generation and energy storage resources would be difficult to integrate into a capacity expansion model.	Why? What other approaches were considered? Any insights from other jurisdictions?	Grid Services Definition Methodology	See slide 12 from the May 22, 2020 SEOWG meeting here: https://www.hawaiianelectric.com/documents/clean_energy_hawaii/integrated_grid_planning/stakeholder_engagement/working_groups/solution_evaluation_and_optimization/20200522_wg_seo_meeting_presentation_slides.pdf for a comparison of the criteria used in other jurisdictions.	1
128	C	C.1.1	Definitions: Regulating Reserve	This whole section should have been discussed in detail within stakeholder process. It appears TAP was engaged, but why the limited stakeholder engagement? Why no shimmy services contemplated? The level of reserves here is concerning since it appears focused on this service as used today and not being use in concert with other DER services providing comparable capabilities.	Grid Services Definition Methodology	The regulating reserve discussed here incorporates two requirements: a longer duration 20-30 minute reserve and a minutely ramp reserve. If DER is capable of providing this service, it would be eligible in the model but as discussed in Section 3, controllability for frequent dispatch signals would be required.	1
129	C	C.1.1	Definitions: Regulating Reserves - Figure C.1	Pretty dated, granted storage is still small, but will impact, so where is this being accounted for?	Grid Services Definition Methodology	Since storage is dispatchable, it would not be accounted for as part of the requirement.	1

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130	C	C.1.1	Definitions: Regulating Reserve - The reason for the different time-intervals was due to the different generator characteristics on the different islands. The change was then divided by the aggregated installed capacity, or the peak load, to normalize it	What does this mean? What is done for Molokai/Lanai? Are these supposed to be the same things (aggregate installed capacity vs. peak load)? Or different ways to calculate?	Grid Services Definition Methodology	Document was modified to make clearer. Different islands consist of different types of thermal generators with different characteristics. Hawaii Island, Molokai, and Lanai have faster generators, and therefore, a 20-minute window was used for these islands. Oahu and Maui have slower generators, and therefore, a 30-minute window was used. The change in renewable energy was normalized by dividing it by the aggregated installed capacity. The change in load was normalized by dividing it by the peak load.	2
131	C	C.1.1	Definitions: Regulating Reserves: Figure C.3 - Grouping of the minutely data into positive and negative values. Positive changes in generation (negative changes in load) represent a need for downward regulation. Negative changes in generation (positive changes in load) represent a need for upward regulation	re pgs. 45-63) This is a seemingly reasonable approach for reserves. 3 sigma maybe a rather tight objective. Is the rationale for that given somewhere? It is unclear that adequate consideration is given to the well behaved down capability of utility connected solar PV and wind.	Grid Services Definition Methodology	Document was modified to add the rationale for using 3-sigma. Basically, the methodology is similar to ERCOT, and while ERCOT uses the 95th percentile when calculating their reserve requirement, given our islanded system and high renewable penetration, a more stringent requirement was used. The intent was to cover most needs but not all, which lead to a 3 sigma requirement. Sensitivity analyses were performed to examine less stringent requirements at one and two sigma.	2
132	C	C.1.1	Definitions: Regulating Reserves - Assumptions: Table C.4.1 Regulation Calculations	How are these aligned with or accounting for load build and curtail services?	Grid Services Definition Methodology	Curtailment is accounted for by not requiring curtailable resources to add to the downward regulation requirement. Load build may not participate in regulating reserves if it is not capable of responding to frequent dispatch signals.	1
133	C	C.1.1	Definitions: Regulating Reserves - Results O'ahu	Could use some context on this methodology and data from other jurisdictions. Is that available?	Grid Services Definition Methodology	Document was modified. A Background section was added which discusses the methodology used in ERCOT, which is similar to the methodology being proposed here.	2
134	C	C.1.1	Definitions: Regulating Reserves - Results O'ahu Table C.4.2, Reg UP Proposed MAX	Oaky this is a lot and concerned with apparently no interplay with other complimentary services. This does all not to be regulating reserves	Grid Services Definition Methodology	The requirement being presented in the tables was to assist with comparing the requirement based on the method used in the PSIP versus the method that was developed for IGP. The method developed for IGP provides coefficients, which when multiplied by either the installed capacity of the various resources or the peak load and summed together, result in the requirement. Therefore, as the resource plan changes, the requirement will change. The requirement presented in the document is based on the PSIP which had approximately 2000MW of Utility Solar, approximately 2000MW of DER, and approximately 330MW of Utility Wind in 2045	1

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135	C	C.1.1	Definitions: Reg Reserves- Result Maui Table C.4 Reg Up MAX	I think a note should be added that this is all subject to change based on IGP portfolio. This seems very large and curious the load and resource assumptions used.	Grid Services Definition Methodology	This requirement was to assist with comparing the requirement based on the method used in the PSIP versus the method that was developed for IGP. The method developed for IGP provides coefficients, which when multiplied by either the installed capacity of the various resources or the peak load and summed together, result in the requirement. Therefore, as the resource plan changes, the requirement will change.	1
136	C	C.1.1	Definitions: Discussion-Resource Diversification : For example, if an island becomes more heavily weighted towards Grid-Scale Solar than Grid-Scale Wind, we want to be sure that we can accurately capture the unique reserve requirements associated with Grid-Scale Solar versus Grid-Scale Wind, and in order to do that, it is better to calculate the reserve required due to each resource separately.	Why is it better	Grid Services Definition Methodology	Document was modified to make this clearer. Document explains that the reserves were calculated for each resource separately to ensure that as the portfolio changes, the reserve requirement represents the unique volatility and reserve needs that are associated with the various resources (ex: the less volatile DER versus more volatile Wind) Because the volatility in one resource may not be coincident with the volatility of another, defining the requirements as an aggregated portfolio may result in a lower requirement for the current portfolio of resources but may not be valid when the portfolio mix in the future skews specifically toward one resource e.g. solar dominant portfolio in 2045.	2
137	C	C.1.1	Definitions: Discussion - Resource Diversification: Time Interval: TAP members also questioned the time interval used when calculating the change in renewable generation and load. As stated earlier, the time interval was based on the time it would take our operators to decide to start a unit plus the time needed, after the decision is made, to bring the unit online. Therefore, the time interval used was partially driven by the unique generator characteristics on each island.	Might have missed this earlier, but how was this calculated? Interviews with operators? Can we cite something?	Grid Services Definition Methodology	System Operations was consulted to determine the appropriate time interval, taking into consideration each island's existing fleet.	1
138	C	C.1.1	Definitions: Discussion - Resource Diversification: Time Interval: To capture both the regulation needed by our operators to bring units online, as well as, the regulation needed to manage short-term fluctuations associated with variable renewable generation, it was decided that for Oahu and Maui, requirements based on both the 1-minute and 30-minute interval would be used. For Hawaii Island, requirements based on both the 1-minute and 20-minute interval would be used.	Could use a little more explanation here.	Grid Services Definition Methodology	Document was modified to address this comment. Basically, the 1-minute requirement would ensure that there is enough generation on the system to meet any short-term fluctuations in variable energy, while the 20-, 30-minute requirement would ensure that there is enough reserve for our operators to bring units online if needed.	2
139	C	C.1.1	Definitions: Load Build and Load Reduce	Will there be added sections for other grid services?	Grid Services Definition Methodology	Document was modified. Includes definitions for other grid services.	2
140	C	C.1.1	Definitions: Load Build and Load Reduce: • Subset of the energy service for resources that can't participate in the regular provision of energy or are constrained on the number of calls for service	Is this not a market design issue?	Edit or Format	Noted. Proposed language is appropriate for the GNA	3

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141	C	C.1.1	Definitions: Load Build and Load Reduce: Methodology -A service requirement will not be input into the RESOLVE model for this service. Rather, a subset of hours (and their marginal avoided costs) for the energy service will be used to identify the need for load build and load reduce.	How does this feed back into capacity planning needs, though I need to go back and review this to see how you are planning for capacity needs as it appears missing.	Grid Services Definition Methodology	Load Build and Load Reduce are assumed to be incremental to the overall portfolio	1
142	C	C.1.1	Definitions: Load Build and Load Reduce: Methodology - The avoided cost for each grid service will be calculated every 5 years, consistent with the planning horizon used in RESOLVE.	Does the avoided cost change over the 5 year period? Is this granular enough to be used as capacity value?	Grid Services Definition Methodology	Document was modified. The planning horizon was revised to be annual over the next 10 years from 2025, then every 5 years thereafter.	2
143	C	C.1.1	Definitions: Transmission Planning Criteria: O'ahu	Transmission. Some of the limits listed seem like they have the possibility to have substantial economic impact. Have these been vetted? Is there any opening for investment in "grid enhancing technologies" that could relieve critical constraints, especially viz. avoiding new lines. Is there a mechanism to check for opportunities? A mechanism to evaluate efficacy and economy of alternatives?	Grid Services Definition Methodology	Broadly - the transmission needs analysis will identify the need and THEN you can do the specific cost analysis and identify potential alternatives within the cost of the traditional solution.	1
144	C	C.1.1	Definitions: Transmission Planning Criteria: O'ahu - Definitions	Some of these have citations, some do not. Would be interested to know where they all come from. Irregular font size throughout this section and beyond.	Edit or Format	Document was changed to incorporate needed citations	2
145	C	C.1.1	Definitions: Transmission Planning Criteria: O'ahu - Definitions = Contingency Reserve: The provision of capacity deployed by system operator to meet reliability requirements in Section 8, Table 1.	Is this different than load build/reduce?	Grid Services Definition Methodology	This is more closely aligned with fast frequency response.	1
146	C	C.1.1	Definitions: Transmission Planning Criteria: O'ahu - Definitions = Distributed Energy Resources or DER: Resources interconnected to the distribution system that produce electricity.	Not consistent w/ other DER definitions from HECO.	Grid Services Definition Methodology	Document modified - this comment will be addressed in the Glossary	2
147	C	C.1.1	Transmission Planning Criteria – Thermal Limits	Source or citation? Where do these come from? This whole transmission planning section could use more citations/explanation of where requirements come from.	Grid Services Definition Methodology	The thermal limits of equipment (transformers, wires) are based on manufacturer ratings of equipment with consideration for engineering installation standards. This is typical in the industry. The actual thermal limits will depend on the size and type of wire, for example. These limits are reflected in the models.	1
148	C	C.1.1	Definitions: Transmission Planning - 7.1 Steady State Voltage	This approach is getting a lot of attention in the industry. Performing the calculations is a good, necessary 1st step. It could advise specifications downstream, as the technical frontier is moving rapidly. However, it has some limitations, as high inverter systems can exhibit transient voltage collapse for which static PV curves provide poor guidance.	Grid Services Definition Methodology	The Company is learning a lot with respect to inverter behavior. Because each island grid is increasingly reliant on inverter based resources, replaces some of the services that conventional generators provided, more modeling is being completed in PSCAD to evaluate inverter control interactions. As part of the Stage 2 IRS with grid forming inverters, PSCAD modeling is being conducted on a system wide basis to look at this issue.	1
149	C	C.1.1	Definitions: Transmission Planning - 7.3.1 Critical Clearing Times	CCT. Getting a lot of traction these days. But needs to be accompanied by deeper root cause investigation that is generally applied. As with other stability issues, it is important that HECO provide sufficient detail in results to allow for a degree of determination of the causality of CCT limitations. These could advise transmission or grid services decisions.	Grid Services Definition Methodology	There are studies underway to look at CCTs in high inverter based scenarios. This will help inform synchronous condenser requirements, if any. If CCTs need to be increased due to angular stability, then fault current may need to be added to the system. CCTs could also be a function of protection coordination in order to maintain or improve SAIDI. These things need to be balanced.	1

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150	C	C.1.1	Definitions: Transmission Planning - Maui Transmission Planing Criteria (To Be Inserted)	Hmm, the grids are very different, no?	Grid Services Definition Methodology	Will provide Hawaii Island criteria. The grids are very different but the criteria i.e., the level of reliability we plan for on the Hawaii and Maui are the same. For example we use an N-1 criteria, 15% load shed criteria for single generator trip. However, the mitigations will no doubt be different since the grids are different.	1
151	D	Fig D.7	On March 16, 2020, the independent evaluation by the TAP was clarified to also include the distribution needs and NWA opportunity evaluation that occurs in the second year of the IGP cycle. Following several working group meeting discussions in the SEOWG and FAWG, the forecast iteration was removed as the forecasts and other assumptions would be stress tested through sensitivity analyses proposed by stakeholders using RESOLVE as described in Appendix E.	Was this ever discussed, this would be a very incomplete sensitivity analysis and you are already significantly reducing planned sensitivities	IGP Solution Sourcing Process	The number of sensitivities were reduced since there are other applicable dockets, such as the EOT docket and DER docket, that can be used for those analyses.	1
152	E	E.1	Sensitivity Categories	This whole section needs work and does not consider impacts of your 5/27 letter to commission	Sensitivity Analysis	Comment Noted. Will update to make clearer.	1
153	E	E.1	Sensitivity Categories - #1: Market DER - The purpose of this sensitivity is to determine the value of the forecasted market DER uptake that is already assumed in the reference portfolio by evaluating a case where no incremental DER is added beyond 2020 levels. RESOLVE will be allowed to build grid-scale resources to meet future RPS and grid needs. Compared to the reference case, this will provide the value of the market DER forecast and a lower bound on the value of DER in the portfolio.	How is this going to align with your May 27, 2020 filing and what are you assuming for DER's moving forward, seems tied to DER market track You will be accounting for +-T&D investment impacts?	Sensitivity Analysis	DER is intended to be evaluated through the DER freeze sensitivity as well as modeling DER as a resource to evaluate the various benefits of DER on the system.	1
154	E	E.1	Sensitivity #2: No Future Transmission Infrastructure: A DER aggregator resource option will be available to be selected by the RESOLVE model. The DER aggregator will be costed as 20 MW of residential PV paired with 20 MW of residential storage with a 10% adder for customer acquisition costs.	This is not realistic of the actual cost benefit from customers perspective and should use shadow pricing.	Sensitivity Analysis	The DER resource will be modeled with capital and operating cost, similar to how all other resources are being modeled in RESOLVE. This will ensure a fair, apples-to-apples comparison between DER and the other potential resources,	1
155	E	E.1	Sensitivity #4: No State ITC Sensitivity for PV	So your lowering adoption forecast? There maybe some benefits, but other sensitivities you dropped would provide much more insights.	Sensitivity Analysis	Again this will help value DER but the State ITC would also affect grid-scale PV as well.	1
156	E	E.1	Sensitivity # 7: Non Grid-Participating Customer Storage - March 12 Stakeholder Council meeting, the council members discussed the merits of this sensitivity and decided that detailed analyses like this sensitivity were better suited for the DER docket.	Does this not require further clarification given you 5/27 letter to commission?	Sensitivity Analysis	Proposals for new DER programs that are defined through the DER docket will be an input into the IGP process.	1
157	E	E.1	Sensitivity #8: Grid-Participating Customer Storage - The purpose of this sensitivity is to understand the value of additional distributed storage that is able to charge from and export to the grid when added to existing and future DER resources. In the March 12 Stakeholder Council meeting, the council members discussed the merits of this sensitivity and decided that detailed analyses like this sensitivity were better suited for the DER docket.	This was not part of the proposal, though would provide similar load build service Does this not require further clarification given you 5/27 letter to commission?	Sensitivity Analysis	Proposals for new DER programs that are defined through the DER docket will be an input into the IGP process.	1
158	F	F.1	Resource Cost Forecast	Where is the cited summary table	Resource Characteristics	Comment Noted. Item has been moved to I&A Report	1

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159	B	B.1	Reserves section	Are these reserves in addition to spinning reserve for 100% of largest generator? Is there a possibility for a new wind/solar project being the largest contingency?	Resource Characteristics	The minimum requirement used in the PSIP was also used in the regulating reserve rule being proposed. For Oahu, the minimum was based on the largest generator. It is possible that a new solar or wind project may become the largest unit contingency.	1
160	B	B.1	Reserves section	Can HECO provide minutely solar and wind minutely data so we can do some analysis Where is the dPV sub-hourly data coming from? Measured? Estimated? Where is the load sub-hourly data coming from? How can we know that the variability does not double count the dPV variability?	Resource Characteristics	The distributed PV data is estimated. The load data is based on the net generation and the distributed PV estimation.	1
161	B	B.1	Reserves section	How are curtailed renewables counted towards regulation requirement? Curtailed renewables are not variable so they shouldn't require regulation -AND- they can provide regulation…Iterative approach?	Resource Characteristics	Resources that can be controlled are not included in the downward regulation requirement. It is assumed that our operators would be able to control these resources if the need arises. These resources are included in the upward regulation requirement. There is no adjustment made for actual taken energy. Resources that are controllable can provide both up and down regulation.	1
162	B	B.1	Reserves section	Can you provide PLEXOS "price" and "shortage" for up-regulation, down-regulation, and ramp products separately	Resource Characteristics	The shortage can be provided but not sure what the price represents.	1
163	B	B.1	Reserves section	Contingency reserves still included?	Resource Characteristics	Contingency reserve related to the loss of the largest unit are still accounted for.	1
164	B	B.1	Reserves section	How is DR treated? Controlled customer resource?	Resource Characteristics	Demand response such as the load build and load reduce resources are not modeled to provide reserves.	1
165	B	B.1	Reserves section	How are you treating curtailment? Curtailed renewables should not require regulation reserves and they should be able to provide reserves	Resource Characteristics	Curtailed renewables that are controllable can provide up and down regulation. However, the regulating reserve requirement is based on the available production of the renewable resources, prior to any curtailment.	1
166	1	1.2.4	Environmental Carbon Impact Reduction	Is the IGP modeling evaluating on cross-sector emissions reduction? i.e. evaluating a Hawaii's full emissions, including transportation and industrial processes to see if electrification 1) leads to emissions reductions overall, and 2) if electrification is the least-cost option for those reductions. Our work with HNEI may be able to help in this respect.	Modeling Inputs	No, cross sector emissions are not being considered.	1

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167	1	1.2.2	Adequacy of Supply (AOS) is the ability of the electric system to supply the aggregate electrical demand and energy requirements of the customers at all times, taking into account scheduled and reasonably expected unscheduled outages of system elements.	Reasonable expectation could be defined more... Are extreme weather events (multi-day low solar events) treated in the AOS analysis or resiliency? If aging steam units have higher probability of forced outages, and longer duration outages, is that 'reasonable' or not. Our work with HNEI may be able to help in this respect.	Modeling Inputs	We would be open to further discussion on this.	1
168	3	3.1	The two models used to identify and verify the system needs are the RESOLVE model and the PLEXOS model.	Limitations of tools will limit the identification of system needs – these tools will not identify system stability needs like inertia, grid strength, or the spec of FFR, which is mentioned below.	GNA Modeling Process	Document was modified. RESOLVE will produce a resource plan that will meet the various Grid Needs. This plan will be run through PLEXOS and other models to ensure system reliability and calculate the system cost.	2
169	3	3.1	RESOLVE produces a proposed optimized resource plan of grid services needs that is confirmed in PLEXOS as a sub-hourly production simulation to capture the total system costs.	While I don't think sub-hourly simulations are required for every year of the plans, it may make sense to test specific years (after key changes) with sub-hourly 10-min simulations.	GNA Modeling Process	Comment Noted	1
170	3	3.1	Following the initial modeling to determine system needs is the Grid Service Needs RFP step. The process iterates during this step, as the solutions bid into the RFP are evaluated through another round of RESOLVE and PLEXOS modeling to create the optimal portfolio of solutions that the utility should procure, while maintaining system reliability and system security at reasonable cost.	Some aspects of system security should be pulled forward and evaluated at the same time as the other services, rather than after. This has a major impact on how the synchronous machine fleet is handled. For instance, grid needs like voltage support/SC/inertia that are not identified in Plexos/RESOLVE and show up later in sys security could lead to must-run or sub-optimal commitment and dispatch of resources.	GNA Modeling Process	Document was modified. The figure was updated to show the feedback from the System Security analysis to PLEXOS if there are any changes that are needed to the plan to ensure reliability.	2
171	3	3.2.1.3	Based on stakeholder feedback, the Company clarified that incremental DER would be available as a resource option to be economically selected. We proposed that the cost of DERs available for selection could be based on a combination of residential PV and residential battery energy storage to approximate the cost of a DER Aggregator.	This is a really good idea to incorporate, but these costs will always, by definition, be more expensive than the utility-scale options. While I think that is a good base case assumption, it may be useful to show this cost based on what the customer sees/pays, which could be very different. Also, in addition to cost of DER resources, you will need to make assumptions on capacity credit (to defer utility-scale assets) and ability to (and cost) provide grid services	GNA Modeling Process	Comment Noted	1
172	3	3.1	Table 3.1 Resource Cost Data Sources	How do you plan to evaluate hybrid projects, where storage+renewable can be provided jointly at a lower price than the two separately?	GNA Modeling Process	Both standalone projects and hybrid projects are included as resource options in RESOLVE.	1
173	3	3.2.1.4	Resource cost assumptions from public data sources	Do you have a table of these costs yet?	Resource Characteristics	The cost will be provided in the Input and Assumptions document.	1

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174	3	3.2.2	Future resources include the projects from the Stage 1 RFP that were filed and approved and the prospective Stage 2 RFP final award group (serving as a proxy for Stage 2 outcomes) will be built into the modeling, as shown in Figure 1.1.	Consistent with our scenario planning	GNA Modeling Process	Comment Noted	1
175	3	3.2.3	Resource generation hourly profiles and day-weighted profiles;	What year(s) do you plan to use for this? Are you going to test with multiple weather years either in the production cost or resource adequacy work?	Resource Characteristics	The resource adequacy energy reserve margin account for multiple years of historical data when setting the hourly dependable capacities for each resource type.	1
176	3	3.3	Transmission Needs will be analyzed by the PSS\E transmission planning model. Identified needs include: •Inertia •Short-circuit current •Voltage support	Great – these are new and should be included.	Transmission Needs	Comment Noted	1
177	3	3.3	In addition to the above transmission needs, Hawaiian Electric will characterize the transmission topology of each island to enable transmission constraints to be reflected in the RESOLVE and PLEXOS models.	Have you built out the PLEXOS model to be full nodal? We have done some of that work and tested if that could help. I believe RESOLVE is just zonal, correct? Are you proposing a zonal breakdown of Oahu or other islands?	Transmission Needs	RESOLVE is zonal and would be modified to reflect the REZ once those transmission needs are known.	1
178	3	3.3	Identifying the cost of potential major & minor transmission upgrades will allow RESOLVE to determine whether generation and transmission buildout decisions are least-cost compared to non-wires alternatives or alternate sites.	This document (or IGP WG) could provide more information here on methodology. I suspect this could alter the availability or location of different resources, which is sure to draw scrutiny from developers and other stakeholders.	Transmission Needs	Document was modified. Additional detail about the Renewable Energy Zone concept was added.	2
179	3	Table 3	Inclusive of the inputs and analyses described above, the following Grid Services have been identified as defining the Grid Service Needs RFP. The definitions are provided in Table 3.2 and the types of properties needed to characterize each service are shown in Table 3.3.	This is missing the Inertia, Grid Strength, and Voltage support needs identified above. How will these be served? Our suggestion is to integrate these into the framework you have below.	Grid Services	Document was modified. The table was updated to include these Grid Services.	2
180	3	Table 3	Inclusive of the inputs and analyses described above, the following Grid Services have been identified as defining the Grid Service Needs RFP. The definitions are provided in Table 3.2 and the types of properties needed to characterize each service are shown in Table 3.3.	Agreed. HECO should strive to make the grid services and definitions consistent across all IGP planning docs, DER dockets, and RFPs. Even if HECO does not plan to procure grid services from the market (Inertia, Short Circuit) it should still be clear what the requirement is and how HECO plans to provide it. This will effect other grid service needs and potential pricing.	Grid Services	Comment Noted	1
181	3	Table 5	Load Reduce	What time frames / duration? What response time? Why is this specific to Loads? Same applies to "Load Build." Recommend this be generalized so that load and generation and participate because they both have the same effect if the service is defined well.	Grid Services	Subsequent table provided information on the response time and duration for the various Grid Services, as well as, the resources that can provide the service. For the Load Build and Load Reduce service, the response time and duration was an hour, and both generators and loads can provide this service.	1
182	3	Table 5	Load Build	I'm not sure I understand the purpose of this service. Couldn't this be achieved via TOU pricing or via curtailment? This would only be required if there was a surplus of uncurtailable DER and inflexible generation	Grid Services	The purpose is to be able to control when the load build occurs. TOU and curtailment could achieve a similar affect but may not be thru a controllable demand side resource.	1

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183	3	Table 6	FFR	Would like to know more about how you plan to incorporate this in PLEXOS (and RESOLVE) and how it relates to other Spinning Reserves and Inertia Constraints. FYI – Inertia can (and probably should) be included in PLEXOS. This is something we (Telos + HNEI) plan to evaluate and could help support some of the IGP work.	Grid Services	Document was modified. Additional detail has been provided in Appendix C.	2
184	3	Table 6	FFR	Great – we have some thoughts on this. Is FFR2 is being dropped?	Grid Services	Comment Noted	1
185	3	Table 5	Regulation Reserve	My recommendation is to use regulation reserves for 1-minute to 10-minute, and run production cost analysis sub-hourly	Grid Services	The 20- to 30-minute time interval was based on feedback from our System Operators who based the timeframe on the time it would take our operators to decide to start a unit plus the time needed, after the decision is made, to bring the unit online.	1
186	3	Table 9	Transmission Deferral	Should this be considered a "grid service" or is this just a value to the grid that some projects will have, depending on the resource capability and location installed?	Avoided Cost of Service	This is also due to how the resource is able to be dispatched and any limitations on its dispatch that may prevent it from deferring transmission needs.	1
187	3	Table 9	Distribution Capacity	Ok, I see the value in proposing this. Isn't think kind-of like a "regulation" reserve where you're responding to AGC (as defined above) – but implemented at the dist level for the purpose of avoiding overloads? In general, our view is it's better to create services that are general enough to be applied anywhere – not isolated to Dist or Trans systems. The duration of this need should be defined.	Avoided Cost of Service	The duration of this service depends on the distribution need. This needs to be separate from bulk system capacity. It could be similar to transmission capacity. But depending on the nature of the overload we dictate the requirements (i.e., magnitude overload, duration of overload, how many time of year we expect the overload to occur, time of day, etc.)	1
188	3	Table 9	Distribution Reliabilty	This is not clear – what is the service? A microgrid controller? Energy-storage with grid-forming capability? Much more definition is needed.	Avoided Cost of Service	This service is to satisfy distribution planning criteria to not allow overload of equipment under N-1 conditions. Anytime a substation gets overloaded due to the transfer of load when another substation fails, we will need distribution capacity to avoid that overload.	1
189	3	Table 9	FFR	Recommend Up and Down as separate services	Avoided Cost of Service	Currently FFR is modeled as an up only service, driven by the loss of a generator.	1
190	3	Table 9	Regulating Reserve	Recommend Up and Down as separate services	Avoided Cost of Service	Both Regulation Up and Regulation Down will be analyzed.	1

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191	3	Table 4	Table 3.3 Property field (Lastest draft is Table 4)	The properties column is a good start. But these will need a lot more definition. Perhaps that is provided elsewhere? There's a lot of nuance in this that is important.	Grid Services	Additional detail can be provided once the analyses are completed.	1
192	3	Table 4	Table 3.3 Load Build and Load Reduce resource type	Ok, good to see that it is acknowledged that generators /storage can participate in the load-reduce service… further under-scores that this service need not be specific to load. Is there a reason generators / storage resources are not listed under the "Load Build Service?"	Grid Services	Storage and Load Under Control can provide the Load Build service.	1
193	3	Table 4	Table 3.3 FFR resource type	Renewables (with headroom/curtailed) could also do this well.	Grid Services	Document was modified. Variable generator was added to the list.	2
194	E	E.1	Hawaiian Electric has also proposed two sensitivities to understand the value of DER. •DER Program Freeze In this sensitivity, DER adoption would be frozen at existing 2020 levels to understand the impact of the market DER uptake assumed in the core scenarios.	This is a great idea, I just suggest rewording to avoid negative perception. Maybe call it "DER Program Valuation" and describe it as "a sensitivity would be conducted without additional DER adoption to understand the impact…"	Sensitivity Analysis	Document was modified. An appendix was created to list the various sensitivities that will be analyzed, and one of the sensitivities is the "Market DER" sensitivity, which will analyze the value of the forecasted DER uptake.	2
195	3	3.7	In this phase of the IGP process, the TAP may independently model and verify the methodology and results developed by the Company.	OK good language to include. See previous comments on where I think HNEI+Telos can augment the good outline of work you have already proposed.	GNA Modeling Process	Comment Noted	1
196	3	3.7	GRID SERVICE NEEDS IDENTIFICATION MODELING PROCESS Proposed Methodology	Consider adding: Run power systems tools (like PSSE or other) in parallel to identify grid service needs like inertia, voltage support, grid strength for each scenario/sensitivity. Use this to inform (or apply constraints) in RESOLVE/PLEXOS. In this way, all needs will be evaluated at the same stage and the results will reach new optima or reliability and cost, especially if the services are generalized more, as suggested above.	GNA Modeling Process	The loop between system security and resource planning will address this.	1
197	3	3.7	GRID SERVICE NEEDS IDENTIFICATION MODELING PROCESS Proposed Methodology	In addition, there needs to be some assessment of Resource Adequacy and capacity value of renewables and energy limited resources (storage & DR). Otherwise it will be hard to know if portfolios are reliable.	GNA Modeling Process	Document was modified. Additional detail about the new Capacity Planning Criteria (Energy Reserve Margin or ERM) being proposed in the IGP was added to the Appendix. The ERM requirement is added to RESOLVE as a constraint to ensure adequate capacity/energy is being built.	2
198	4	4.2.1	We propose keeping a ranked list of resource options to help guide the contract negotiation process.	This is a great idea. Question: how will you handle hybrid projects? Or will you provide storage and renewable options separately?	Sol Eval Meth - Avoided Cost Screen	RESOLVE will be allowed to choose both standalone options, such as standalone PV, as well as, paired options, such as PV paired with a 4-hour BESS.	1

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199	A	Table 10	Fuel Blend	This can be done in PLEXOS as well.	Model Mechanics	Document was modified. Fuel blending can be done in PLEXOS.	2
200	A	Table 10	Must Run Must Commit	Why are these not reflected in PLEXOS as well?	Model Mechanics	Document was modified. Must-run was added as an input in PLEXOS.	2
201	A	Table 10	Spining Reserve	Why not include this in PLEXOS as well. This quantity will depend on the amount of Frequency response you have, no?	Model Mechanics	Document was modified. Spinning reserve is not being used in RESOLVE and was removed.	2
202	A	Table 10	Load Following Reserve	This is inconsistent with grid service needs above. Requires definition. Why not include in PLEXOS? How do you plan to model forecast errors.	Model Mechanics	Document was modified. Load-following reserve is not being used in RESOLVE and was removed.	2
203	A	Table 10	DER in PLEXOS	Telos has some work done in this space that could help.	Model Mechanics	Comment Noted	1
204	A	Table 10	Regulating Reserve Service	This detail is great. Would be important to define the other grid services rigorously, too.	Model Mechanics	Comment Noted	1
205	A	Table 10	Regulating Reserve Service	Agreed – I had previously provided some comments on potential sensitivities that could be done on regulation reserve requirements, but overall a good improvement from PSIP	Model Mechanics	Comment Noted	1
206	C	C.2.2	For each category, for each minute, the change over a 30-minute time-interval was calculated for the islands of Oahu and Maui.	See previous comment about regulation being sub-10 minute and using PLEXOS to model sub-hourly	Grid Services Definition Methodology	Comment Noted	1

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207	C	C.2.2	The total reserve required for a given month and hour was calculated by summing the requirement in each of the four categories: 1.Aggregated Utility Solar 2.Aggregated Utility Wind 3.Aggregated DER 4.Gross Load	While I understand the need to do this separately for ease of scenario development, I think there needs to be a check conducted to see if that deviates significantly from developing the requirement on the TOTAL net load variability of the aggregated resources in this list. There may be benefits of resource diversity where some resources cancel out the variability from the other.	Grid Services Definition Methodology	Document was modified to make this clearer. Document explains that the reserves were calculated for each resource separately to ensure that as the portfolio changes, the reserve requirement represents the unique volatility and reserve needs that are associated with the various resources (ex: the less volatile DER versus more volatile Wind) Because the volatility in one resource may not be coincident with the volatility of another, defining the requirements as an aggregated portfolio may result in a lower requirement for the current portfolio of resources but may not be valid when the portfolio mix in the future skews specifically toward one resource e.g. solar dominant portfolio in 2045."	2
208	C	C.2.3	Table C.1 Resources included and excluded from the calculation of Regulation Up and Regulation Down.	Good table, provide a similar one for reserve PROVISION What are you going to assume if there is curtailment? Curtailed resources should not add ot the reserve requirement, and could potentially provide reserves toward the requirement	Grid Services Definition Methodology	Document was modified. The Tables 13 and 34 were expanded to include the assumptions made regarding which type of resources can provide regulation. Curtailment is accounted for by not requiring curtailable resources to add to the downward regulation requirement. Curtailed resources can provide both upward regulation and downward regulation.	2
209	C	C.2.3	Table C.2: Maximum, Average, and Minimum Regulation Up requirement based on the current methodology used in the PSIP and the proposed methodology for the island of Oahu.	Doesn't this depend on the resources going in? are you using the PSIP proposed plan as a starting point?	Grid Services Definition Methodology	The requirement being presented in the tables was to assist with comparing the requirement based on the method used in the PSIP versus the method that was developed for IGP. The method developed for IGP provides coefficients, which when multiplied by either the installed capacity of the various resources or the peak load and summed together, result in the requirement. Therefore, as the resource plan changes, the requirement will change. The requirement presented in the document is based on the PSIP which had approximately 2000MW of Utility Solar, approximately 2000MW of DER, and approximately 330MW of Utility Wind in 2045	1
210	C	C.2.4	Table C.2: Maximum, Average, and Minimum Regulation Up requirement based on the current methodology used in the PSIP and the proposed methodology for the island of Oahu.	This is the loss of the largest generator… shouldn't that be classified as a separate spinning reserve requirement.	Grid Services Definition Methodology	It could be. For modeling simplicity, we included it as part of the regulating reserve.	1
211	C	C.2.4	Table C.2: Maximum, Average, and Minimum Regulation Up requirement based on the current methodology used in the PSIP and the proposed methodology for the island of Oahu.	The maximum requirements get to be huge. Part of this may be due to calculating the reserve separately for the different resources, also using a 30 minute window instead of a shorter regulation window.	Grid Services Definition Methodology	The requirement presented in the document is based on the PSIP which had approximately 2000MW of Utility Solar, approximately 2000MW of DER, and approximately 330MW of Utility Wind in 2045.	1
212	C	C.2.9.1	There was an inquiry from the TAP members regarding why the requirement was calculated for each resource separately and then aggregated at the end versus aggregating everything at the beginning.	OK, thank you for taking this into account (comment above)	Grid Services Definition Methodology	Comment Noted	1

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213	C	C.2.9.1	There was an inquiry from the TAP members regarding why the requirement was calculated for each resource separately and then aggregated at the end versus aggregating everything at the beginning.	You would still get the relative weighting if you analyzed the combined net load variability. Also, by doing the reserve calculations based on the aggregated variability, it may actually provide a result that favors resource diversity because the requirement would be lower, despite one resource being significantly cheaper.	Grid Services Definition Methodology	There certainly may be times where the aggregated variability is less because the PV and wind profiles cancel each other but there may be other times where their profiles are additive. We're open to discussing further.	1
214	C	C.2.9.2	One question raised by the Technical Advisory Panel (TAP) members was why we chose to use three standard deviations when calculating the reserve requirement. As a result, the requirement for one and two standard deviations was also calculated.	Thanks for following up on this request. These results are significant. One more column to add to this would be the total production cost of each PLEXOS case… I think its important that stakeholders and the PUC understand the tradeoff between reliability and cost. The difference between 2 sigma and 3 sigma is not trivial.	Grid Services Definition Methodology	Comment Noted	1
215	C	C.2.3	Table C.15: Impact of time interval on the Maximum, Average, and Minimum Regulation Up requirement for the island of Oahu.	So 99% confidence interval (instead of 99.9%) and dropping the window to 10-minutes could lead to a very large reduction in the requirement and cost to provide.	Grid Services Definition Methodology	The time interval and confidence interval was based on the experience and expertise of our System Operators who run the system and the risk of running a system that is islanded and projected to have high levels of renewable penetration.	2
216	E	E.1	Sensitivity	Rather than just selecting low renewable scenarios, propose using a large sample of historical weather years, so that these are reasonable selections and can inform probabilities.	Sensitivity Analysis	This could be something considered as part of stochastic analyses in PLEXOS. However, RESOLVE is not able to model stochastic profiles. The intent here was to see the impact on the resource plan where variable renewable generation is limited.	1
217	E	E.1	Sensitivity	Storage is only one way to shift load. Not necessarily recommending it should be modeled differently, just presented more broadly.	Sensitivity Analysis	Comment Noted	1
218	E	E.1	Sensitivity	Maybe I missed this, but can you provide a map of the proposed transmission limits?	Sensitivity Analysis	HECO will be developing such a map as the Renewable Energy Zone concept is developed as part of the Transmission needs work.	1
219	E	E.1	Sensitivity	This could be too extreme of a bookend. What about limiting the maximum build of onshore resources further? I'm not sure this is as black-and-white as you are proposing.	Sensitivity Analysis	We're open to discussing this sensitivity. The intent was to model a scenario where onshore development runs into delays or headwinds that forces development offshore.	1
220	E	E.1	Sensitivity	See comment above. We are doing a lot of work on stochastic PELXOS runs across 21 historical years of weather. Something we can share with you if that is of interest.	Sensitivity Analysis	We're open to discussing the work that has been done around stochastic modeling of historical weather.	1

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221	E	E.1	Sensitivity	Are you going to also split out NEM loads from the model? How will you determine what gets exported to the grid vs. self-consumed?	Sensitivity Analysis	NEM will be modeled as a load offset as a part of the forecast or as a resource that can participate in the provision of grid services. The NEM loads are not anticipated to be split.	1
222	3	Table 8	TAP Slides - Q&A Session 17DEC20	The short circuit current (SCC) coded in yellow seems appropriate. Generally, I agree with the information in the chart. SCC could be provided by a grid-following inverter but may not respond as quickly. Grid-forming versus grid-following is the larger question at hand. The issue is not necessarily PV or wind technology specific.	Sensitivity Analysis	Not all the inverters respond in the same way in the PSCAD model. We test for voltage capability but need to supplement the plant design.	1
223	3	Table 8	TAP Slides - Q&A Session 17DEC20	Software-limited models may not show the full capability of inverters. Consider a reactive capability curve versus a square one The modeling should consider a replacement reserve/non-spinning reserve. This would be a slower response than frequency response or regulating reserve. The state of charge for BESS resources would need to be managed.	Sensitivity Analysis	We will soon have many BESS resources to manage, but it will be difficult to value a replacement reserve	1
224	3	Table 8	TAP Slides - Q&A Session 17DEC20	In a future meeting, it would be helpful to spend some time to talk through how the Stage 1 and 2 projects will be operated. There may be a surplus of services after those projects are in service, potentially leading to a lower value for some services.	Sensitivity Analysis	Comment Noted	1
225	3	Table 8	TAP Slides - Q&A Session 17DEC20	The yellow coding for distributed resources seems reasonable as they may not be able to run on AGC (automatic generation control) or require curtailment.	Sensitivity Analysis	Comment Noted	1
226	3	Table 8	TAP Slides - Q&A Session 17DEC20	The grid services by technology table seems more comprehensive than what we've previously looked at.	Sensitivity Analysis	Comment Noted	1
227	3	Table 8	TAP Slides - Q&A Session 17DEC20	For standalone PV, wind, and storage resources, I'm unsure if those should be marked as green for transmission and distribution capacity. These would be capable of providing a portion of the deferral (yellow coding) and could fully defer the need if they were paired resources (green coding).	Sensitivity Analysis	We could add additional columns to the grid services by technology table to distinguish paired systems from standalone resources.	1
228	3	Table 8	TAP Slides - Q&A Session 17DEC20	It could be informative to sort the chart by speed of response. This may illustrate a gap in the breadth of services where only partially capable resources can contribute.	Sensitivity Analysis	For visual purposes the Company will adjust the chart in the next iteration of the grid services table.	1

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229	3	Table 8	TAP Slides - Q&A Session 17DEC20	Should a new service called, Grid Forming, be considered? It would be especially relevant on Maui or Hawaii Island at or near 100% IBR (inverter-based resource). There is emerging consensus in the industry that you need something to provide very short-term voltage stability (i.e., form the voltage waveform). Conventional thermal, pumped storage hydro, synchronous condensers, and grid-forming IBRs would be coded green. All others would be coded red.	Sensitivity Analysis	Document was modified to incorporate this suggestion	2
230	3	Table 4	TAP Slides - Q&A Session 17DEC20	How do you think about load build and load reduce versus a permanent change in load?	Sensitivity Analysis	In the market, we've seen more PV+BESS type projects providing the load build and load reduce services. Are you thinking more of a traditional energy efficiency approach as a permanent reduction. Our first approach would be through time-varying rates. This could also include EV charging loads	1
231	3	Table 4	TAP Slides - Q&A Session 17DEC20	How would load build / load reduce be modeled	Sensitivity Analysis	It could be modeled as a subset of energy, looking at the 8760 hourly results from PLEXOS for arbitrage opportunities	1
232	3	Table 4	TAP Slides - Q&A Session 17DEC20	Price can be used as a signal. However, in Hawaii, I don't know what supplants that. What would these reserves respond to? The number of times the resource is called could be adjusted over time.	Sensitivity Analysis	Load build / load reduce could respond through widespread TOU rates. Though we try to mitigate realizing the same services through a free rider situation.	1
233	3	Table 4	TAP Slides - Q&A Session 17DEC20	Regarding PFR and FFR and Inertia: A quicker droop response seems preferable, so good that's being considered, but this will blur the line with PFR. Essentially, it will be a fast PFR Near-term transition will be important. I'm not seeing how this process here will help to identify near term challenges with Stage 1 and 2 projects.	Sensitivity Analysis	Stage 1 and 2 RFP portfolio studies will identify resources needed to maintain system security. System impact studies will identify additional requirements for those facilities and needs on the grid side. These will be inputs into the RESOLVE and PLEXOS modeling	1
234	C	C.1.2	TAP Slides - Q&A Session 17DEC20	How were the ERM target percentages set? What is accounted for in the percentage? It seems like there may be some double counting there. How is the future maintenance and forced outages captured?	Grid Services Definition Methodology	The targets are based on testing that was done to ensure the percentage could account for certain emergency conditions. Forced outages are accounted for under the right-hand side of the equation under the ERM percentage.	1
235	C	C.1.2	TAP Slides - Q&A Session 17DEC20	Traditional reserve margin accounts for generator outages, weather, and load uncertainty. I like that the ERM accounts for an hourly requirement. Would it be possible to move all of the uncertainty to the left-hand side of the equation, resulting in a lower ERM target percentage? Were generator outages associated with transmission outages considered? How is transmission maintenance accounted for?	Grid Services Definition Methodology	We have generation today on the sub-transmission and distribution. We don't have the same redundancy as if it were on the transmission network.	1
236	C	C.1.2	TAP Slides - Q&A Session 17DEC20	Is the standard deviation the same across the year?	Grid Services Definition Methodology	The standard deviation varies by hour	1

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237	C	C.1.2	TAP Slides - Q&A Session 17DEC20	Does this consider multiple years of data?	Grid Services Definition Methodology	Yes	1
238	C	C.1.2	HECO asked: Are there ideas on how to incorporate additional data to better inform the HDC statistics?	How is the PV minimum HDC 0%? The solar HDC percentage will be important. On a cloudy day, you might still get around 10% from solar. It will be important to account for BESS SOC (battery state of charge) in ERM. There may be a saturation risk and unintended ERM shortfalls	Grid Services Definition Methodology	Comment noted and taken into consideration	1
239	E	E.1	TAP 24AUG20 Meeting - Review of FAWG work products	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.	Sensitivity Analysis	The approach suggested was adopted and Appendix E was added to provide more detail on the sensitivities performed	2
240	E	E.1	TAP 24AUG20 Meeting - Review of FAWG work products	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.	Sensitivity Analysis	Tie to what comes out of DER docket for TOU impact. Managed EV charging profile will address TOU for EV.	2
241				For the load build and load reduce methodology, why did you choose to go to every 5 years after the first 10 years (in which you do a calculation of avoided cost every year)? Wouldn't keeping it annual give you better information? How do you account for projects with long term development.	Grid Services Definition Methodology	It would provide better information. However, the model has a very difficult time optimizing on an annual basis over the entire planning horizon. We put greater emphasis on the near-term and 5 year analysis is sufficient for the longer-term view. We use PLEXOS to run annually through 2050. PLEXOS will incorporate anything that is currently under development.	1
242				With respect to the "bookends" analysis approach, will you be running a "most probable" analysis?	Sensitivity Analysis	The base case represents the most probable. The bookends represent the outer bounds under a given change in assumptions. The load forecast developed through the FAWG represents our base case/most probable.	1
243				Programs that emerge from the DER docket (like a TOU) would be modeled as a sensitivity. You won't be building in TOU in the base case?	Sensitivity Analysis	Correct. When TOU programs are adopted, the model will be modified to reflect those program parameters.	1
244				Regarding the TOU profile for EV charging, are the details going to be shared	Sensitivity Analysis	Yes. A workbook will be made available to stakeholders. Oahu workbook is already available on the website	1
245				Does HECO consider different periods of the year with materially different weather behavior	Model Mechanics	Intend to address with a sensitivity analysis. In the Appendix we describe the details, including low renewable generation periods from days to several weeks based on historical data in hand and determine what the impact is on the 8760 modeling.	1
246				Due to rapidly changing climate, use of a more narrow range for backcasting may be more appropriate. Longer-term history may not be the best representation of what is coming in the future	Model Mechanics	FAWG did consider a warming trend based on FAWG stakeholder feedback	1
247				Most of the focus is on the affect on demand but there is an affect on generation. Global warming would affect wind velocity and frequency of high wind which affects generation production of wind and cloud cover for solar. Increased temperature lowering solar generation. Even impacts thermal plant performance, particularly CTs	Model Mechanics	Have not incorporated in the base case. Use of a more narrow historic record may be more appropriate with rapid climate change. Will need to have more discussion about how to approach low renewable generation scenarios and the data needed to do it.	1

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248				Please provide a little more background on the adding of Optional DER on top of the DER layer	Model Mechanics	Yes. We are trying to make DER a resource option. Trying to model a DER aggregator as a DER option and what was the best way to model that. Initial approach was cost of residential solar + 10% acquisition cost as a resource cost. This was modeled as a resource option for RESOLVE to choose from. Under sensitivity analysis where grid scale resources are more limited we may see that RESOLVE selects the aggregated DER for the portfolio. Keep in mind that the resource plan that comes out of the RESOLVE modeling is not prescribing specific resources but is used as a proxy for the least-cost grid services that would be needed in any given year. RESOLVE is trying to select resources that meet the grid needs. The resource represents the specific need that the resource can provide (e.g. energy, capacity, AS, etc.) . In reality, those services may be obtained from a different resource in the sourcing process.	1
249				Need to consider the impact on demand and generation simultaneously (e.g. what happened in Texas)	Model Mechanics	Good point. Will take a note of that for future discussion	1
250				In the DER Aggregator scenario, are you assuming the full cost of the DER + 10% for customer acquisition. Does this make this resource overly expensive?	Model Mechanics	That is the cost of the resource option but not the avoided cost in the model. The capital cost and the aggregator costs are fixed. We are open to feedback on ways to adjust it with some specific data to use and the rationale behind it. We use the sensitivity analysis and the DER Freeze as a way to value DER. By freezing DER adoption at 2020 levels, then RESOLVE will choose other resources and the difference between that portfolio cost and the base case (with DER adoption forecast) is a proxy for the inherent value of DER. There is a subset of the DER forecast data set that could be modeled separately as other approach for valuing DER.	1
251				Regarding transmission constraints and renewable energy zones. Is there an explanation of that or will it be documented how transmission constraints are determined or how much capacity is available?	Transmission Needs	HECO is using the NREL solar potential data to determine where potential Renewable Energy Zones might be located, looking at the current capacity of the transmission and distribution system. HECO will evaluate the current remaining capacity in these high potential areas then determined major transmission upgrades needed to interconnect up to the potential of a given renewable energy zone. These transmission cost will be attached to the cost of building solar in certain regions, and will be reflected regionally within the RESOLVE model. Some zones are large and HECO will need to model what scale would trigger transmission upgrades. This work is in-progress and will be completed as part of the transmission needs analysis. Assumptions and outputs of this analysis will be provided when it is available.	1
252				Did you evaluate whether agriculture was more valuable than generation in these renewable energy zones or did you calculate the zones from a silo approach	Transmission Needs	Have to take in other forms of land use and community concerns. REV tool is a good to start with. We posted the renewable potential study under SC subgroup that NREL did. Exclusions were detailed out in the report.	1

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253				How are transmission constraints modeled	Transmission Needs	The transmission system is not specifically modeled in RESOLVE, but reflects potential transmission upgrades as part of the resource costs. If the model tries to build out more resources in a given area, the resource costs are higher to reflect the higher transmission interconnection costs. Resource costs are increased as a constraint on the amount of capacity that can be built in a given Renewable EZ.	1
254				How are renewable energy zones determined	Transmission Needs	We just started the process. Can share results. E.g. NREL said Oahu has a lot of potential in central area around the agriculture that is excluded	1
255				Regarding initial modeling results of offshore wind in 2040 with large generation addition. It may make more sense to consider starting to add resources earlier (than the model would suggest needing it) to avoid the problem of large resource adds at the very last minute, particularly if this is working towards meeting RPS targets. It is a risk management consideration	Model Mechanics	Will take that into consideration. We generally procure to the needs of the system. The model just suggests what might be needed. Actual procurement will be adjusted as appropriate.	1
256				Regarding aggregated portfolio - Concern that one resource type might dominate. Doesn't the portfolio approach mitigate that issue	Grid Services Definition Methodology	Going back to initial feedback on regulation reserve rule. Rather than disaggregating wind, solar and DER consider them together. If one resource ramps up when another ramps down then they would net out with fewer total resources. It would be fine if that could be guaranteed if proportions stayed the same as historical. Because RESOLVE is trying to incorporate reg reserve needs of the existing resources as well as incremental resources, Resolve builds a PV heavy portfolio. The more balanced reg reserve in the portfolio may not apply in that case. We are capturing the total regulating reserve requirements for load, DER, Grid scale PV and wind.	1
257				For the different grid service definitions, what do you intent to include. Will there be an explanation of the analytical Basis for determining those in the next iteration?	Grid Services Definition Methodology	Yes. Inputs workbook gives a glimpse of this. 2nd draft will try to define all of the services.	1
258				Different grid service requirements are a constraint on the model. At the end of the process we are looking for avoided cost based on the value of the service itself. Curious if you could explain a bit more how the value is determined? Resolve -> Plexos -> PSSE or another tool. How is the value of grid services estimated?	Grid Services Definition Methodology	For each grid service there is a requirement for the service. Each resource characterized on whether it can or cannot provide a service. As RESOLVE solves for reserve, RPS, or load, it will create a set of dispatches using a marginal incremental resource to meet the marginal service needs. The cost of the marginal resource to meet that marginal service provides the marginal avoided cost. Marginal avoided costs were planned to be used as an initial screening approach for the RFPs. RESOLVE publishes a set of avoided marginal costs and planning to incorporate in the resource plan small increments of capacity amounts (PV, PV+battery, wind) and use the dispatch of that representative dispatch to evaluate how a similar proposal from the RFP will look like. Doesn't affect the modeling cost significantly, but gives a sense of how that resource may be dispatched and the marginal avoided cost value to understand the benefit of the resource. Compare the benefit of the scaled up representative resource to the proposal cost from the RFP.	1

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3 - Question/Not adopted and reason provided

259				Why is the planning horizon starting in 2025 for RESOLVE. What happens between now and 2025? May need to think about how to best look at those early years in the planning horizon.	Grid Services Definition Methodology	Within Plexos, will model that through 2050, but not modeling prior to 2025 in RESOLVE because we are making the assumption that a resource (PV, battery, wind, synchronous condenser) the earliest it is reasonably in service is 2025. Some thermal and offshore wind, they will take a bit longer and modeling 2028-2030. The early part of the planning horizon will be modeled in PLEXOS. Could shift first 10 years. 2025 seemed like a reasonable first year. Could consider other resources sooner.	1
260				Does Resolve or Plexos have the capability of valuing T&D and paring with certain types of resources	Transmission Needs	Interconnection costs are being captured in, for example, the renewable energy zones if additional transmission is required. Doesn't assume unlimited transmission capacity for grid scale solar and DER could potentially have lower interconnection cost. Goal is to identify the capital needed for distribution upgrades needed. Thought is to encourage development in areas. To the extent that there is still unresolved needs, those would be filled by procurement or programs.	1
261				Does the workbook 2 list costs for different types of resources. Will there be associated costs for T&D?	Transmission Needs	Transmission costs are not in the workbooks yet. The other resource costs should be in the workbook	1
262				Resolve is not set up to look at DR and other technologies. CA working to reflect this in modeling. May want to see how those are applicable to HI. Recent award to LBNL for flexible load hub and E3 is part of that and resolve may be modified as a result.	Model Mechanics	We do have DR as part of grid services RFP and they are being modeled in Resolve. Capacity projects for load build and load reduce. In Resolve model we have today, modeling DR resource there is just a limit on the number of calls. A lot of functionality in a battery system that could be a proxy for load build and load reduce. Can make adaptations to current framework	1
263				Does any modeling take into account any plans you have to replace or upgrade T&D systems?	Transmission Needs	If it's aging infrastructure, it is part of base capital expenditures under RAM or ARA. If it is resilience type investment, we proposed a resilience framework in the updated workplan and we need to start discussing it with stakeholder council with generation and transmission hardening. Interconnection transmission costs go back to renewable energy zone concept and capturing transmission upgrades. Distribution will go through NWA process to determine if there is DER available to defer distribution investment.	1
264				There is a lot of discussion on how we do NWAs and limit transmission upgrades, but at some point we will need new transmission.	Transmission Needs	Yes – looking at the renewable energy zones need for transmission upgrades and interconnection but the effort is just starting. Looking at more granular details of the NREL study. Wild fire part of a broader resiliency effort and strategy. At some point we need a more detailed discussion on resilience framework and how to prioritize investments. Microgrid component consideration as well as T&D and wildfire areas.	1
265				Does HECO have any plans to integrate everything in to a master model or keep the tools independent for long range planning?	Model Mechanics	There is not a model that integrates it all. There is a concerted effort for ARA or EPRM to look at the various strategies to prioritize hardware investments. So there is coordination among the T&D strategies to improve reliability and resilience on a year over year basis trying to get the biggest bang for the buck. Various T&D investments also impact resource integration.	1

SERVICE LIST
(Docket No. 2018-0165)

DEAN NISHINA
EXECUTIVE DIRECTOR
DEPARTMENT OF COMMERCE AND CONSUMER AFFAIRS
DIVISION OF CONSUMER ADVOCACY
P.O. Box 541
Honolulu, HI 96809
Dean.K.Nishina@dcca.hawaii.gov

1 Copy
Electronic Transmission

JOSEPH K. KAMELAMELA
CORPORATION COUNSEL
ANGELIC M.H. HALL
DEPUTY CORPORATION COUNSEL
COUNTY OF HAWAI'I
101 Aupuni Street, Suite 325
Hilo, Hawaii 96720
Attorneys for COUNTY OF HAWAI'I
AngelicMalia.Hall@hawaiicounty.gov

1 Copy
Electronic Transmission

ISAAC H. MORIWAKE
KYLIE W. WAGER CRUZ
Earthjustice
850 Richards Street, Suite 400
Honolulu, HI 96813
Attorneys for BLUE PLANET FOUNDATION
imoriwake@earthjustice.org
kwager@earthjustice.org

1 Copy
Electronic Transmission

WILLIAM J. ROLSTON
DIRECTOR – ENERGY ISLAND
73-4101 Lapa'au Place
Kailua Kona, Hawaii 96740-8424
willenergyisland@gmail.com

1 Copy
Electronic Transmission

BEREN ARGETSINGER
Keyes & Fox LLP
P.O. Box 166
Burdett, NY 14818
Counsel for HAWAI'I PV COALITION
bargetsinger@keyesfox.com

1 Copy
Electronic Transmission

TIM LINDL
Keyes & Fox LLP
580 California Street, 12th Floor
San Francisco, CA 94104
Counsel for HAWAI'I PV COALITION
tlindl@keyesfox.com

1 Copy
Electronic Transmission

SERVICE LIST
(Docket No. 2018-0165)

WILLIAM G. GIESE
Executive Director
HAWAII SOLAR ENERGY ASSOCIATION
c/o Hawaii Solar Energy Association
PO Box 37070
Honolulu, HI 96817
wgiese@hsea.org

1 Copy
Electronic Transmission

HENRY Q CURTIS
VICE PRESIDENT FOR CONSUMER AFFAIRS
LIFE OF THE LAND
P.O. Box 37158
Honolulu, Hawaii 96837
henry.lifeoftheland@gmail.com

1 Copy
Electronic Transmission

DOUGLAS A. CODIGA
MARK F. ITO
Schlack Ito
A Limited Liability Law Company
Topa Financial Center
745 Fort Street, Suite 1500
Honolulu, Hawaii 96813
Attorneys for PROGRESSION HAWAII OFFSHORE WIND, LLC
dcodiga@schlackito.com

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Electronic Transmission

GERALD A. SUMIDA
ARSIMA A. MULLER
Carlsmith Ball LLP
ASB Tower, Suite 2100
1001 Bishop Street
Honolulu, HI 96813
Attorneys for ULUPONO INITIATIVE LLC
gsumida@carlsmith.com
amuller@carlsmith.com

1 Copy
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Chun, Marisa

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