

Clean Energy Transition Opportunity and Costs - The Hawaii Experience



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UNIVERSITY
of HAWAII
MĀNOA



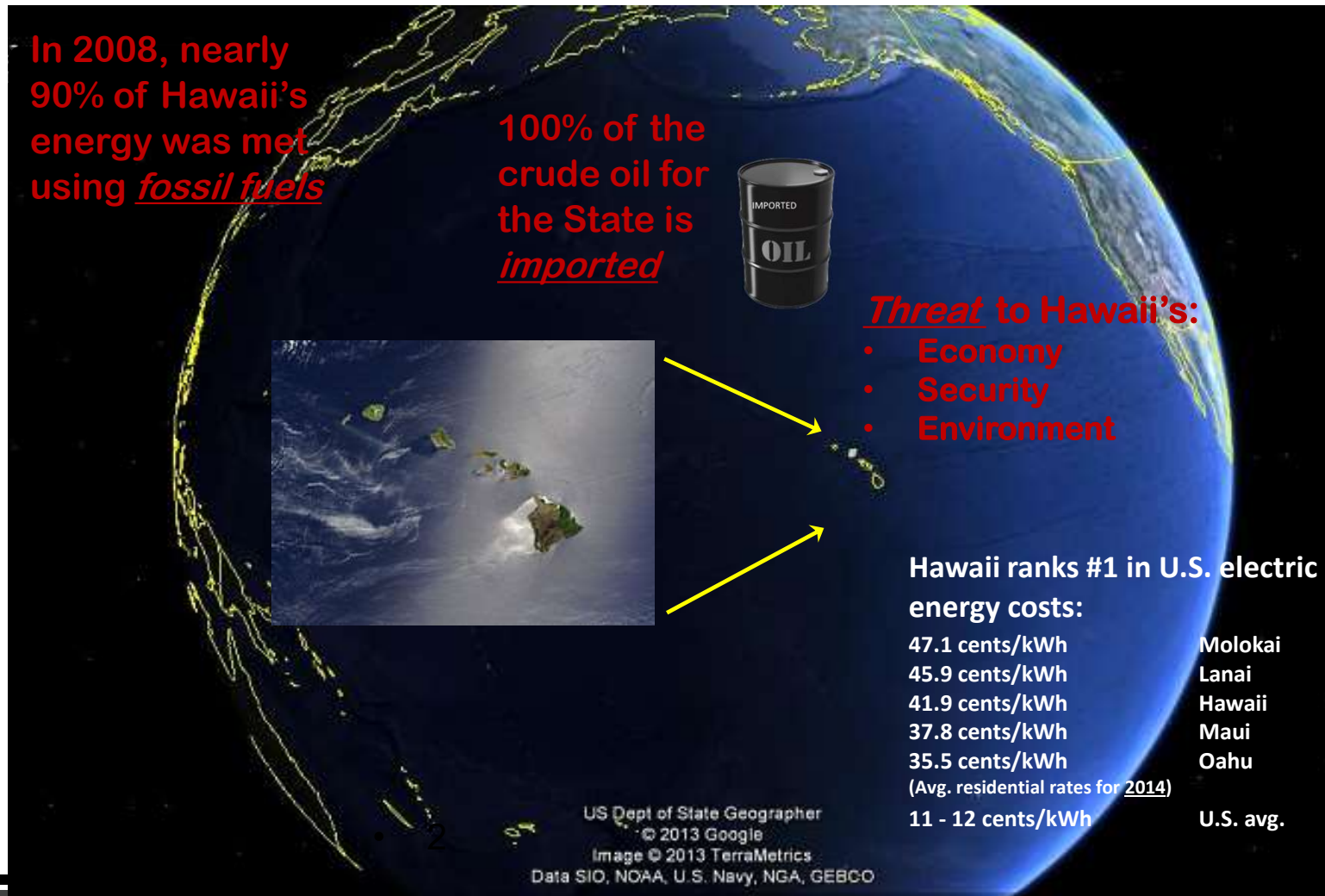
APERC ANNUAL CONFERENCE 2023

“BALANCING ENERGY SECURITY, AFFORDABILITY, AND DECARBONIZATION”

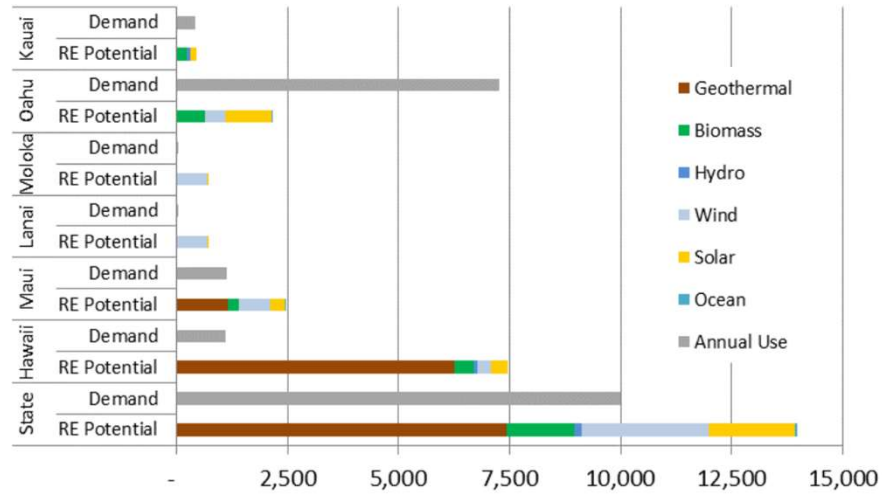
TOKYO, JAPAN

April 25 - 26, 2023

Hawaii's Isolation Poses a Serious Challenge



Opportunity for Sustainability in Hawaii is Abundant



Renewable Electricity Potential and Demand by Island, Gigawatt-hours

Source: National Renewable Energy Laboratory, Hawaii Clean Energy Initiative Scenario Analysis, 2012; and DBEDT

Hawaii's Progressive Clean Energy Policy Leadership

Editorials
TUESDAY | OCTOBER 21, 2008

Ambitious energy agreement charts right course

A promising new agreement between the state and Hawaiian Electric Co. is expected to make some significant progress in reducing Hawaii's dependence on fossil fuels.

It calls for streamlining the regulatory process to achieve some worthy goals, including sending wind energy from Maui, Lanai and Molokai to Oahu via state-of-the-art under-sea cables, and developing a "smart grid" so customers can get lower rates during off-peak hours.

That's the good news. But

Join the conversation. Post your comments about our editorial at www.honolulupress.com

The 50-page agreement also lacks some key details. Perhaps the most important one, given these tough economic times, is how much will it all cost, and how much of that cost will the consumer be asked to bear?

Admittedly, it's a difficult question to answer, given the scope and complexity of the plan. Still, looking out for rate payers' and taxpayers' interests will be crucial. Part of that responsibility rests with one of the agreement's signatories, consumer advocate Catherine Awakuni, and the Public Utilities Commission.

Awakuni and the PUC have the obligation to ensure that the average ratepayer isn't unfairly burdened by the cost of developing the new, renewable-energy infrastructure.

There will be significant up-front investment costs. The under-sea cable alone could run in the hundreds of millions of dollars, and the state should maximize opportunities for federal funding through the Department of Energy or similar sources.

And even with federal funding — U.S. Sen. Daniel K. Inouye attended the signing ceremony for the new agreement — ratepayers will likely be asked to pick up some of these costs as an investment in the state's renewable energy future.

Certainly, this future is the direction in which the state needs to be moving. Achieving the state's goal of 70 percent clean energy by 2030 is a laudable plan that sets us on the right path. Indeed, Hawaii is uniquely positioned to be a leader in the area of wind, wave and solar energy efforts.

And in the long term, renewables offer an unlimited supply of environmentally friendly energy and reduces our over-reliance on fossil fuels — a more sensible and sustainable future.

It's an ambitious plan. If the agreement's goals are met, the result will be a fundamentally changed energy model. A more unified, more efficient grid will support different energy sources, primarily wind. HECO will move from a sales-based company to an energy services provider, and the consumer will have more control over energy costs with new ways to conserve using technology.

TheINGLE administration hopes the agreement will be a win-win for everyone — the state, HECO and consumers. Refining these details will help ensure that success.

Hawaii Clean Energy Initiative (HCEI)

The State of Hawaii, US DOE, and local utility launched HCEI in January 2008 to transform Hawaii to a 70% clean energy economy by 2030:

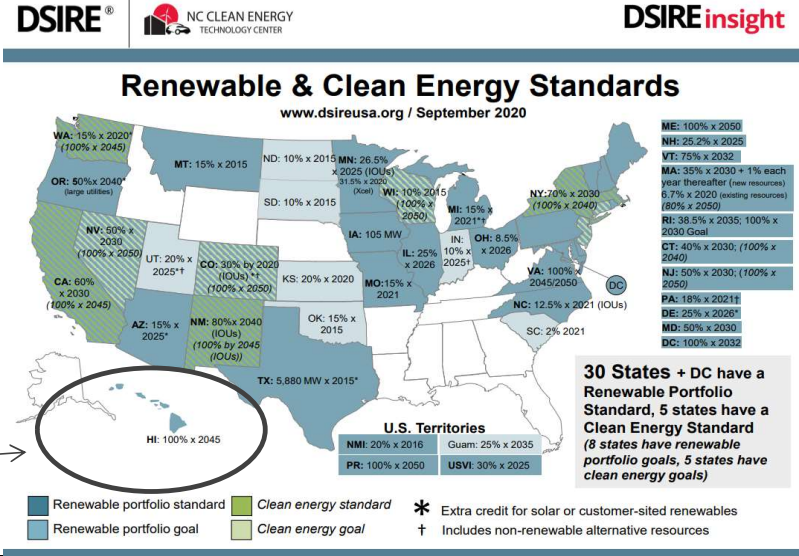
- Increasing Hawaii's economic and energy security
- Fostering and demonstrating Hawaii's innovation
- Developing Hawaii's workforce of the future
- Becoming a clean energy model for the U.S. and the world

Strong Hawaii Policies

- 2009 (Act 155)
 - 10% by 2010
 - 15% by 2015
 - 25% by 2020
 - 40% by 2030
- 2015 (Act 97)
 - 10% by 2010
 - 15% by 2015
 - 30% by 2020
 - 40% by 2030
 - 70% by 2040
 - 100% by 2045

Highest RPS Target in the United States

100% by 2045



Renewable Energy Tax Incentives

Tax credits:

- A dollar-for-dollar reduction in the amount of income tax you would otherwise owe
- Think of it as an “*IRS gift card*”



Federal

- Renewable Electricity Production Tax Credit (PTC)
- Energy Investment Tax Credit (ITC)
- Residential Energy Credit
- Modified Accelerated Cost-Recovery System (MACRS)

State (State of Hawaii)

- Renewable Energy Technologies Income Tax Credit (RETITC)

Local

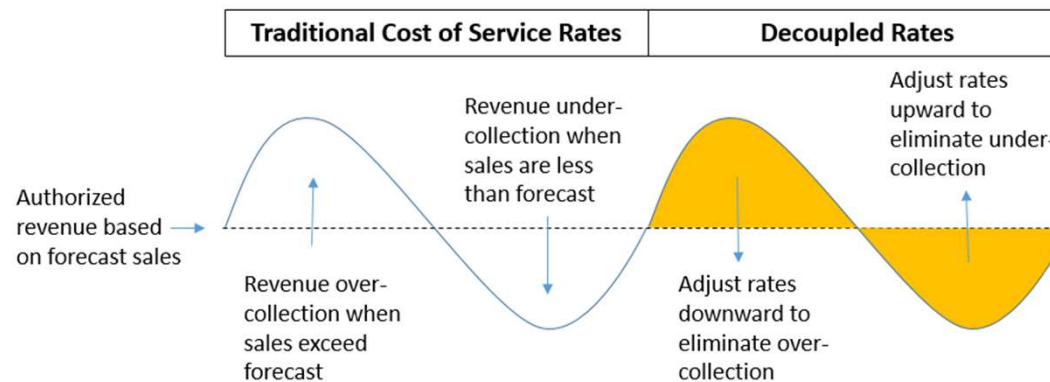
- City and County of Honolulu - Real Property Tax Exemption for Alternative Energy Improvements

Revenue Decoupling at Hawaiian Electric

See Docket No. 2008-0274, Final Decision and Order (Haw. P.U.C., August 31, 2010).



- Since traditional COSR electric rates are based on forecast sales:
 - Lower-than-forecast sales leads to under-recovery of fixed costs
 - Creates economic disincentive to do anything that reduces sales (e.g., customer-sited RE, EE)



- **Decoupling:**
 - Adjusts electric rates *between* rate cases to address deviations from sales forecasts (reduction in regulatory lag)
 - Delinks the utility's profits from its sales
 - Stabilized revenues and protected the utilities' financial health from erosion as Hawaii pursued its clean energy initiatives
 - **Removes the disincentive to pursue energy efficiency and customer-sited behind-the-meter renewable energy projects**

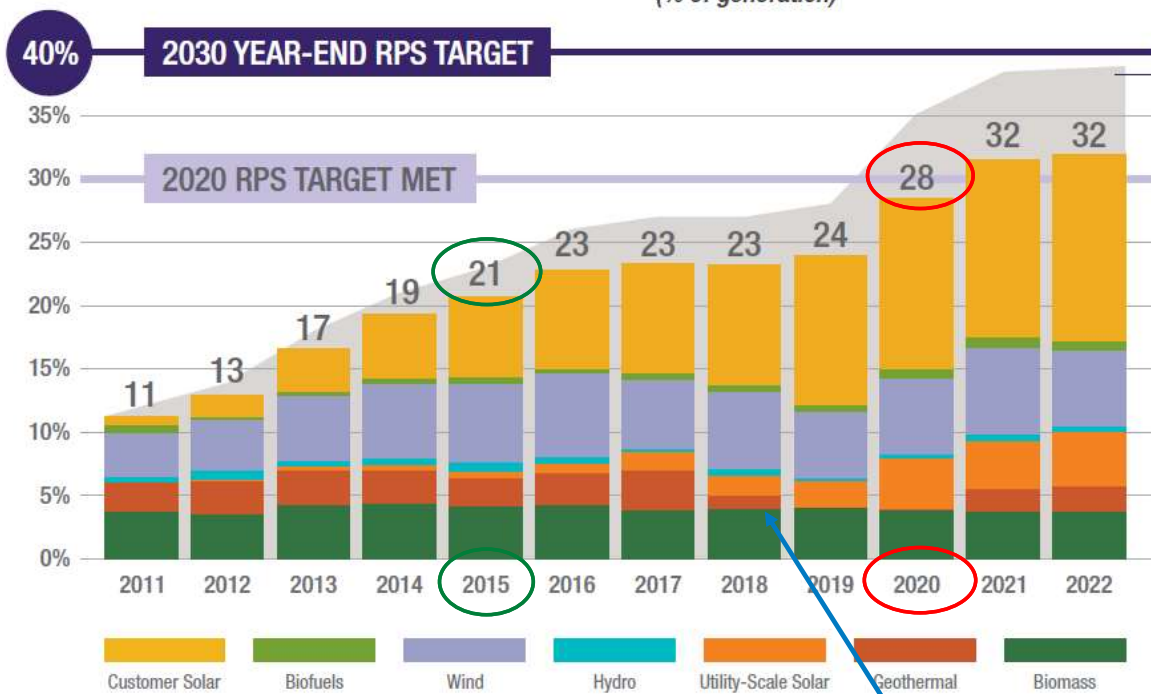
Progress Toward A Clean Energy Future

Hawaiian Electric Companies

Hawaii RPS Goals

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

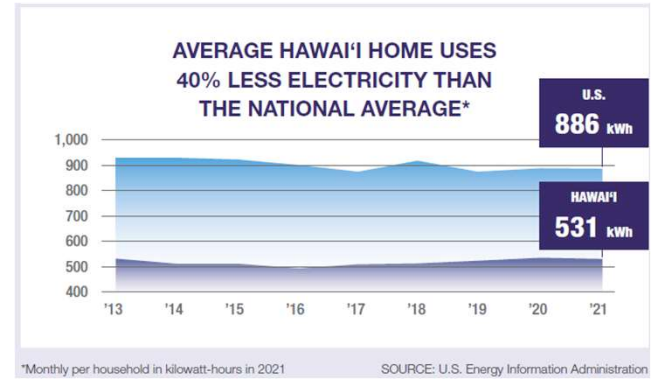
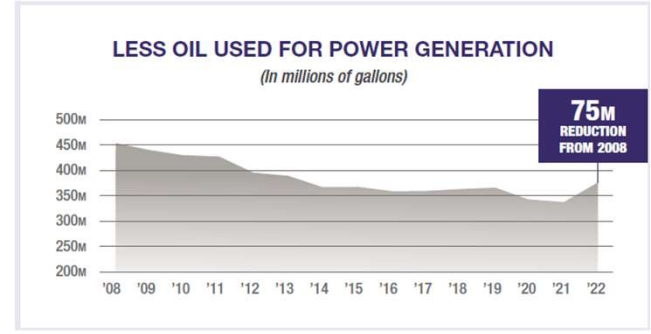
RENEWABLE PORTFOLIO STANDARD PROGRESS
(% of generation)



Shaded area shows RPS as % of sales

NOTE: The definition of Renewable Portfolio Standard (RPS) was changed by state law in 2022. It is now defined as the percentage of electricity generated by renewable resources. It was previously defined as the percentage of electricity sold that came from renewable resources. The revised definition is a more accurate way to measure progress toward the goal of achieving 100% renewable energy by 2045.

Loss of Geothermal Production (May 2018)



Source: Hawaiian Electric Sustainability Report 2022-2023

Hawaii Electric Systems –

4 Electric Utilities; 6 Separate Grids; % Renewable Energy

Kaua'i Island Utility Cooperative (2021 Yr.-end)

System Peak: 78 MW

119 MW PV* / 7 MW Biomass / 16 MW Hydro*

Installed PV: 153% of Sys. Peak

*West Kauai Energy Project (Approved)

Hydro 4 MW
PV 35 MWac/56 MWdc
+ 35 MW/70 MWh BESS
20 MW Pumped Hydro

Hawaiian Electric (March 2022)

System Peak: 1,216 MW

768 MW PV* / 123 MW Wind /
69 MW WTE / 168 MW Biofuel

Installed PV & Wind:

73% of Sys. Peak

* **311.5 MW PV + 1,373 MWh BESS (Approved)**

42 MW PV + 168 MWh BESS (Pending Approval)

Maui Electric (March 2022)

Maui System Peak: 206 MW

135 MW PV* / 72 MW Wind

Installed PV & Wind:

100% of Sys. Peak

Lana'i System Peak: 5.1 MW

2.9 MW PV* (**57% of Sys. Peak**)

Moloka'i System Peak: 5.6 MW

2.7 MW PV (**48% of Sys. Peak**)

Maui (Approved)

* **175 MW PV + 700 MWh BESS**

- 60 MW PV + 240 MWh BESS
- 20 MW PV + 80 MWh BESS
- 40 MW PV + 160 MWh BESS
- 15 MW PV + 60 MWh BESS
- 40 MW PV + 160 MWh BESS

Lanai (Pending Approval)

*18 MW PV + 74 MWh BESS

Hawaii Electric Light (March 2022)

System Peak: 191 MW

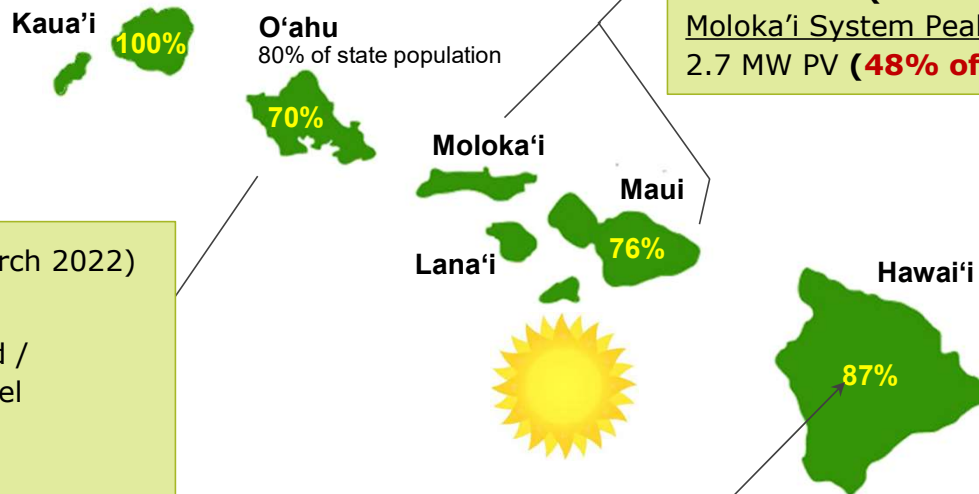
118 MW PV* / 34 MW Wind /
38 MW Geothermal* / 17 MW Hydro

Installed PV & Wind:

80% of Sys. Peak

* **2 x 30 MW PV + 120 MWh BESS (Approved)**

Proposing an 8 MW expansion, to 46 MW Geothermal Plant in operation at reduced capacity (25 MW) due to volcanic eruption.



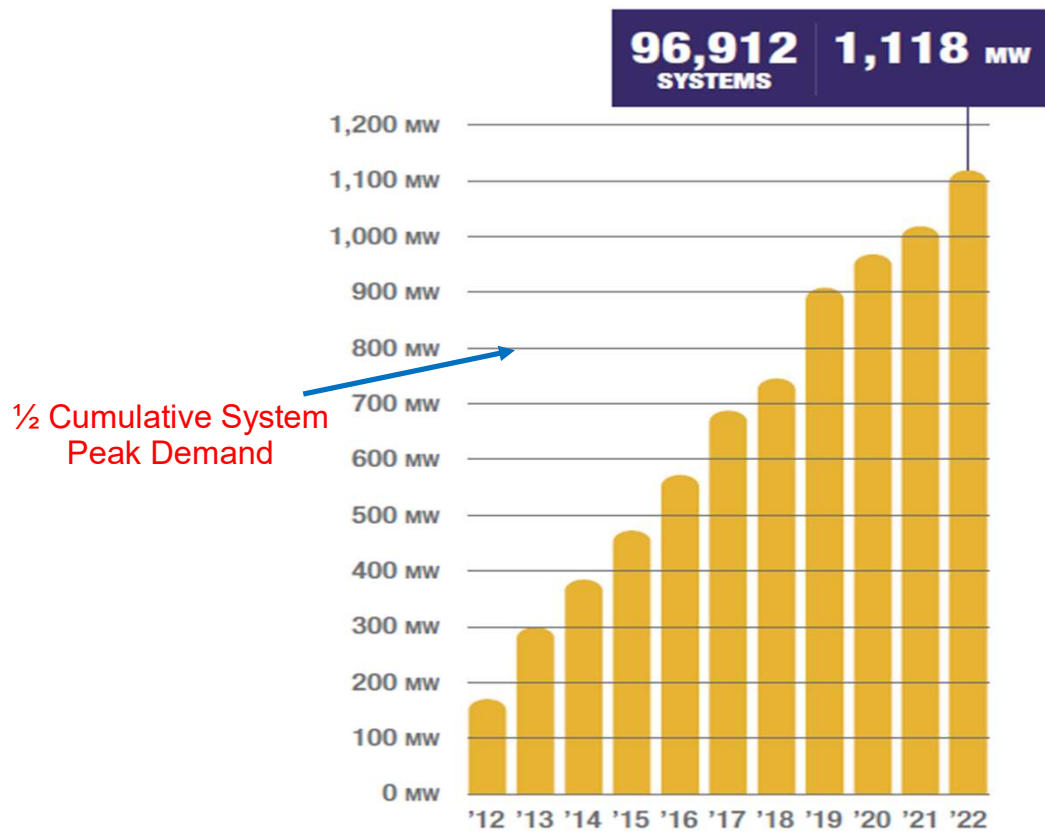
Renewable Energy Peak Daily Production in 2021

(e.g. occurred on 7/1/2021)

Installed PV Capacity - HECO Companies

(2005 to 2022)

CUMULATIVE SOLAR INSTALLATIONS



2022 At a Glance

We're on track to meet our year-end 2030 goal of 40%



RENEWABLE PORTFOLIO STANDARD (RPS)
Percentage of power generation coming from renewable sources

99.98%
RELIABILITY
Average service availability

37%
SINGLE-FAMILY HOMES WITH ROOFTOP SOLAR

+25.5%
INCREASE IN PASSENGER EVS FROM JANUARY TO DECEMBER 2022

32.4%
CUSTOMERS ENROLLED IN PAPERLESS BILLING

1,118 MW
TOTAL SOLAR CAPACITY

-22%
GHG EMISSIONS
Reduction from 2006 baseline levels* Preliminary 2022 data**

4.2M
SOLAR PANELS IN USE

4,408
NEW SOLAR SYSTEMS, MOSTLY RESIDENTIAL ROOFTOP

91%
NEW ROOFTOP SOLAR INSTALLED WITH BATTERY STORAGE

Source: Hawaiian Electric Sustainability Report 2022-2023

Distributed PV Programs in Hawaii Today

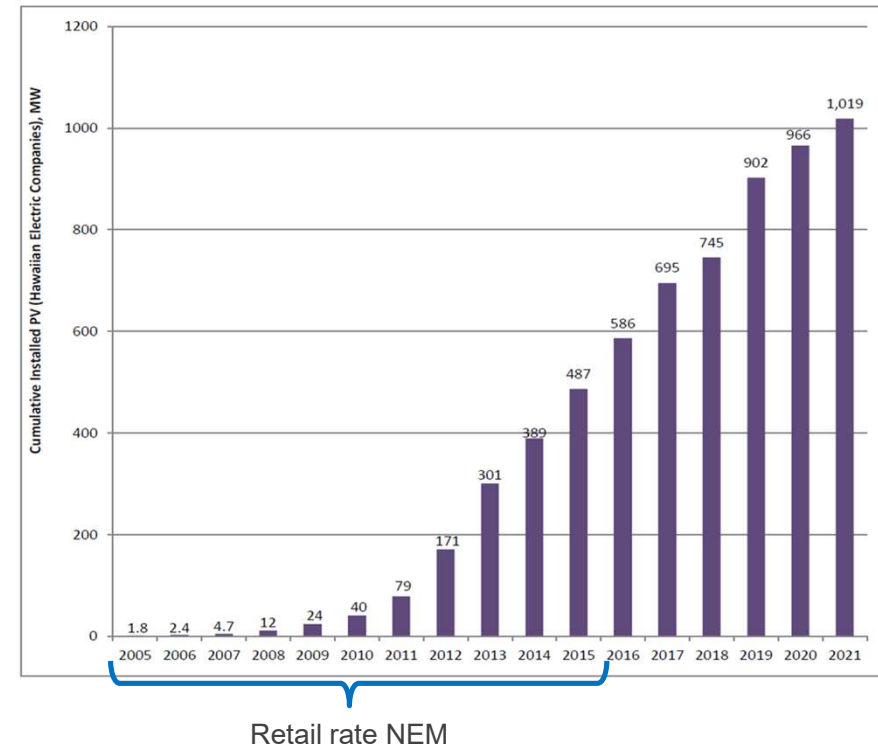
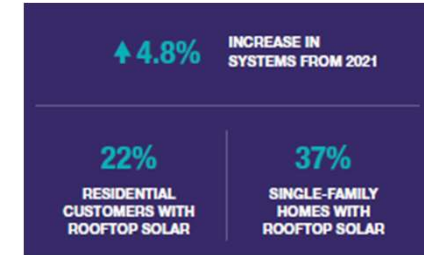
- **Retail Rate Net Energy Metering (NEM)** was closed to new applicants in 2015.
- **Customer Grid-Supply (CGS)** participants receive a PUC-approved credit (less than full retail rate) for electricity sent to the grid and are billed at the retail rate for electricity they use from the grid. Program is fully subscribed today; the program only remained open until the installed capacity was reached.
- **Customer Grid-Supply Plus (CGS Plus)** systems must include grid support technology to manage grid reliability and allow the utility to remotely monitor system performance, technical compliance and, if necessary, control the system for grid stability.
- **Customer Self-Supply (CSS)** is intended only for private rooftop solar installations that are designed to not export any electricity to the grid. Utility verifies non-export controls enabled for the system.
- **Smart Export (SE)** customers with a renewable system and battery energy storage system have the option to export energy to the grid from 4 p.m. – 9 a.m. Systems must include grid support technology to manage grid reliability and system performance.
- **Standard Interconnection Agreement (SIA)** is designed for larger customers who wish to offset their electricity bill with on-site generation. Customers are not compensated for any export of energy.

Rooftop Solar Integration

OAHU	CGS	CGS Plus	CSS	Smart Export
Export Allowed	Yes	Yes	No	Yes
Export Restrictions	No	No	N/A	Solar Day
Reconciliation	Monthly	Annual	N/A	Annual
Minimum Bill	\$25	\$25	\$25	\$25
Credit rate (c/kWh)^{***}	\$0.15	\$0.10	N/A	\$0.15
Program Cap	51.3 MW	50 MW	N/A	25 MW
Inverter Requirements	Advanced with Volt Var and Frequency Watt activated; Fixed Power Factor deactivated.*	Advanced with Volt Var and Frequency Watt activated; Fixed Power Factor deactivated.	Advanced with Volt Var and Frequency Watt activated; Fixed Power Factor deactivated.	Advanced with Volt Var and Frequency Watt activated; Fixed Power Factor deactivated.
Controls	N/A	Yes: Utility or Aggregator	Customer	Yes: Economic
Communications	N/A	N/A	Yes	N/A
Hypothetical Bill Comparison:^{**}	\$93.28	\$118.38	\$169.09	\$93.79

Closed

2022 Customer Energy Resources



DPV Staffing Needs Increase

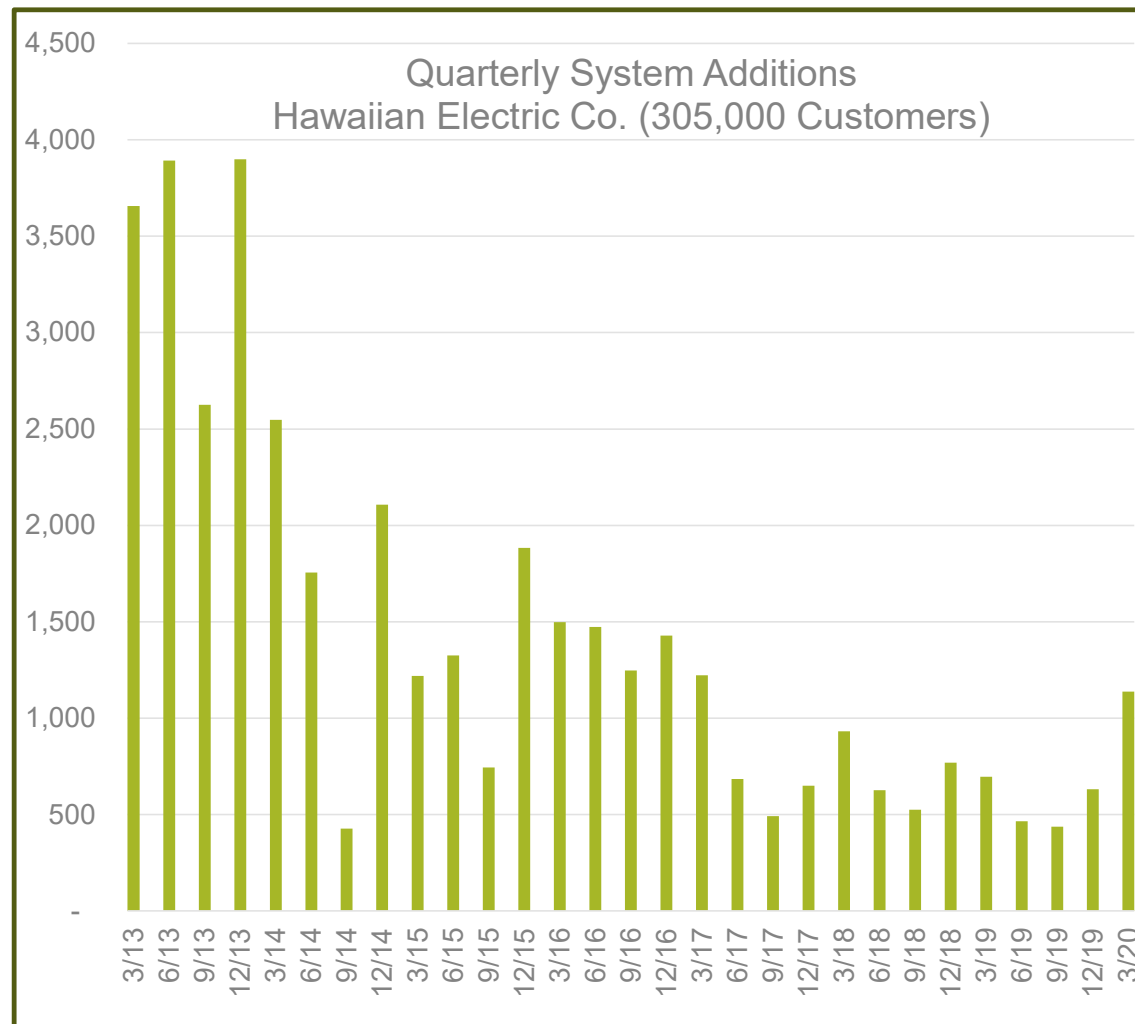
Hawaiian Electric Company:

Application tracking and processing: 8 Positions

Technical screening and analysis: 4 to 5 full-time equivalent (FTE)

- Distribution Planning staff today has doubled to 14 planners since 2012
- Foundational work to update models and conduct hosting capacity studies added another 2 to 3 FTE for approximately two years

DPV program implementation requires additional administrative and technical staff/budget/capacity building to implement



Existing and Planned Generating Facilities on Oahu

-- Hawaiian Electric Company's service territory

Retirement of AES Coal Plant

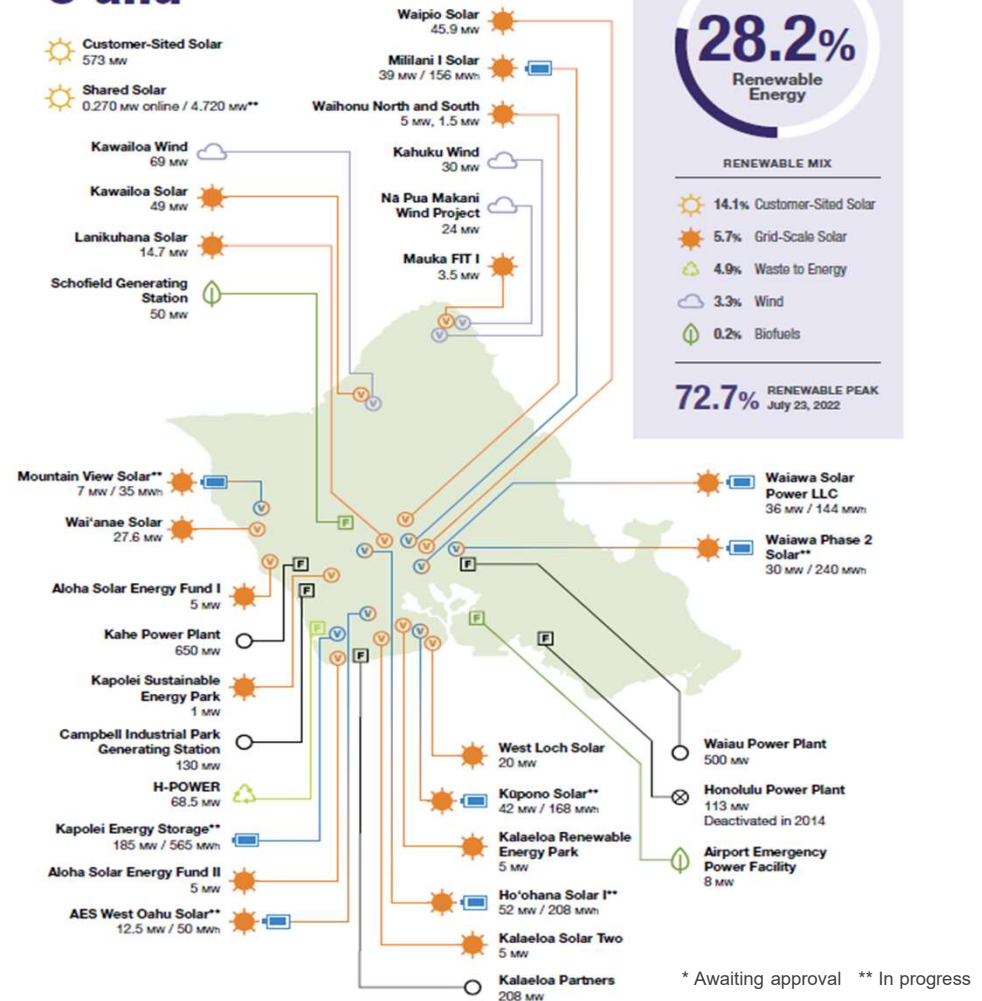


Retirement of the 180-megawatt AES Hawaii coal plant on Oahu ends the use of coal for power generation in the state. Closure of the plant — one of the largest emitters of greenhouse gases — aligns with Hawaiian Electric's overall plans to decarbonize its energy systems. Photo courtesy of AES.

Firm capacity coal being replaced by Solar + BESS

- At the end of July 2022, Clearway Energy's Mililani Solar I, a 39 MW PV / 156 MWh BESS project, came online.
- In January 2023, Clearway's Waiawa Solar Power, a 36 MW PV / 144 MWh BESS reached commercial operation.
- Coming online in 2023, AES West Oahu Solar, a 12.5 MW PV / 50 MWh BESS.
- Coming online in 2023, Kapolei Energy Storage, a 185 MW / 565 MWh lithium-ion BESS project by Plus Power LLC. The project will enhance grid reliability and enable more renewable energy on Oahu.

O'ahu



Source: Hawaiian Electric Sustainability Report 2022-2023

“Hawaiian Electric Announces ‘Mind-Blowing’ Solar-Plus-Storage Contracts”



NEWS RELEASE

FOR IMMEDIATE RELEASE



“It’s hard to overstate the scale of this announcement,” said Dan Finn-Foley, a senior energy storage analyst at Wood Mackenzie Power & Renewables.

Source: Jan. 4, 2019, Greentech Media

New solar-plus-storage projects set low-price benchmark for renewable energy in Hawai’i

Seven contracts submitted to regulators for review

HONOLULU, Jan. 3, 2019 – Hawaiian Electric Companies have submitted contracts for seven grid-scale, solar-plus-storage projects on three islands to the Public Utilities Commission for review. The projects are part of the largest and lowest cost portfolio of new renewable energy resources to be assembled in Hawai’i.

The projects – three on O’ahu, two on Maui and two on Hawai’i Island – will add approximately 262 megawatts (MW) of solar energy with 1,048 megawatt-hours (MWh) of storage. The energy storage can provide four hours of electricity that can further reduce fossil fuel use during peak demand in the evening or at other times when the sun isn’t shining.

HECO to install 1 GWh of new BESS Entire BESS market in US (in 2019) was 1.4 GWh

Project name	Island	Developer	Size	Storage	Cost per KWh
Waikoloa Solar	Hawai’i	AES	30 MW	120 MWh	\$0.08
Hale Kuawehi	Hawai’i	Innergex	30 MW	120 MWh	\$0.09
Kuihelani Solar	Maui	AES	60 MW	240 MWh	\$0.08
Paeahu Solar	Maui	Innergex	15 MW	60 MWh	\$0.12
Hoohana	O’ahu	174 Power Global	52 MW	208 MWh	\$0.10
Mililani I Solar	O’ahu	Clearway	39 MW	156 MWh	\$0.09
Waiawa Solar	O’ahu	Clearway	36 MW	144 MWh	\$0.10

Source: Jan. 4, 2019, Greentech Media

Community Based Renewable Energy (CBRE)

The CBRE program is designed to promote broader participation in renewable energy projects by allowing electric utility customers unable to install private rooftop solar to purchase shares in a renewable energy facility to offset their monthly energy consumption via a credit for that renewable energy on their utility bills.

$$\text{Bill credit} = \frac{\text{Credit Rate} \times \text{Energy Generated}}{\text{Size of Subscription}}$$



The 28 kW ROIZ CBRE Maui project is online.

Procedural History Of CBRE In Hawaii

- On June 8, 2015, Act 100 requires Hawaii's electric utilities to create a tariff by October 1, 2015 to enable customers to join community renewable programs.
- On April 5, 2018, the PUC, in Order No. 35395, approved and directed KIUC to implement its CBRE tariff.
- On June 29, 2018, the PUC, in Order No. 35560, approved HECO to implement their CBRE program (Phase 1).

<https://www.hawaiielectric.com/products-and-services/customer-renewable-programs/shared-solar>

CBRE Phase 1 Projects

Name	Island	Size (kW)	Credit Rate (\$/kwh)
ROIZ CBRE	Maui	28.32	0.165
Mililani Tech Solar 1	Oahu	270	0.15
Palailai Solar 1	Oahu	3,000	0.15
KHLS	Oahu	1,720	0.15
South Point	Hawaii Island	750	0.15
Kawela Plantation	Molokai	250	0.225

CBRE Phase 2 Projects

- Now open to PV projects that may or may not include BESS.
- Unlike Phase 1, which was limited to 8 megawatts, Phase 2 will be open to about 250 MW of renewable generation across the five islands Hawaiian Electric serves. The second phase places special emphasis on opportunities for low-to-moderate-income residential customers to participate.

Mahalo!

(Thank you)



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Hawaii Natural Energy Institute (HNEI)

University of Hawai'i at Mānoa

Organized Research Unit in School of Ocean and Earth Science and Technology
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 Hawaii's dependence on fossil fuels.
- Diverse staff includes engineers, scientists, lawyers; students and postdoctoral fellows; visiting scholars

Areas of Interest

- **Grid Integration (GridSTART)**
- **Policy and Innovation**
- **Alternative Fuels**
- **Electrochemical Power Systems**
- **Renewable Power Generation**
- **Building Efficiency**
- **Transportation**

Core Functions

- **State Energy Policy Support**
- **Research & Development**
- **Testing and Evaluation**
- **Analysis**
- **Workforce Development**



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

- Serves to integrate into the operating power grid other HNEI technology areas: energy efficiency, renewable power generation, biomass and biofuels, fuel cells and hydrogen
- Strong and growing partnerships with Hawai'i, national and international organizations including Asia-Pacific nations

Expertise & Focus:

- | | |
|--------------------------------------|---|
| ➤ Energy Policy and Regulation | ➤ Power Systems Operation |
| ➤ Renewable Energy Grid Integration | ➤ Power Systems Engineering and Standards |
| ➤ Smart Grid Planning & Technologies | ➤ Communications Design and Testing |
| ➤ Power Systems Planning | ➤ Project Management and Execution |
| ➤ RE Resource Procurement | |



Lead for many public-private demonstration projects