ERRA 21st Annual Conference
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Energy Regulatory Commission
Office of the Energy Regulatory Commission

Session II:

IMPACT OF CLEAN ENERGY SOURCES ON THE GRIDS AND SYSTEM STABILITY

Hawaii Best Practices and Lessons Learned for Grid Modernization and Renewable Energy Impacts on Island Grid Systems

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Hawaii Electric Systems – 4 Electric Utilities; 6 Separate Grids; % Renewable

Kauaʻi Island Utility Cooperative

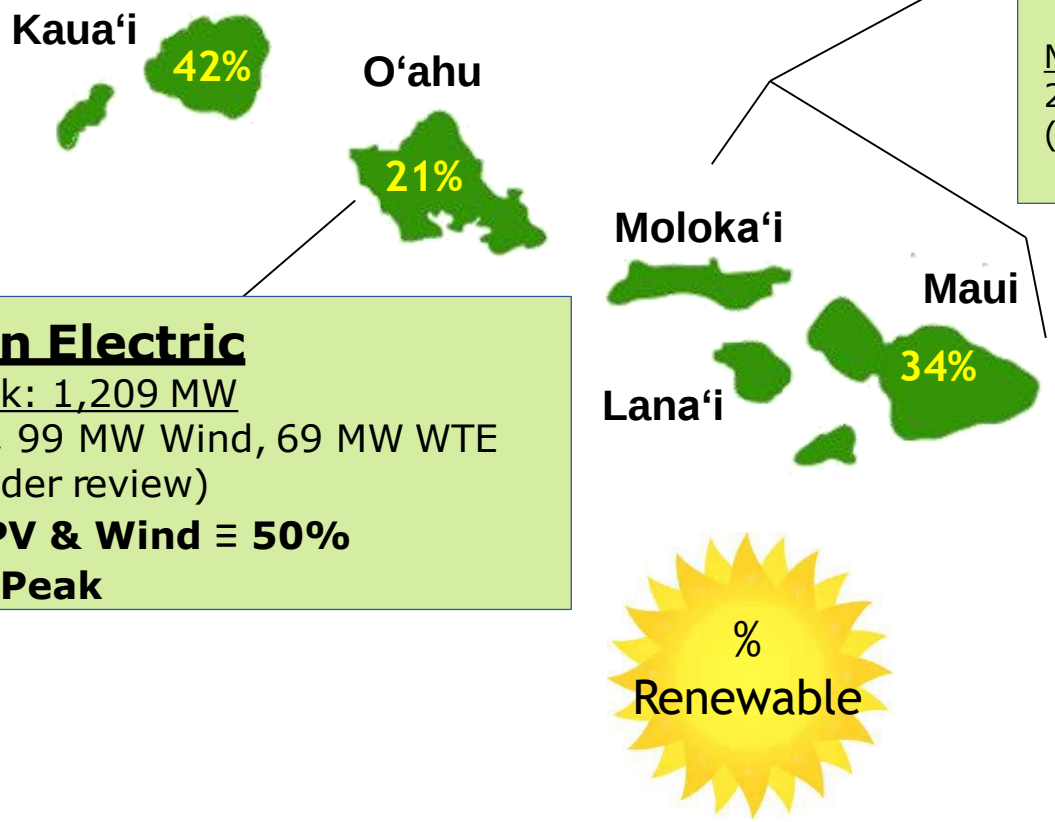
System Peak: 75 MW
77 MW PV, 7 MW Biomass, 9 MW Hydro
(+~34 MWac PV, 170 MWh storage under construction)
Installed PV ≡ 103% of System Peak

Maui Electric

Maui System Peak: 199 MW
110 MW PV, 72 MW Wind (+ more PV under review)
Installed PV & Wind≡ 91% of System Peak

Lanaʻi System Peak: 5.4 MW
2.8 MW PV **(52% of System Peak)**

Molokaʻi System Peak: 5.9 MW
2.2 MW PV **(37% of System Peak)**
(+2.64 MWac PV under review)



Hawaiian Electric

System Peak: 1,209 MW
502 MW PV, 99 MW Wind, 69 MW WTE
(+ more under review)
Installed PV & Wind ≡ 50% of System Peak

Hawaiʻi Electric Light

System Peak: 191 MW
90 MW PV, 32 MW Wind, 38 MW Geothermal, 16 MW Hydro
(+ more under review)
Installed PV & Wind ≡ 64% of System Peak

Distributed Energy Resources

- In addition to large scale utility wind, solar, hydro, biomass and geothermal on various islands Hawaii has the largest amount of installed rooftop PV in the United States

System Stability for Island Grids: Challenges and Opportunities

- Hawaii's electric system is comprised of 6 separate island grids with no interconnection and transmission capability between islands
- Each island grid operates independently for energy generation and system balancing
- Mandate of 100% renewable energy on Hawaii electric grids by 2045
- Increasing levels of variable intermittent energy generation from utility scale solar and wind and distributed rooftop PV
- Need for distribution circuit monitoring and demand side management tools at the sub-transmission level
- Integrated Grid Planning and modern grid infrastructure are critical given the impacts from distribution circuits on transmission system
- Increased utilization of smart grid technology including advanced meters and smart inverters in PV and energy storage systems

Envision the Integrated Grid of the Future

- Hawaii is the living laboratory for the integrated grid of the future to achieve the 100% renewable energy portfolio standard and 100% decarbonization
- Implementing distributed energy resource actions and combining the tools of both traditional central plant, large utility scale renewable generation and decentralized distribution generation models
  Utilizing energy storage technology, microgrid services and demand side management resources to support a 100% renewable energy grid
- Achieving an integrated energy network through grid modernization and a shared integrated grid with water, telecommunications and electrification of transportation
- Investing in smart grid infrastructure and grid edge technologies
- Regulating in a time of innovation includes empowered customers, dynamic markets and sustainable infrastructure

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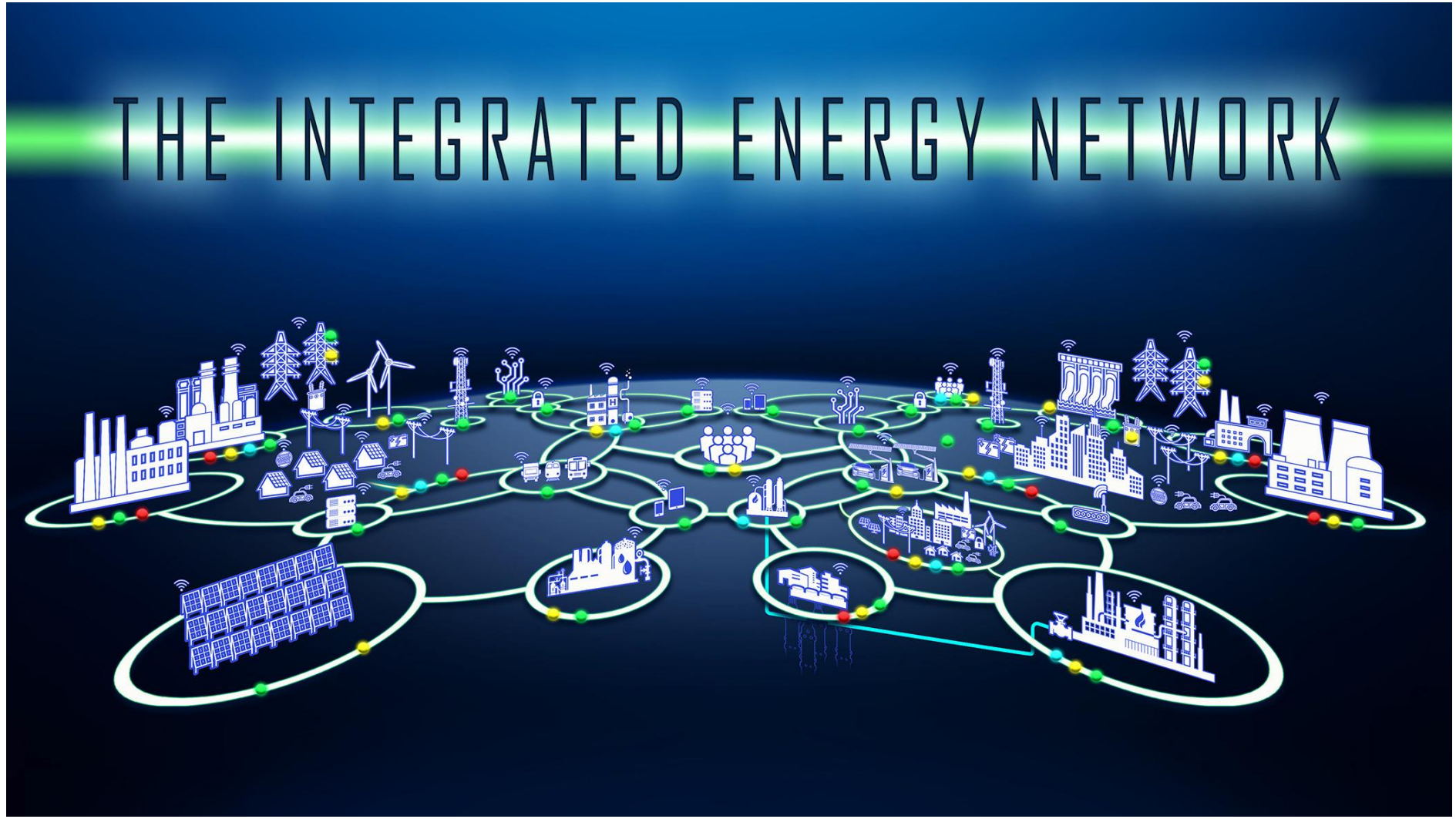

THE INTEGRATED ENERGY NETWORK

Hawaii's Regulatory Framework for Renewable Energy Integration and Grid Modernization

- Hawaii PUC Whitepaper: "Inclinations on the Future of Hawaii's Electric Utilities", Order 32052, Docket 2012-0036
- In April 2014, the PUC set forth policy guidance for usage of distributed energy resources including energy storage technology to provide grid support
- Hawaii Legislature in 2015 enacts law to increase the renewable energy portfolio standard for electric utilities to 100% by 2045
- Hawaii already had laws in place since 2008 requiring 70% renewable energy by 2050 and 30% energy efficiency portfolio standards
- In 2018, the Legislature passed Act 15 requiring 100% carbon reduction in other sectors and Hawaii to be carbon neutral by 2045
- Policies to address climate change impacts and mitigation

HAWAII REVISED STATUTES SECTION 269-145.5

- Legislation addressing advanced grid modernization technology and principles
- Directed that the Hawaii PUC shall consider the value of improving electrical generation, transmission and distribution systems and infrastructure through use of advanced grid modernization technology in order to improve reliability and operational efficiency of Hawaii's electrical system
- Required balancing technical, economic, environmental and cultural considerations associated with grid modernization in accordance with enumerated principles:
- Enabling a diverse renewable energy resources portfolio
- Expanding customer options to manage their energy usage
- Maximizing interconnection of distributed generation
- Determining fair compensation for grid services received and provided by customers
- Maintaining or enhancing grid reliability and safety

GRID MODERNIZATION - DOCKET NO. 2017-0226

- Hawaii PUC issues Order 34281 in Docket 2016-0087 which rejected w/out prejudice the HECO Smart Grid Foundation Project and outlined concerns regarding cost effectiveness, how the project would support renewable and DER integration, risks of technology obsolescence and stranded costs, and the pace of implementation of the “smart grid”.
- The commission ordered the utility to develop a holistic grid modernization strategy including not just sound technology solutions and tools but also providing new business models, new regulatory approaches, and the emergence of new providers to facilitate increasingly innovative solutions
- Grid modernization guidance in April 2014 when the Hawaii PUC issued the seminal white paper and strategic road map for the utilities, “Commission’s Inclinations on the Future of Hawaii’s Electric Utilities”
- The Inclinations and the corresponding orders in 4 separate dockets initiated proceedings addressing:
  1) Migrating from net metering to a grid services market;
  2) Launching community renewables (community solar);
  3) Growing demand response capabilities; and
  4) Aligning cost recovery with performance incentive mechanisms and new performance metrics
  5) Integrated resource planning;

- Integrated Planning through PSIP and DGIP and Grid Modernization dockets
- Integrated energy systems planning is a must to achieve the 100% RPS goal
  - Grid Modernization as Part of the Regulatory Framework
  - DER Investigation and Grid Modernization
  - Demand Response and Grid Modernization
- After receiving input from stakeholders, HECO filed its final grid modernization strategy on August 29, 2017, in Docket No. 2017-0226
- On February 7, 2018, Order 35268 gave final approval for the HECO grid modernization plan focusing on:
  1) use of advanced inverter technology for rooftop PV
  2) expanded use of voltage management tools, especially on circuits with heavy solar penetration
  3) enhanced outage management and notification technology
  4) strategic deployment of AMI rather than blanket system wide deployment; which will enhance sensing and monitoring functions to work with DR portfolio plan actions and implementation

Grid Modernization Integrating More Renewables

- Grid Modernization provides grid operators and engineers with more data and tools to improve and increase integration of more renewable energy as we move forward to accomplish Hawaii's 100% renewable energy goal by 2045
- Technology allows quicker response and ancillary services to support the high renewables grid with wind and solar resources
- Advanced Meters are important components of the grid modernization strategy and implementation with digital technology that enables real time trouble shooting
- Advanced Meters also allow shared access to energy usage data for customer choices and controls for energy management so customers can benefit from time of use pricing

Grid Modernization Technologies

- Enhancing the operational capabilities of the electric grid by improving reliability
- Grid modernization technologies and advanced meters can enable direct communication with each other to automatically send outage messages to the electric utility
- Identifying and locating problem areas quicker on the electric grid and in some areas remotely fixing the outages to restore service to customers faster
- Additional data analytics and AI tools for disaster mitigation and response like wildfires

HECO Grid Modernization Strategy

- HECO's Grid Modernization Strategy is part of the new planning process put in place with the Hawaii PUC's directives in Docket 2018-0165
- The grid modernization action plan incorporates communications and information technologies to better manage how electricity is produced, stored, delivered and consumed
- Technology and data analytic tools enable collection of real time data across the electric grid and capability to remotely adjust grid operations and regulate the power supply at both the distribution and transmission system
- Grid modernization also gives the electric grid greater flexibility to integrate more intermittent renewable energy and more energy management tools with dynamic pricing options for customer time of use rates

HECO Integrated Grid Plan

- In Docket 2018-0165 the Hawaii PUC reviewed Hawaiian Electric's Integrated Grid Plan (IGP) Report filed in July 2018 to provide guidance and directives where necessary and appropriate regarding the integrated grid planning process
- In March 2019 the first phase of HECO's four year IGP was approved and authorized an $86.3 million expenditure to install digital technology across all of its service territories
- Allows the utility to develop a dynamic high technology open platform for its grids that can provide real time data on two-way power systems
- Will help expand amount of private rooftop solar including behind the meter storage, advanced meters and smart inverter usage to provide demand response tools and ancillary services to the grid

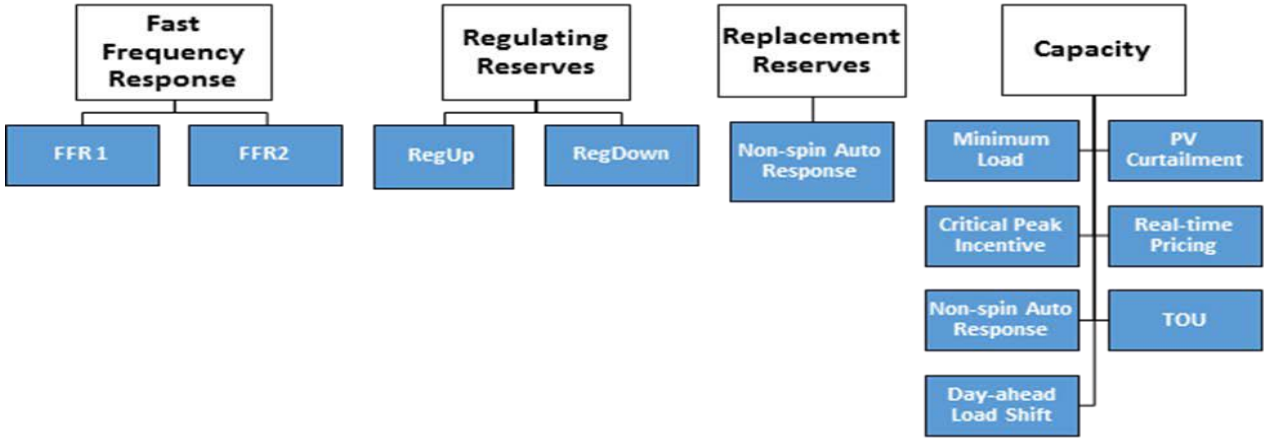
HECO Integrated Grid Planning (IGP)

- IGP is the implementation methodology for HECO's Grid Modernization Strategy
- IGP touches upon almost every element of HECO's business and per Hawaii PUC Orders must be be transparently coordinated with other HECO dockets like Performance Based Regulation, Microgrid Tariff, Distributed Energy Resources, and HECO's RFPs for renewable energy procurement
- Stakeholder engagement is a hallmark requirement to make sure IGP is rooted in customer and stakeholder input including formally constituted Stakeholder Engagement Groups and a Stakeholder Council with members from specific representative stakeholder interests
- Formalized various regular Working Groups addressing technical and policy issues
- Technical Advisory Panel of independent experts established to provide independent industry peer assessment

DEMAND RESPONSE - DOCKET NO. 2015-0412

- The HECO Companies first set of comprehensive DR Portfolio Plans approved on January 25, 2018
- Significant stakeholder input and engagement through technical working groups comprised of industry and community representatives with analysis and recommendations gathered from 2 years of meetings
- Core efforts include:
  a) identify system response requirements;
  b) define grid service needs in technology-neutral terms;
  c) model costs of requisite ancillary services (avoided cost basis);
  d) determine DR potential to meet said ancillary services
- HECO identified 4 broad ancillary service tariff categories: Fast Frequency Response; Regulating Reserves; Replacement Reserves; and Capacity.

- Under each of these tariffs, more granular service riders can be included:
- FFR1 and FFR2
- RegUp/RegDown
- Non-spin Auto Response
- Capacity services including time-of-use and PV curtailment



- Broad open platform technology approach using third party DR aggregators and customer sited energy storage systems and EVs

Resources for Integrated Distribution Planning and Grid Modernization

Smart Electric Power Alliance, “Integrated Distribution Planning: A Framework for the Future”

- Integration of internal elements and processes within a utility to enhance distribution planning
- Integration of distribution planning with transmission, and generation planning as applicable

Six key elements:

- Core IDP elements include forecasting, sourcing solutions for grid needs, and transmission and distribution grid integration
- Additional elements include interconnection data integration, hosting capacity analysis, and stakeholder engagement

Technical Resources for Integrated Distribution Planning and Grid Modernization

Interstate Renewable Energy Council and GridLab, ”A Playbook for Modernizing the Distribution Grid”, Volume 1, Grid Modernization Goals, Principles and Plan Evaluation Checklist

- Grid Modernization Principles:

  1) Support and enable policy goals including decarbonization of the electricity system and beneficial electrification of the transportation and building sectors
  2) Enable the adoption and optimization of DERs
  3) Empower people, communities and businesses to adopt affordable clean energy technologies and solutions
  4) Support secure and transparent information sharing and data access
  5) Enable innovation in technology and business models

Technical Resources for Interconnection Standards and Best Practices

Interstate Renewable Energy Council (IREC) Model Interconnection Procedures, 2023 Edition, https://irecusa.org/resources/irec-model-interconnection-procedures-2023

IREC Report: Key Decisions for Hosting Capacity Analyses, September 2021. Guidance to regulators in overseeing utilities developing hosting capacity analyses to integrate DERs on their distribution grids

Institute of Electrical and Electronic Engineers (IEEE) IEEE- standards for interconnection, including IEEE 1547-2018. See resources at: www/ieee.org.

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