GridSTART
Hawai'i Natural Energy Institute | University of Hawai'i
Grid System Technologies Advanced Research Team

Modernized Resource Planning in PICs for Orderly Energy Transition

Pacific Power Association 32nd Annual Conference | Palau, September 22, 2025 |

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Grid System Technologies Advanced Research Team (Grid*START*)

HNEI, SOEST, University of Hawai'i at Mānoa

- Grid***START*** delivers comprehensive power system solutions through a unique blend of technical expertise and industry insights and experience.
- Diverse staff of engineers, lawyers, MBAs, postdoctoral fellows, students, and visiting scholars.
- We excel in:
  - **Energy Transition**: Grid integration of diverse energy resources, developing smart grid technologies, and modernizing power systems to accelerate the transition and integration of the energy and transportation sectors.
  - **Scalability**: Addressing challenges across diverse project scales, from grid-wide modeling and analytics to grid-edge solutions.
  - **Applied Research**: Bridging the gap between research and real-world applications to solve pressing power grid issues.
  - **Regional and Global Impact**: Providing specialized technical support, energy policy and regulatory guidance and energy sector advisory services and training with a focus on the Asia-Pacific region.

Lead for many public-private demonstration projects

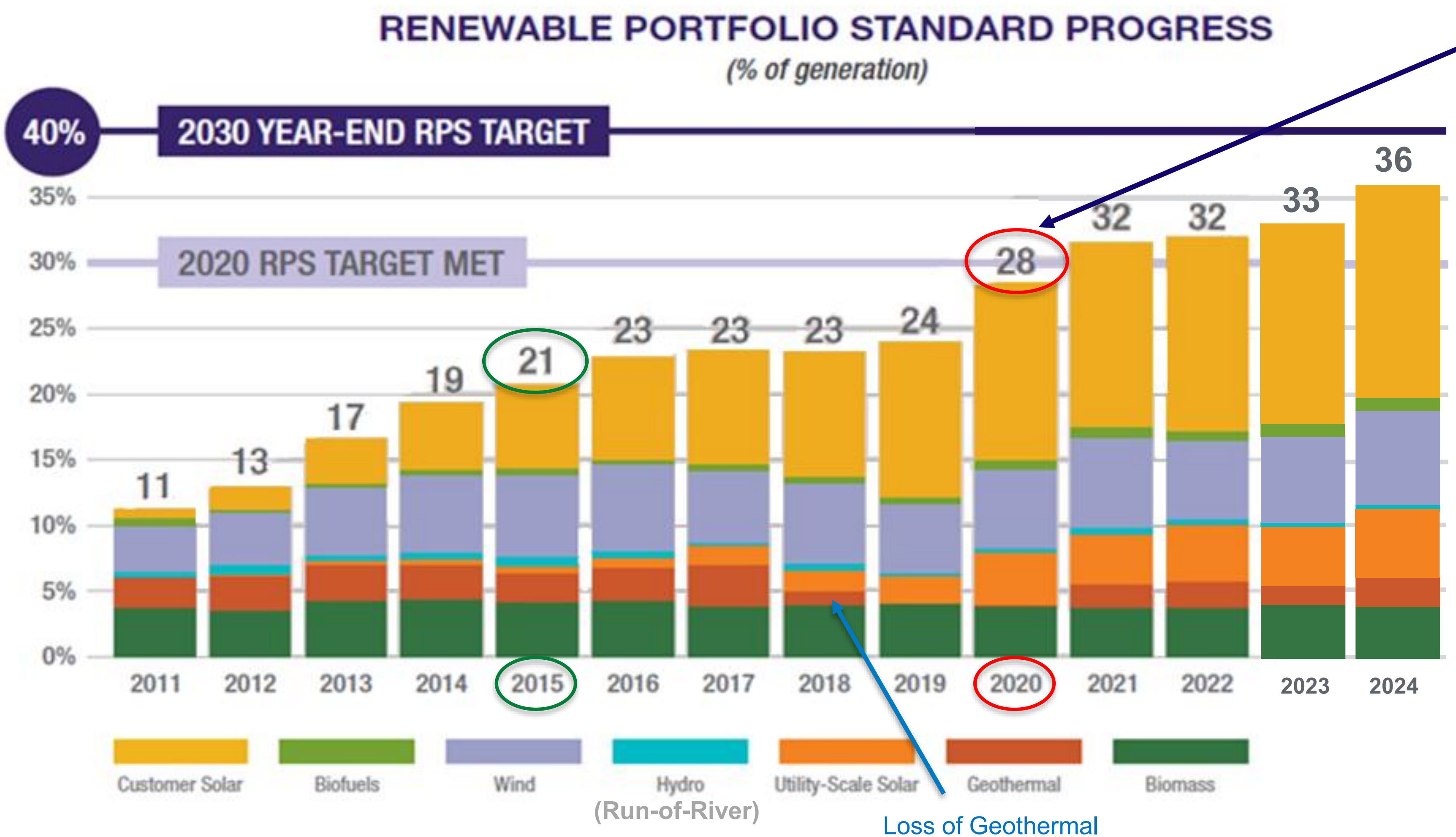
Established to develop and test advanced grid architectures, new technologies and methods for effective integration of renewable energy resources, power system optimization and resilience, and enabling policies and regulations

Expertise & Focus:

- Energy Policy and Regulation
- Power Systems Planning
- RE Resource Procurement
- Power Systems Operation
- Energy Transition Technology Solutions
- Energy Sector Capacity Building
- Project Management and Execution

Progress Toward A Clean Energy Future

Hawaiian Electric Companies

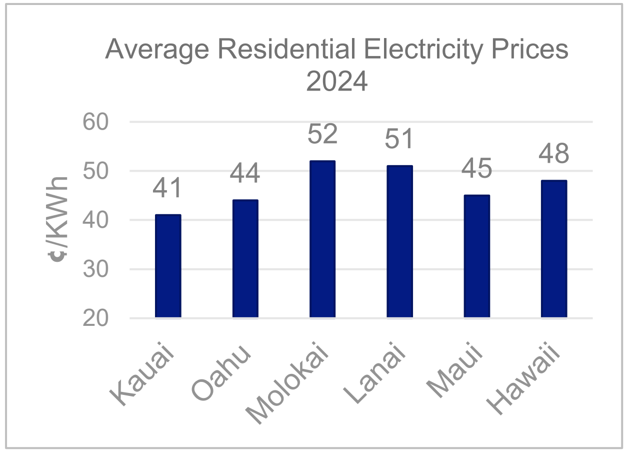


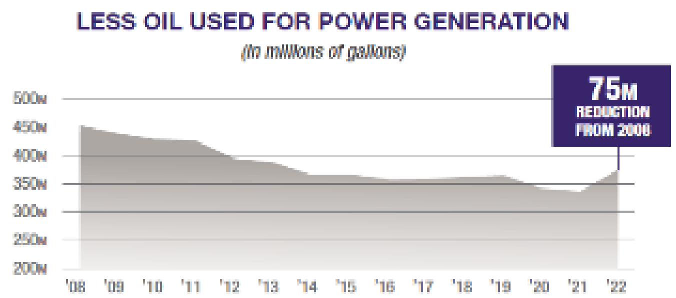
Loss of Geothermal Production (May 2018)

Source: Hawaiian Electric Sustainability Report 2022-2023
Hawaiian Electric Performance Score Cards Historical Data (through Q3, 2024)

Hawaii RPS Goals

- 2015 - 15%
- 2020 - 30%
- 2030 - 40%
- 2040 - 70%
- 2045 - 100%





Hawai‘i’s Electric Systems

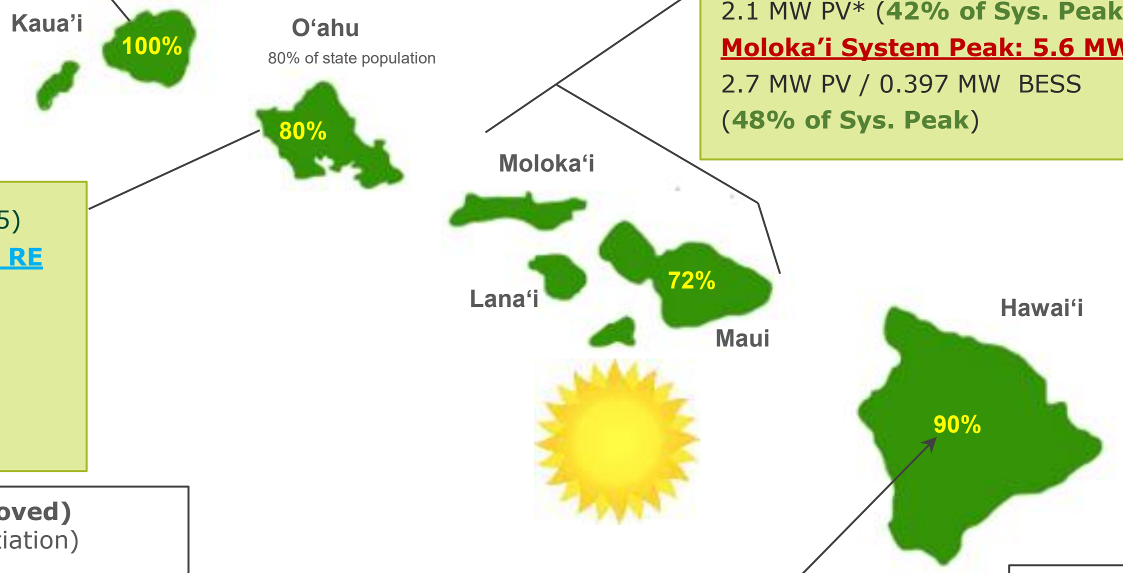
4 Electric Utilities; 6 Separate Grids; High Renewable Energy Penetrations

Kaua‘i Island Utility Cooperative (Dec 2024)
System Peak: 80 MW, **60% RE**, Target: 100% RE by 2033
132 MW PV* / 7 MW Biomass / 16 MW Hydro* / 252 MWh BESS
Installed PV: 165% of Sys. Peak

* 78 MW - additional Solar + BESS

Maui Electric (June 2025)
Maui System Peak: 206 MW, **41% RE**
225 MW PV* / 72 MW Wind/ 264 MWh BESS
Installed PV & Wind:
144% of Sys. Peak
Lana’i System Peak: 5.1 MW
2.1 MW PV* (**42% of Sys. Peak**)
Moloka’i System Peak: 5.6 MW
2.7 MW PV / 0.397 MW BESS
(**48% of Sys. Peak**)

Maui
***160 MWh BESS (Approved)**
60 MW PV/ 240 MWh BESS (In Negotiation)
40 MW Biofuel (In Negotiation)



Hawaiian Electric (June 2025)
System Peak: 1,216 MW, **31% RE**
1,040 MW PV* / 123 MW Wind /
69 MW WTE / 50 MW Biofuel /
1,291 MWh BESS*
Installed PV & Wind:
96% of Sys. Peak

* **37 MW PV + 275 MWh BESS (Approved)**
126 MW PV/ 510 MWh BESS (In Negotiation)
560 MW Biofuel/CHP (In Negotiation)

Hawaii Electric Light (June 2025)
System Peak: 191 MW, **59% RE**
211 MW PV* / 31 MW Wind / 240 MWh BESS
38 MW Geothermal* / 17 MW Hydro
Installed PV & Wind:
127% of Sys. Peak

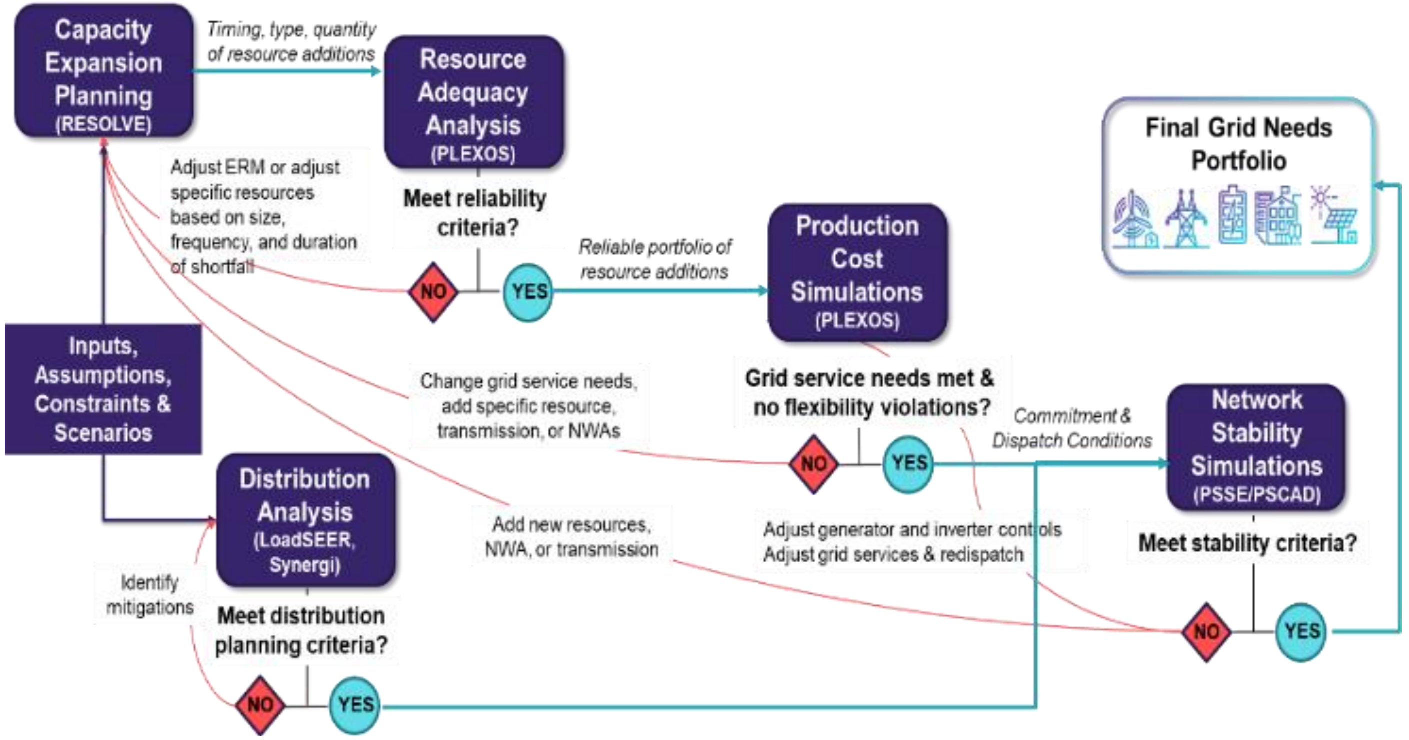
Renewable Energy Peak Daily Production in 2024
(e.g. occurred on July 9, 2024)

* 86 MW PV / 374 MWh BESS (In Negotiation)
60 MW Biofuel (30%) / 30 MWh BESS (In Negotiation)
Geothermal Plant is in operation at reduced capacity (30 MW) due to volcanic eruption. An 8 MW expansion, to 46 MW, is approved

Integrated Resource Planning for Renewable Energy

Hawaiian Electric Company

- Classical integrated resource planning (IRP) processes focus on least cost generation and network _capacity expansion needs_ to meet forecasted electricity demand over a specified future period.
- Today, while grid expansion needs must certainly be addressed, IRP focus has markedly shifted to grid transition requirements defined by socio-economic and policy goals, such as renewable energy (RE) or carbon reduction targets, all at "lowest reasonable" cost.
  - RE resources, especially intermittent and variable renewable energy (VRE) resources, require more _detailed and sophisticated_ analysis of resources across a wide range of types and sizes, and grid support measures needed to make it work.
  - VRE resources introduce uncertainty in energy production that must be assessed in timeframes of seconds /minutes /hours /days /weeks /years to ensure grid reliability, operability and economic viability.
  - This requires the use of advanced tools and methods in planning.



Source: Hawaiian Electric Company, Integrated Grid Planning

System Planning Studies vs ***Project*** Impact Studies

GridSTART

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Long-range Grid Planning Study (aka System Integration Study)

System level impacts and solution sets for optimal resource portfolio mix (multiple projects over planning horizon)

- System frequency management
- General mitigation strategies
- Develop performance requirements for renewable generation projects
- Generation reserve requirements
- Production analysis & curtailment risk
- Steady state and transient contingency analysis

Interconnection Requirements Study (aka Grid Impact Study)

Local level impacts and solution sets for individual project interconnections

- Voltage
  - Steady state (voltage regulation requirements)
  - Transient (including ride-through requirements)
  - Flicker
- Short circuit
  - Voltage strength (short circuit ratio)
  - Protection
    - Fault detection and coordination
    - Islanding (Transfer Trip Protection)
    - Breaker Overload Assessment
- Inverter Based Resource (IBR) Stability
  - PSCAD (EMTP) high resolution stability assessment

SAInt by encoord

PLEXOS BY ENERGY EXEMPLAR

HOMER®Energy

XENDEE

REopt

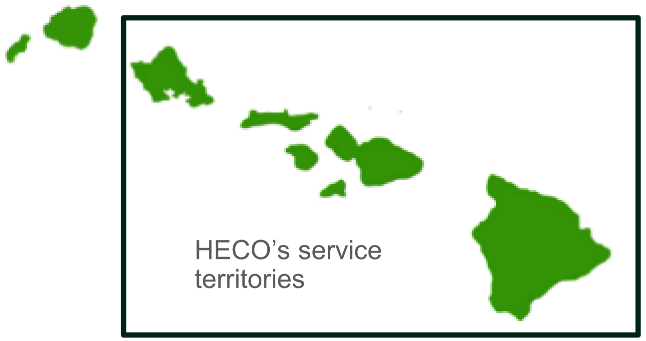
PSS®E

PSCAD

From Planning to Procurement

Hawaiian Electric Company, Inc. (HECO)

HECO in Hawaii centralizes integrated planning and procurement in its Oahu office for all of its five island grids, from its 1.2 GW Oahu grid, its ~200 MW Maui and Hawaii island grids, to its 5 MW grids on Molokai and Lanai. HECO leverages the use of common tools and technical resources across **all** of its island grids.

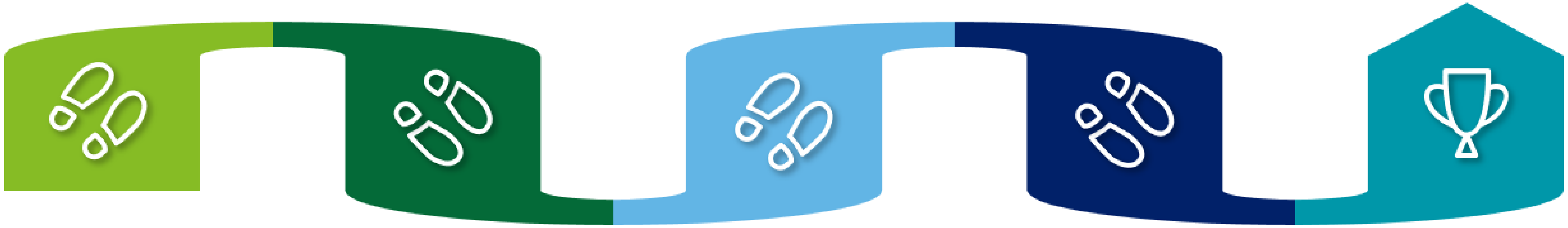


PATHWAY TO 100 PERCENT RENEWABLE ENERGY

FORECASTS AND ASSUMPTIONS
Based on customer needs and feedback, previous planning cycle results, and policy goals

SOLUTION SOURCING
Identification of least cost, best fit solution options to fulfil grid needs through the establishment of a marketplace through procurements pricing, and programs.

COMMISSION REVIEW OF PLAN
Seek commission approval of 5-year plan with discrete investments, programs and pricing proposals



GRID NEEDS IDENTIFICATION
Engineering analysis to determine optimal energy needs to meet policy goals and system reliability. Includes generation, transmission, and distribution needs.

SOLUTION OPTIMIZATION
Evaluation and optimization of resource and transmission and distribution solutions acquired through marketplace. Includes an optimized 5-year grid plan.

STAKEHOLDER AND CUSTOMER ENGAGEMENT

Evolution of Power Purchase Agreement (PPA) Structures in Hawaii

As-Available

- Utility only pays for energy export
- Accounting is simple.
- RE project owner bears the risk of curtailment, but risk is priced into their energy price at a premium.
- PPA curtailment order is reverse-chronological seniority of PPAs.
- Curtailment risk estimated with grid modeling and projection of utility operating practices and system changes over PPA term.
- **Utility bears a significant and increasing risk of litigation over curtailment events and practices.**

Take or Pay

- Utility pays for available energy.
- Available energy must be calculated during curtailment events or an average energy amount can be agreed to up front.
- Risk is better placed on utility; utility in best position to make grid and operational changes to reduce curtailment risk.
- **Utility bears the risk of curtailment which reduces the energy price; more bankable.**
- Litigation risk greatly reduced.

Lump Sum

- Utility pays for availability rather than energy.
- Most recent structure used to procure “dispatchable” PV+BESS RE.
- Provides more grid flexibility and benefits from RE resources.
- Sets target for project operational “availability” & MWh “performance”.
- **Further reduces developer risk / price.**

Evolution of Customer-Sited RE Export Programs Today

(Oahu)

2001 | 2015 | 2017 | 2024 | 2031

Full Retail NEM (~40¢)

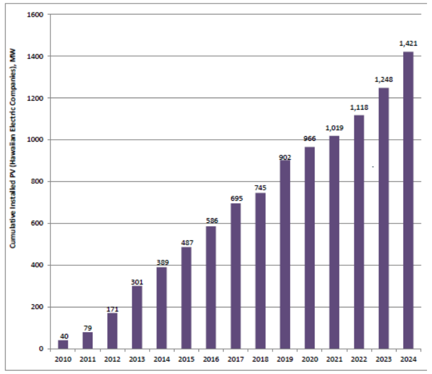
Customer Grid Supply (CGS) (15¢) ← 7 years →

CGS+ (10¢) ← 7 years →

Smart Export (15¢, 4pm-9am) ← 7 years →

Smart DER Export*
9pm - 9am (18.9¢)
9am - 5pm (13.5¢)
5pm - 9pm (32.9¢)

*Requires enrollment in new Advanced Rate Design (ARD) Time-of-Use (TOU) rates. Non-exporting interim tariff customers (e.g., CSS, SIA) may, but are not required to, transition to the Smart DER Tariff.



"While other states are in the process of determining appropriate NEM successor tariffs, [Hawaii is] establishing a 'second round' of successor tariffs to replace the initial NEM successor tariffs. Hawaiian Electric has the opportunity to utilize the high penetration of DERs on its grid to provide energy and grid services to an extent shared by few other utilities."

Docket No. 2019-0323, Decision and Order No. 40418 (**Haw. P.U.C., Dec. 4, 2023**).

Planning Considerations for Island Power Systems are Unique

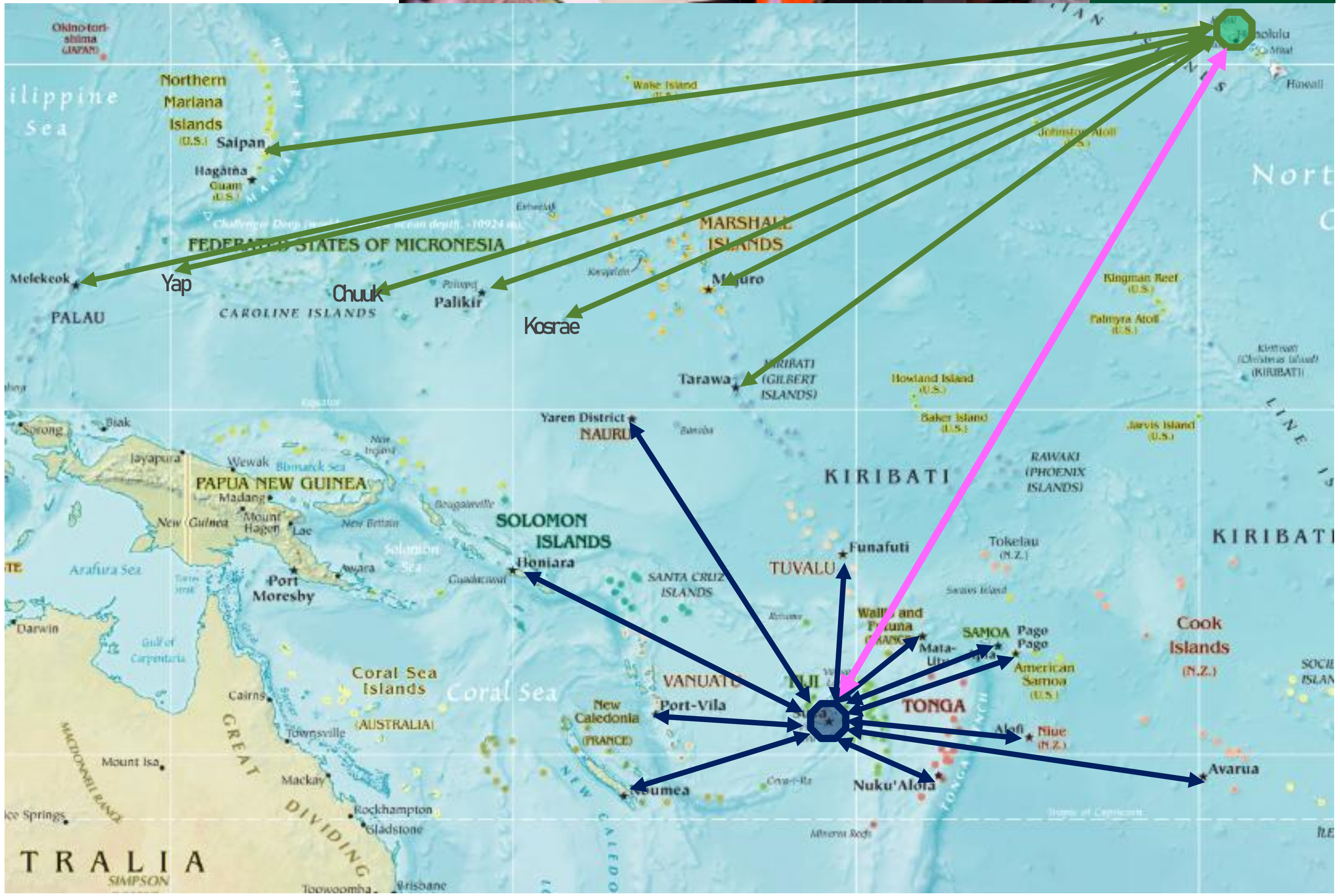
- Islands pose unique resource planning challenges:
  - Geographic isolation (high energy and shipping costs)
  - No interties to neighboring grids
  - Limited land area
  - RE resource limitations (many are limited to only PV)
  - Higher capital costs and O&M expenses
  - Lack of economies of scale in project development
  - Vulnerability to extreme weather events and importance of addressing grid resilience in long-range planning
  - Handling RE "e-waste" at asset end-of-life needs to be considered in planning
  - **Insufficient resources (engineers) to develop deep expertise and dedicate needed focus on system planning**
  - **These deficiencies limit the return on investment placed in licensing of modeling tools (tools can be expensive!) and deep training on their use, if tools and learning aren't consistently applied**

Pacific Island Regional Planning Hubs

Avoiding Planning Pitfalls

An approach to avoid planning pitfalls may be to establish a ***Regional Hub for Planning Excellence (RHEP)***, one each in the Northern and Southern Pacific, to support utility planning needs across PICs

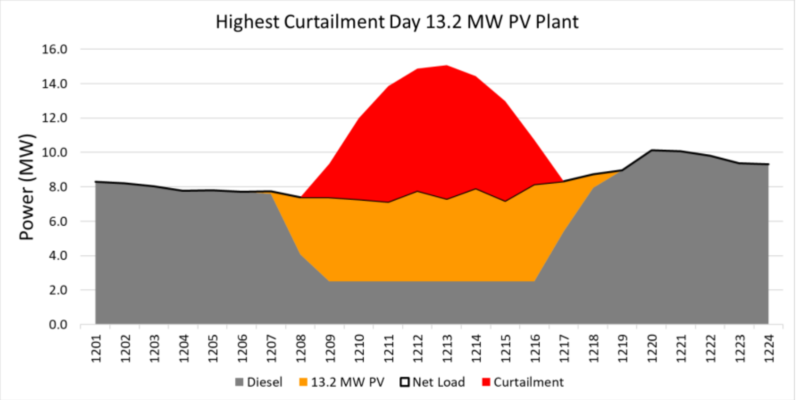
- Improved efficiency through the provision of shared costs, resources and tools
- Address the reality that maintaining full-time dedicated planning engineers is likely *not* practical for most small island utilities
- Maintain planning continuity through use of a common expert pool across PICs and over time to ensure engaged experts have a deep contextual understanding of each island grid
- A *Technical Review Committee* (TRC) approach may be employed to ensure high quality studies and cross-learning between hubs
- *Example*: To start, HNEI recently built detailed production costs models (in SAInt) for Rarotonga and Palau, with utility staff training included

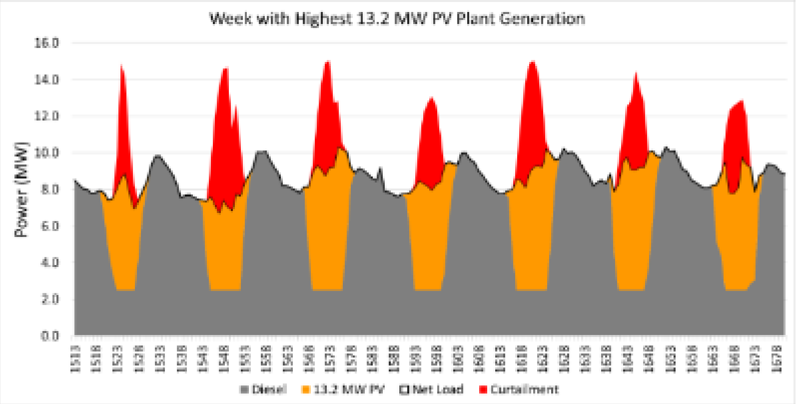


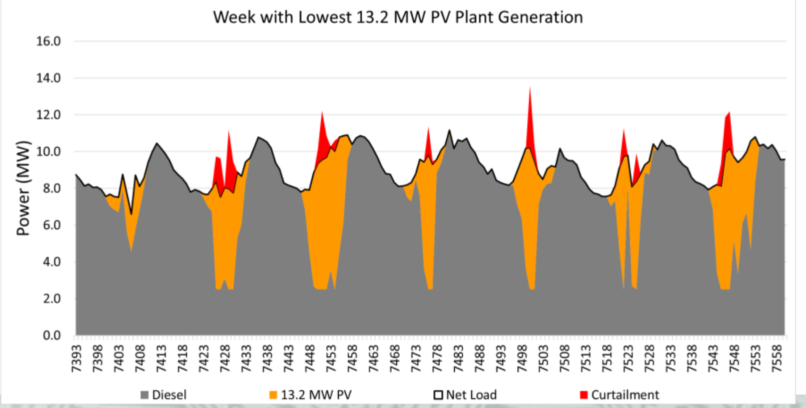
Lessons Learned from Palau's Utility-Scale PV+BESS Project Experience

Modeled curtailment of 13.2 MW PV plant with existing BESS

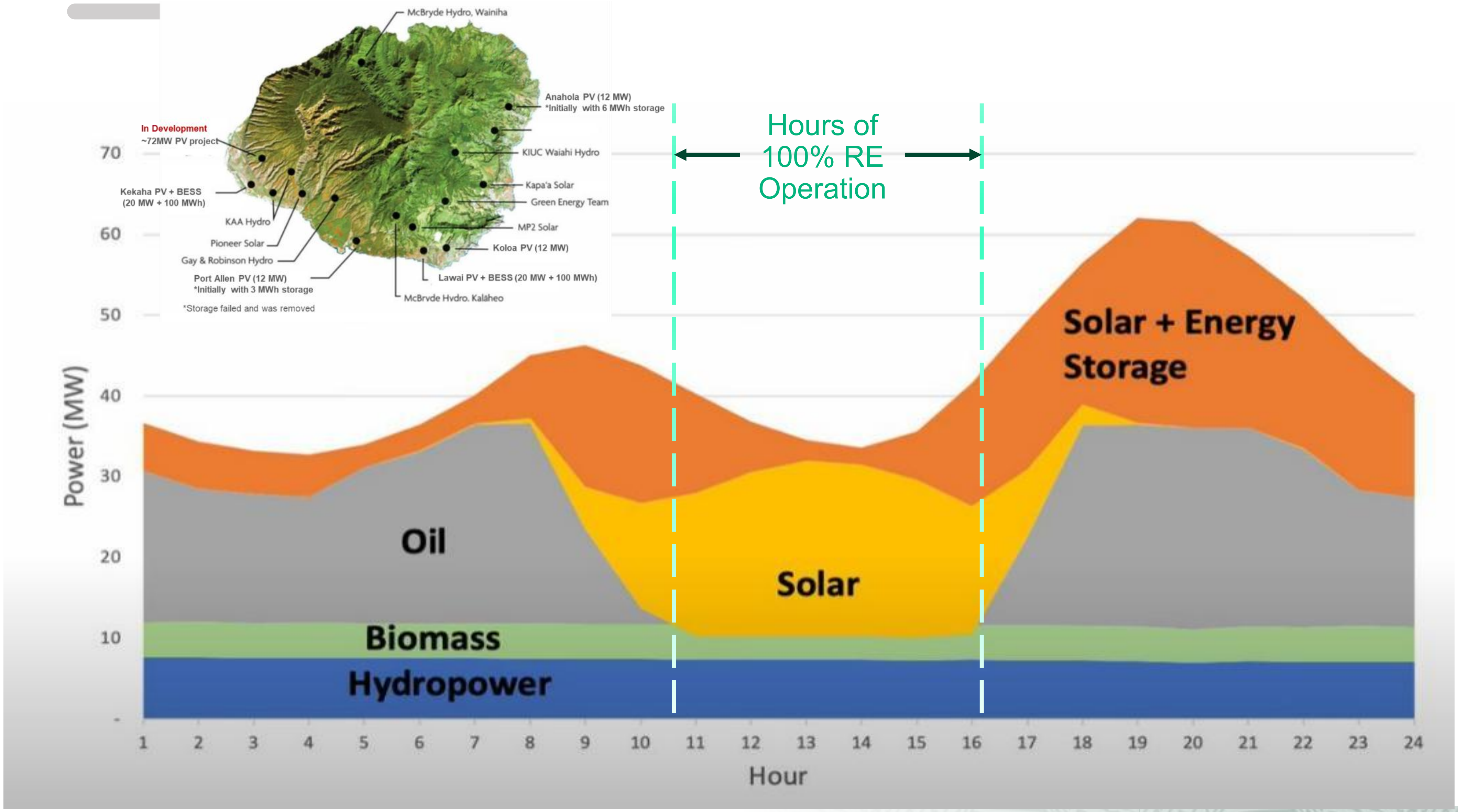
- In 2023, Palau commissioned a 13.2 MW_{ac} PV farm with a 12.9 MWh battery energy storage system under a take-or-pay PPA with an independent power producer (IPP).
- The resulting excess PV energy curtailment (and take-or-pay payments to the IPP) have been significant and exacerbated by significant installations of rooftop PV under Palau's Net Energy Metering Program.
- Although Palau is working hard to rectify this problem, it highlights a situation that appears to have high repeat potential in PICs, namely:
  - The need for technical expertise and holistic modern planning processes that first define and then drive energy project procurements to **ensure optimal resource mix, technical operability and financial viability** suited to the contextual need of each PIC.
  - Toward that end:
    1. PIC utilities need to be supported by power system engineers with the analytical knowhow, tools and contextual knowledge of the island grid to **effectively plan their energy transition**; and
    2. PIC utilities then enabled to seek developers that are fully committed to delivering **projects that their island grids actually need as derived through comprehensive planning**



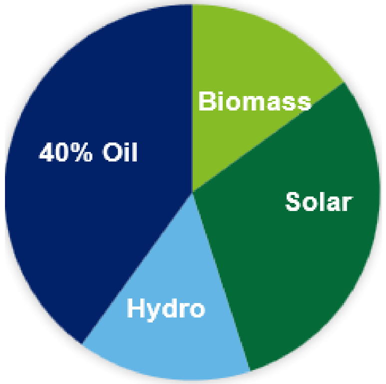


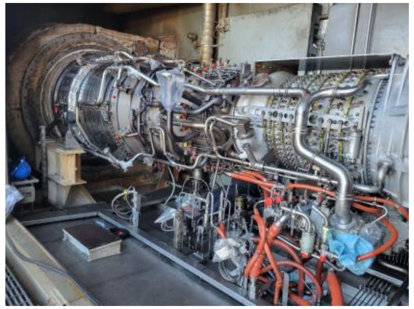


Kauai Island Utility Cooperative (KIUC) – A Success Story



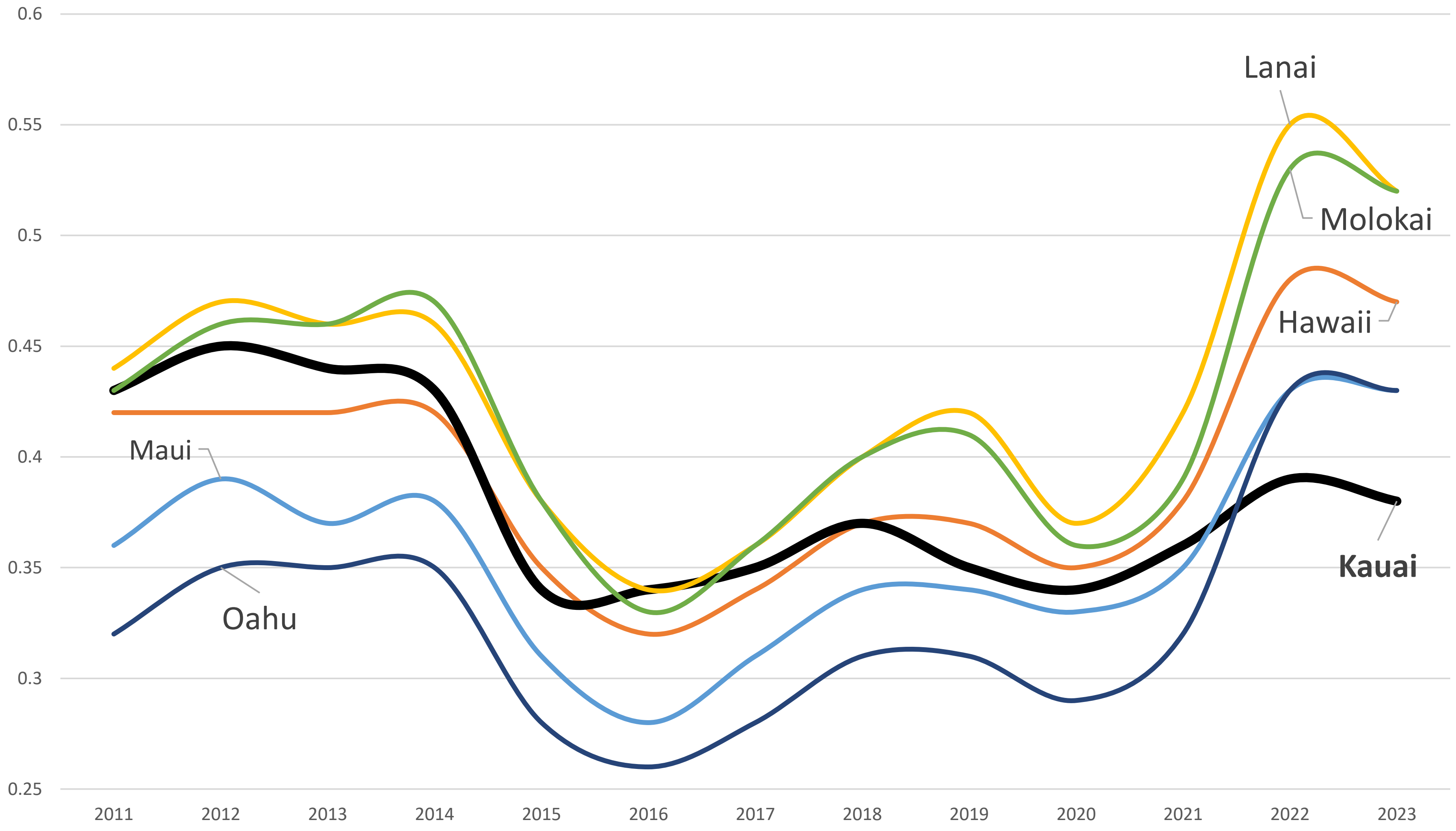
2022 Energy Mix





CT/Synchronous Condenser

Annual Average Residential Electricity Rates by Island



Mahalo!

(Thank you)

For more information, contact:

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Leon R Roose

Chief Technologist

Mr. Roose is a tenured faculty member of the Hawai‘i Natural Energy Institute (HNEI), University of Hawai‘i at Mānoa, where he formed and has led for over a decade HNEI’s Grid***START*** (Grid System Technologies Advanced Research Team), a team of professionals focused on energy transition enabling policy and regulation, advanced grid architectures, grid modernization technologies, and novel methods to achieve reliable grid integration of RE resources, power system optimization and energy resilience goals.

He served in numerous leadership roles at the Hawaiian Electric Company for 19 years prior including management of renewable energy planning and integration, generation resource planning and competitive procurement, negotiation and administration of all power purchase agreements for the utility, transmission and distribution system planning, smart grid planning and projects, system relaying and protection, and fuel purchase and supply to all utility generating plants. He is a licensed attorney, formerly in private law practice in Hawai‘i and served as Associate General Counsel at Hawaiian Electric. He holds a B.S. in Electrical Engineering and a J.D. from the University of Hawai‘i at Mānoa.

Marc M. Matsuura

Sr. Smart Grid Program Manager

Mr. Matsuura joined HNEI, at the University of Hawaiʻi at Mānoa in 2013 as its Senior Smart Grid Program Manager. He is a founding member of HNEI's Grid***START***.

Prior to joining HNEI, he worked with the Hawaiian Electric Company for 21 years. His career at Hawaiian Electric included leadership positions in transmission and distribution (T&D) engineering, T&D standards and technical services, system operation, transmission planning, smart grid planning, and system integration. Marc is a licensed professional electrical engineer in Hawaiʻi. He holds a B.S. in Electrical Engineering and an M.B.A. from the University of Hawaiʻi at Mānoa.

Damon L. Schmidt

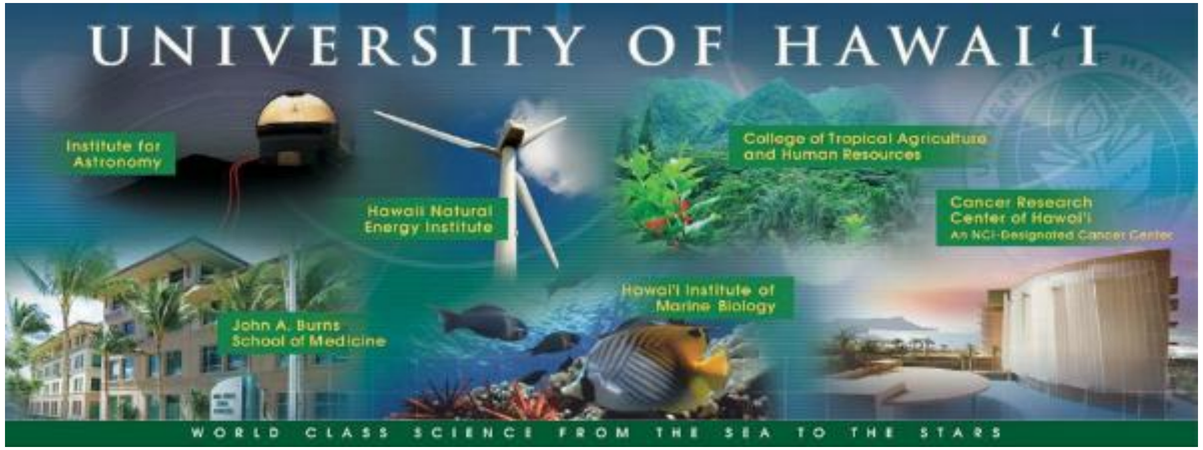
Sr. Energy Regulatory/Policy Analyst

Mr. Schmidt is a Senior Energy Regulatory/Policy Analyst with Grid***START***. He has over 15 years of experience in the energy sector. Prior to joining HNEI, he served as the Director/Manager of Hawaiian Electric Company's Regulatory Non-Rate Proceedings group. He also worked in outside regulatory counsel and financial consulting roles for Hawaiian Electric, both as a solo practitioner, and with the law firm of Goodsill Anderson Quinn & Stifel. Mr. Schmidt delivered key regulatory and financial guidance to shape Hawaiian Electric's positions in numerous proceedings before utility regulators.

Mr. Schmidt is a licensed attorney in the State of Hawaiʻi. He holds a B.S. in Finance from the University of Hawaiʻi, an M.B.A. with an international business focus from Pepperdine University in California, and a J.D. from the University of Hawaiʻi William S. Richardson School of Law.

University of Hawaiʻi

- Founded in 1907, the ***University of Hawaiʻi System*** includes 3 universities and 7 community colleges with approximately 50,000 students.
- ***University of Hawaiʻi at Mānoa*** is the flagship campus (the largest and oldest) of the system.
  - 14,576 undergraduate student enrollment
  - 4,680 graduate student enrollment
- ***School of Ocean and Earth Science and Technology (SOEST)*** is the largest research unit on the Mānoa campus.
  - Bring in more than $100 million extramural funding per year



UNIVERSITY of HAWAIʻI SYSTEM

UNIVERSITY of HAWAIʻI MĀNOA

SCHOOL OF OCEAN AND EARTH SCIENCE AND TECHNOLOGY

Hawai’i Natural Energy Institute (HNEI)

SOEST, University of Hawai’i at Mānoa

- Organized Research Unit in School of Ocean and Earth Science and Technology (SOEST), University of Hawai‘i.
- Founded in 1974, established in Hawai‘i statute in 2007 (HRS 304A-1891).
- Conduct RDT&E to accelerate and facilitate the use of resilient alternative energy technologies and reduce Hawai‘i’s dependence on fossil fuels.

Areas of Focus

- **Grid Integration (Grid*START*)**
- Energy Policy and Analysis
- Electrochemical Power Systems
- Alternative Fuels
- Advanced Materials
- Ocean Energy

Core Functions

- State Energy Policy Support
- Testing and Evaluation
- Education and Capacity Building
- Research and Development
- Modeling and Validation