

# ***Hawaii Clean Energy Initiative***

## ***Policy and Regulation for a Renewable Energy Future***



*Grid System Technologies Advanced Research Team*

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***ADB Workshop on Developing Sustainable Mini-Grids***

***Session 1: Policy and regulatory framework in developing renewable energy mini-grids***

***Asia Clean Energy Forum 2018***

June 5, 2018

Manila, Philippines

# *Hawaii's Isolation Poses a Serious Challenge ....*

**In 2008, nearly 90%  
of Hawaii's energy  
was met using  
fossil fuels**

**100% of the  
crude oil for the  
State is imported**

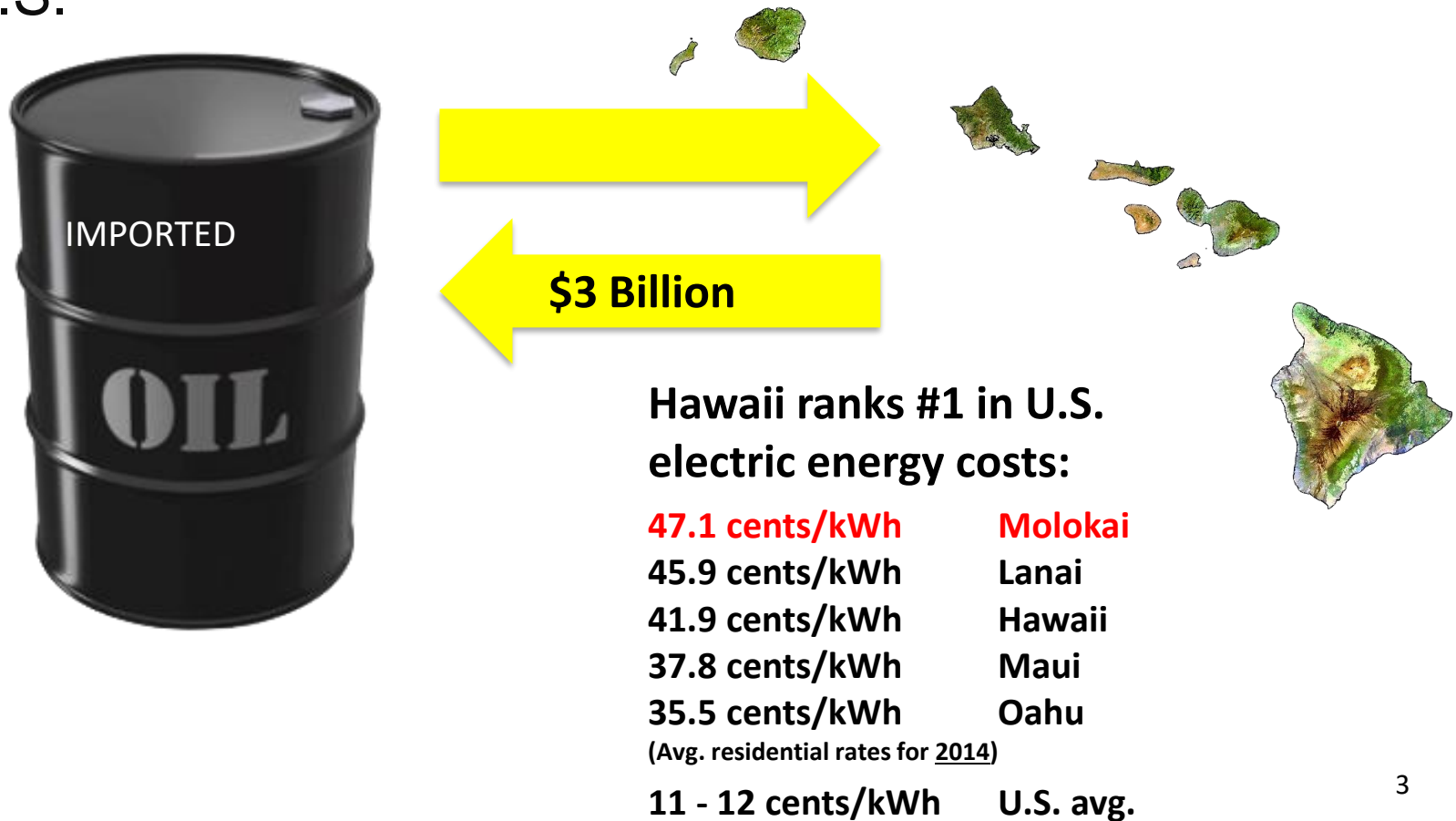


## **Threat to Hawaii's:**

- **Security**
- **Economy**
- **Environment**

# Over-Dependence on Fossil Fuels

- Has been the most oil dependent state in the U.S.
- Hawaii still pays the highest electricity rates in the U.S.



# High Energy Cost Drains the Island Economy

Hawaii Residential Electric Cost per kWh and Oil Cost

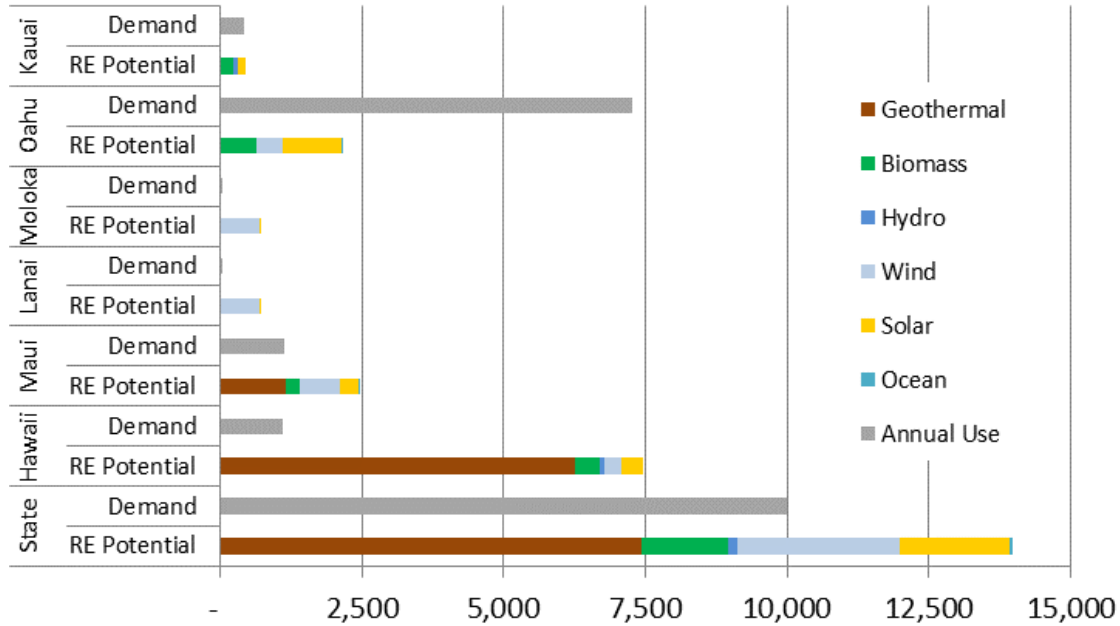
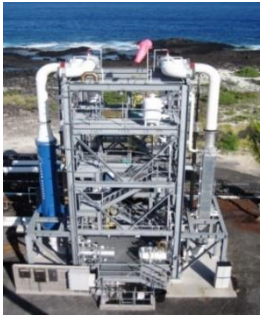


**High Electricity Price and Volatility Linked to Cost of Oil**

**Renewable Energy Aimed to “Break the Link” and Lower Cost**



# 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 Leadership in Clean Energy Policy

## 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 undersea cables, and developing a "smart grid" so customers can get lower rates during off-peak hours. That's the good news. But

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 undersea 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. The Lingle 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

### Highest RPS Target in the United States

**100% by 2045**

(2015 - 15%; 2020 - 30%, 2030 - 40%, 2040 - 70%)

### Other key policies:

- Tax incentives
- Net metering
- Feed in tariffs
- Decoupling

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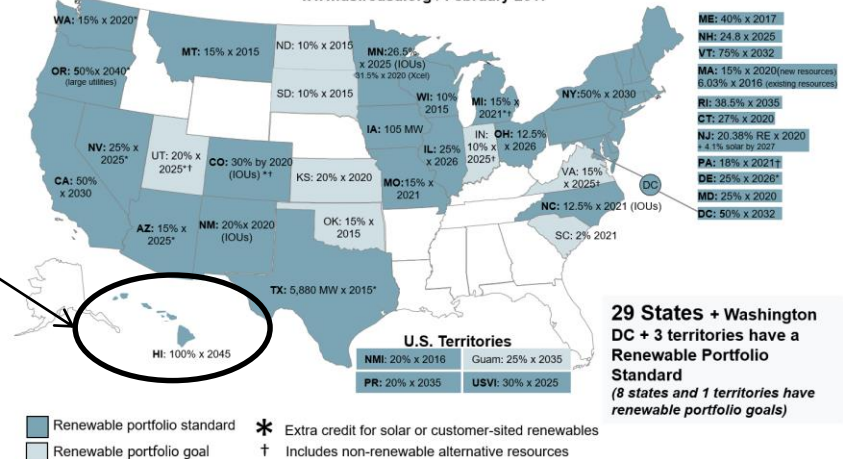


U.S. DEPARTMENT OF  
**ENERGY**

Energy Efficiency &  
Renewable Energy

### Renewable Portfolio Standard Policies

www.dsireusa.org / February 2017



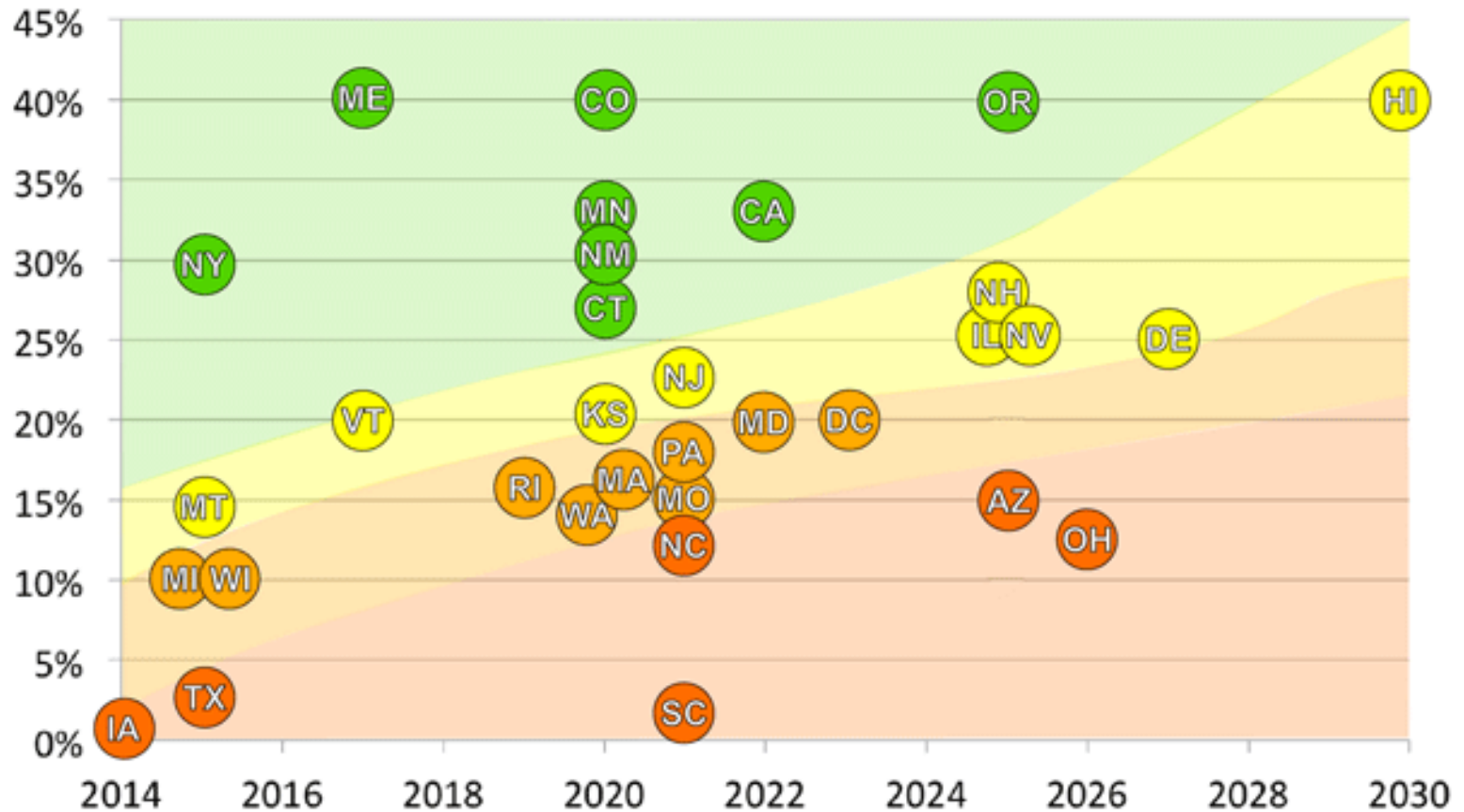
# Renewable Portfolio Standards in US

Voluntary RPS

IN ND  
OK SD  
VA UT  
WV

No RPS

AL AK  
AR FL  
GA ID  
KY LA  
MS NE  
TN WY



Courtesy of SolarPowerRocks.com



# ***Policy Team Overview***

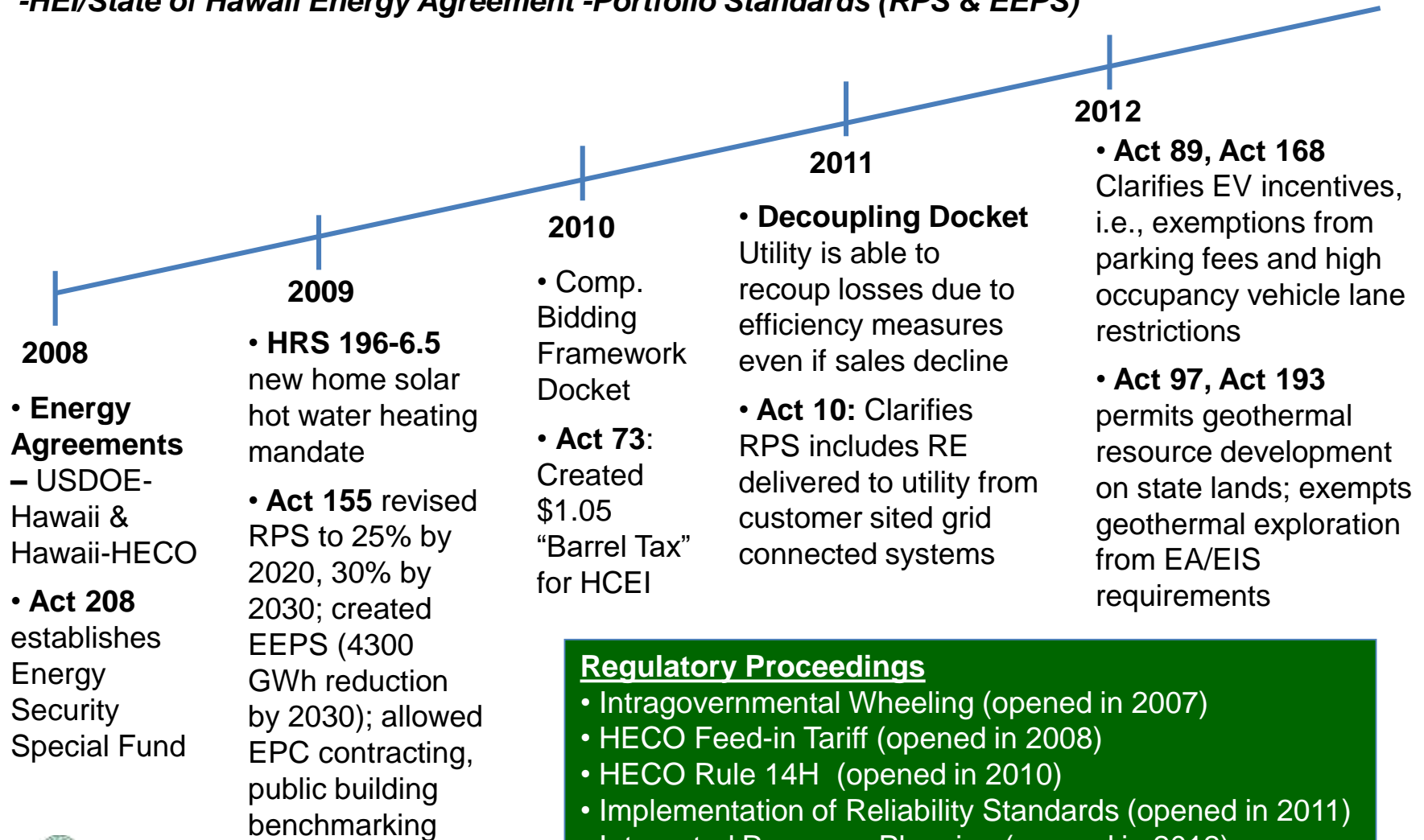
- **DECISIVE POLICY DIRECTION** – a 30 year adventure energized by the Hawaii Clean Energy Initiative (HCEI)
- **PRINCIPLED, POLICY LEADERSHIP** – Hawaii's plan for HCEI is embodied by **policies & a stakeholder alliance**
- **STAKEHOLDER ALLIANCE IS KEY** – Energy stakeholders are aligned on Hawaii's energy policy agenda
- **POLICY & TECHNOLOGY INNOVATION LEADERSHIP** – HNEI and our technology and policy partners are collaborating on building a resilient, cost-effective, efficient & self-sufficient energy future for Hawaii.



# Hawaii's Energy Transformation Policies

## INITIAL FIVE YEAR DRIVERS

*-HEI/State of Hawaii Energy Agreement -Portfolio Standards (RPS & EEPS)*



### Regulatory Proceedings

- Intragovernmental Wheeling (opened in 2007)
- HECO Feed-in Tariff (opened in 2008)
- HECO Rule 14H (opened in 2010)
- Implementation of Reliability Standards (opened in 2011)
- Integrated Resource Planning (opened in 2012)



# ***Policy Highlights (2013-2016)***

- **Act 97 (2015)** 100% RPS (electricity sector) by 2045
- **Act 99 (2015)** Net zero energy requirement for University of Hawaii
- **Act 100 (2015)** Community-based renewable energy program
- **Act 185 (2015)** Applies barrel tax to other fossil fuels like natural gas as follow-up to ending sunset on source of funding under **Act 107 (2014)**
- **Act 201 (2015)** Repayment for clean energy improvements via electricity bill
- **Act 164 (2014)** State Building Code adoption streamlined & strengthened
- **Act 37 (2013)** Authorizes PUC policy to accelerate retirement of utility fossil generation

# *Hawaii's Energy Transformation Drivers*

**RPS**

**EEPS**

**Regulatory  
involvement**

**Incentives**

**Legislation**

**Transportation  
Roadmap**

- 100% RE in the power sector by 2045 – currently 27% statewide
- 4,300 GWh reduction in electricity use by 2030
- Public Utilities Commission at center of changes to electric grid.
- Renewable energy tax credits, net energy metering, feed-in tariff
- Continued diligence on improving laws at federal and state level
- Petroleum reduction plans in transportation of 62-72 MGY

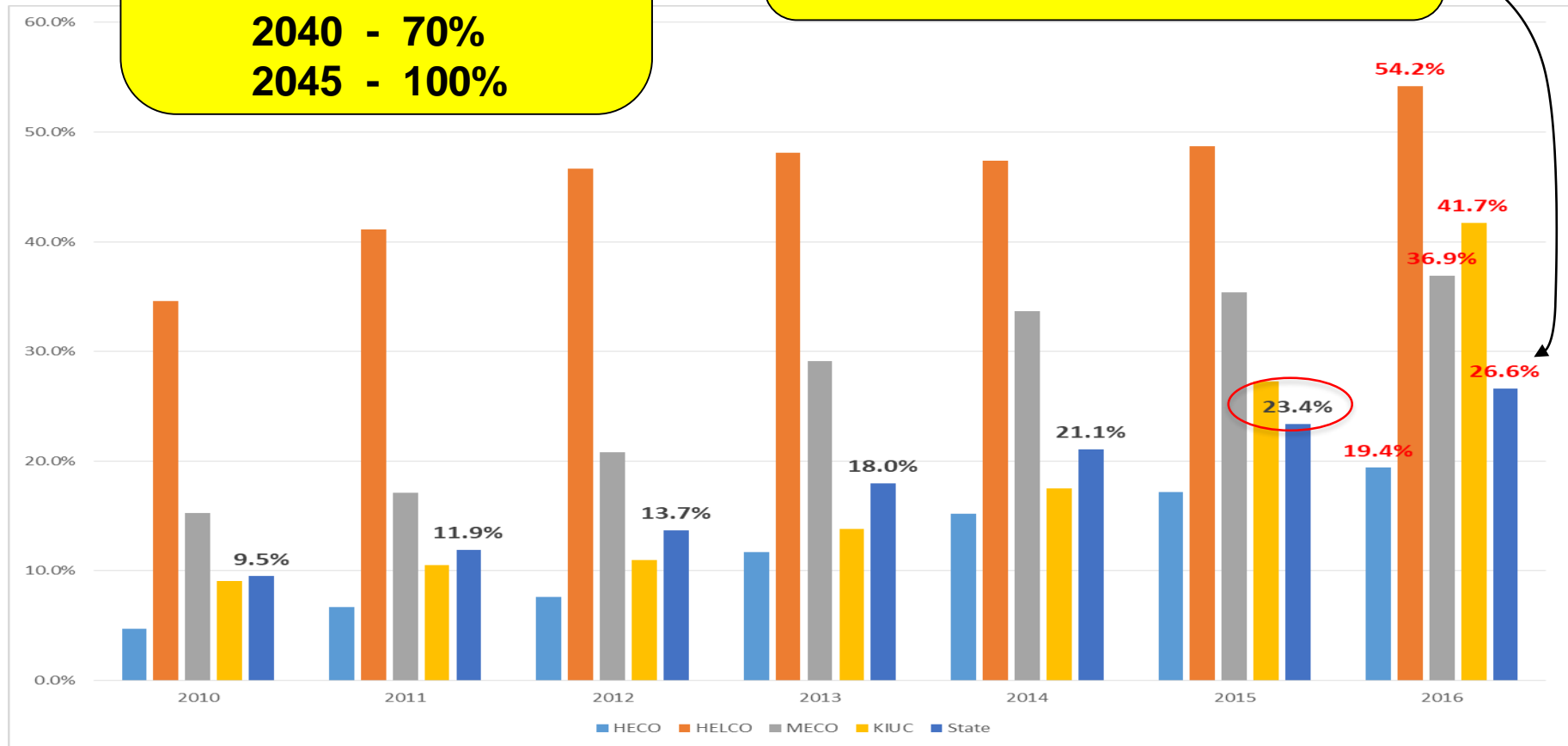


# Exceeding Hawaii RPS Goals

## Hawaii RPS Goals

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

State-wide 2015 RPS Goal = 15%  
RPS year-end 2016 @ 26.6%  
(9.5% RPS at year-end 2009)



Source: State of Hawaii, "Hawaii Energy Facts & Figures," Hawaii State Energy Office, Honolulu, May 2017



# Hawaiian Electric Company RPS - 2017

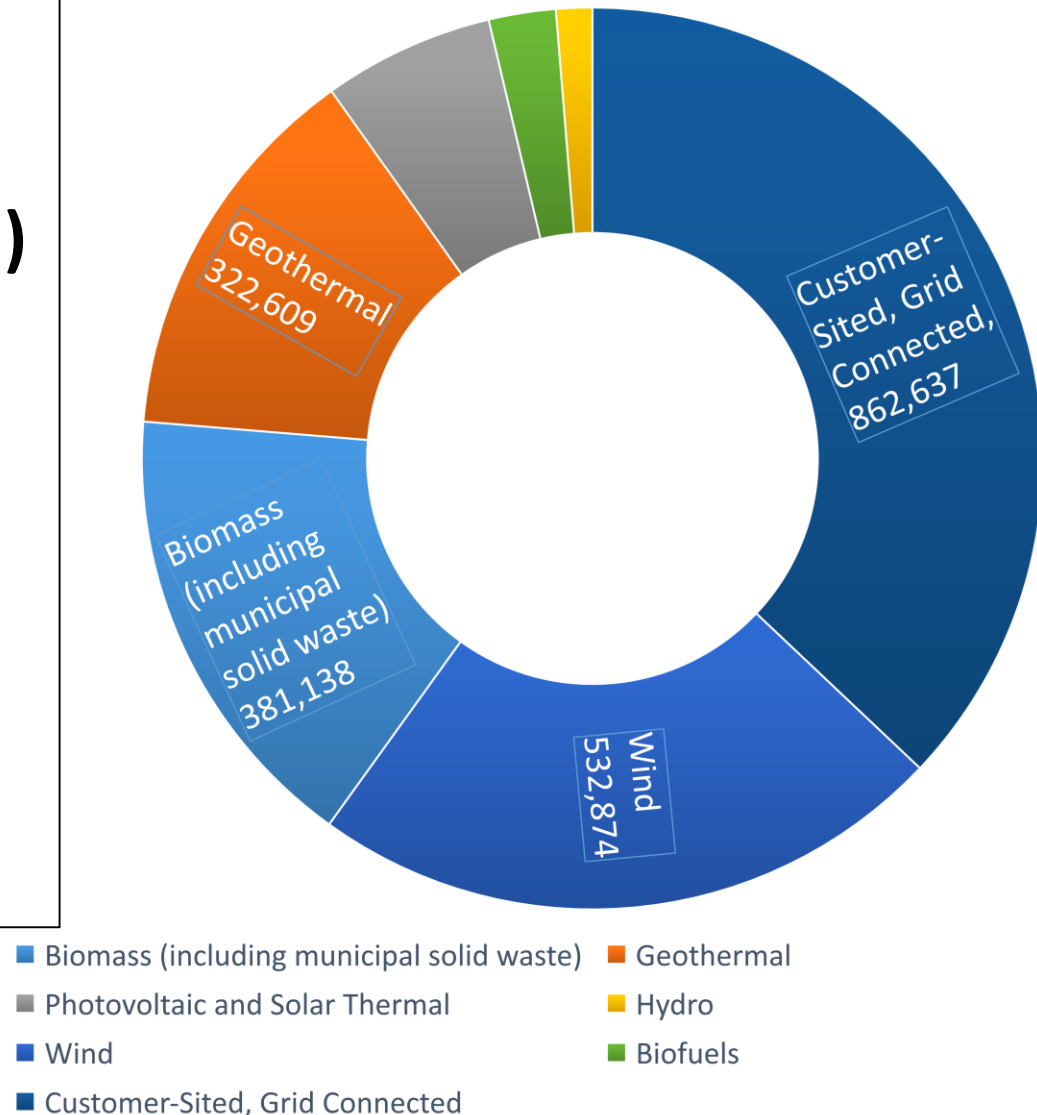
**27% Statewide**

**21% HECO  
(Oahu – Honolulu)**

**57% HELCO  
(Hawaii Island)**

**34% MECO  
(Maui, Molokai,  
Lanai)**

2017 Renewable Energy Mix - HEI Companies  
In Net Megawatt Hours



# Hawai'i Electric Systems –

## 4 Electric Utilities; 6 Separate Grids; % Renewable Energy

### Kaua'i Island Utility Cooperative

System Peak: 78 MW

65.6 MW PV / 7 MW Biomass / 9 MW Hydro

**Installed PV: 84% of System Peak**

41.7% RE in 2016

### Maui Electric

Maui System Peak: 202 MW

102 MW PV / 72 MW Wind

**Installed PV & Wind:**

**86% of Sys. Peak**

34.2% RE in 2017

Lana'i System Peak: 5.1 MW

2.53 MW PV (**50% of Sys. Peak**)

Moloka'i System Peak: 5.6 MW

2.3 MW PV (**41% of Sys. Peak**)

Kaua'i

41%

O'ahu

80% of state population

19%

Moloka'i

Maui

37%

Lana'i

Hawai'i

54%

### Hawaiian Electric

System Peak: 1,206 MW

512 MW PV / 99 MW Wind /  
69 MW WTE

**Installed PV & Wind:**

**50% of System Peak**

20.8% RE in 2017

### Hawaii Electric Light

System Peak: 192 MW

92 MW PV / 30 MW Wind /

38 MW Geothermal / 16 MW  
Hydro

**Installed PV & Wind:**

**64% of System Peak**

56.6% RE in 2017

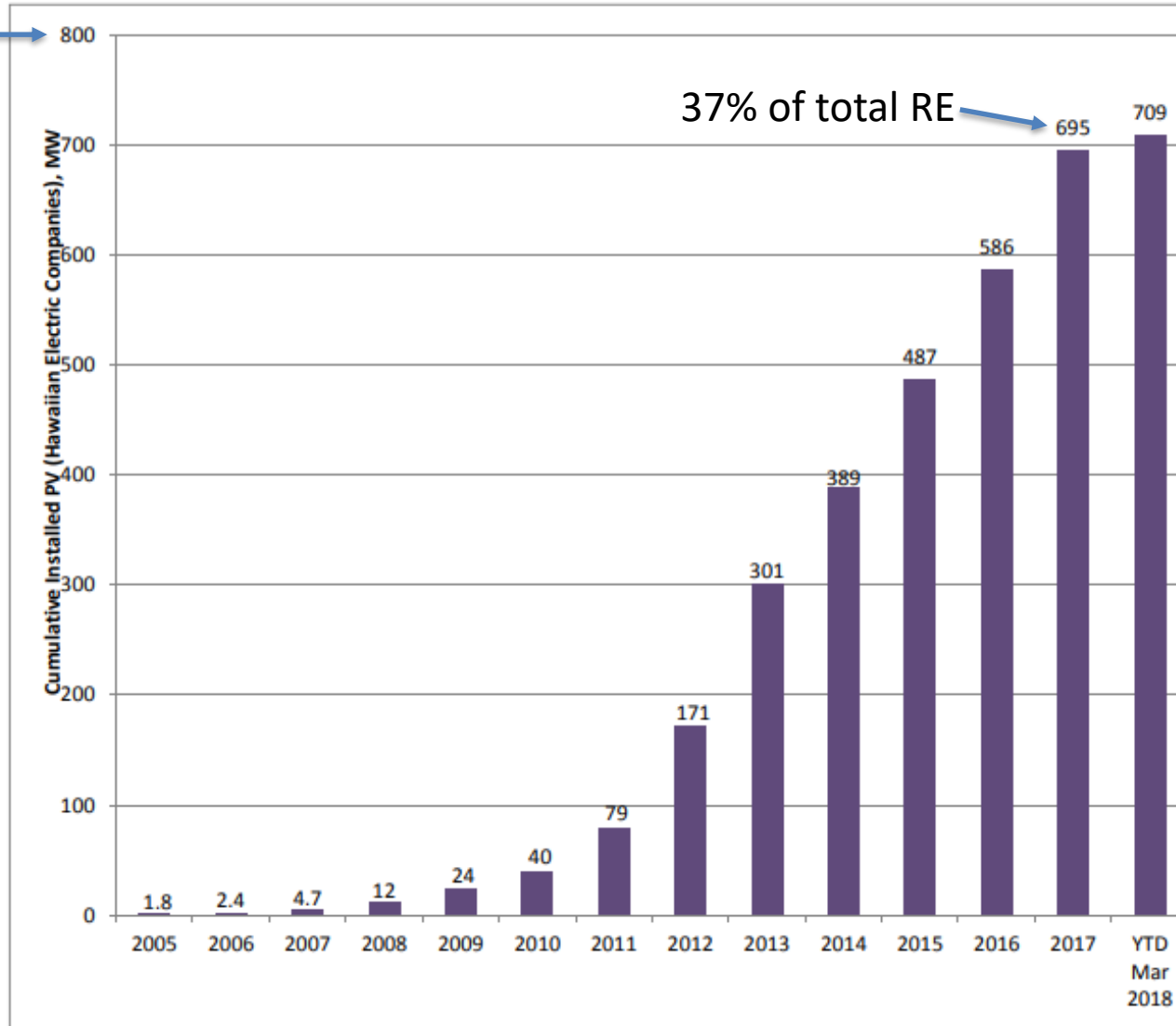
% Renewable  
Energy



# Installed PV Capacity - HECO Companies

(2005 to 3/2018)

½ Peak Load



# Why is DG PV So Popular in Hawaii

## Federal Incentives

- 30% of the cost of Solar systems with no cap. *Extended to 2019*
- *(Ramps down through 2020 to 26%, then in 2021 to 22%)*

## State Incentives

- 35% of the actual cost or \$5,000 per system, whichever is less. No expiration date

### Average Price of Residential Electricity (EIA)

	State	Mar-18
1	North Dakota	9.65
2	Washington	9.65
3	Louisiana	9.79
4	Idaho	9.99
5	Nebraska	10.25
	.	
	.	
46	New Hampshire	19.93
47	Rhode Island	20.22
48	Connecticut	21.04
49	Alaska	21.47
50	Massachusetts	22.49
51	Hawaii	32.05
	U.S. Average	12.99

The average Hawaii resident spends about 0.37 per kilowatt-hour (kWh) and uses about 515 kilowatts (kW) per month. With an average month's electric bill totaling \$190.36 it definitely makes sense to see if you can save money on power.

## Key Solar Facts – Averaged for Hawaii

**Average savings per year:** \$3539.18 (\$294.93 per month)

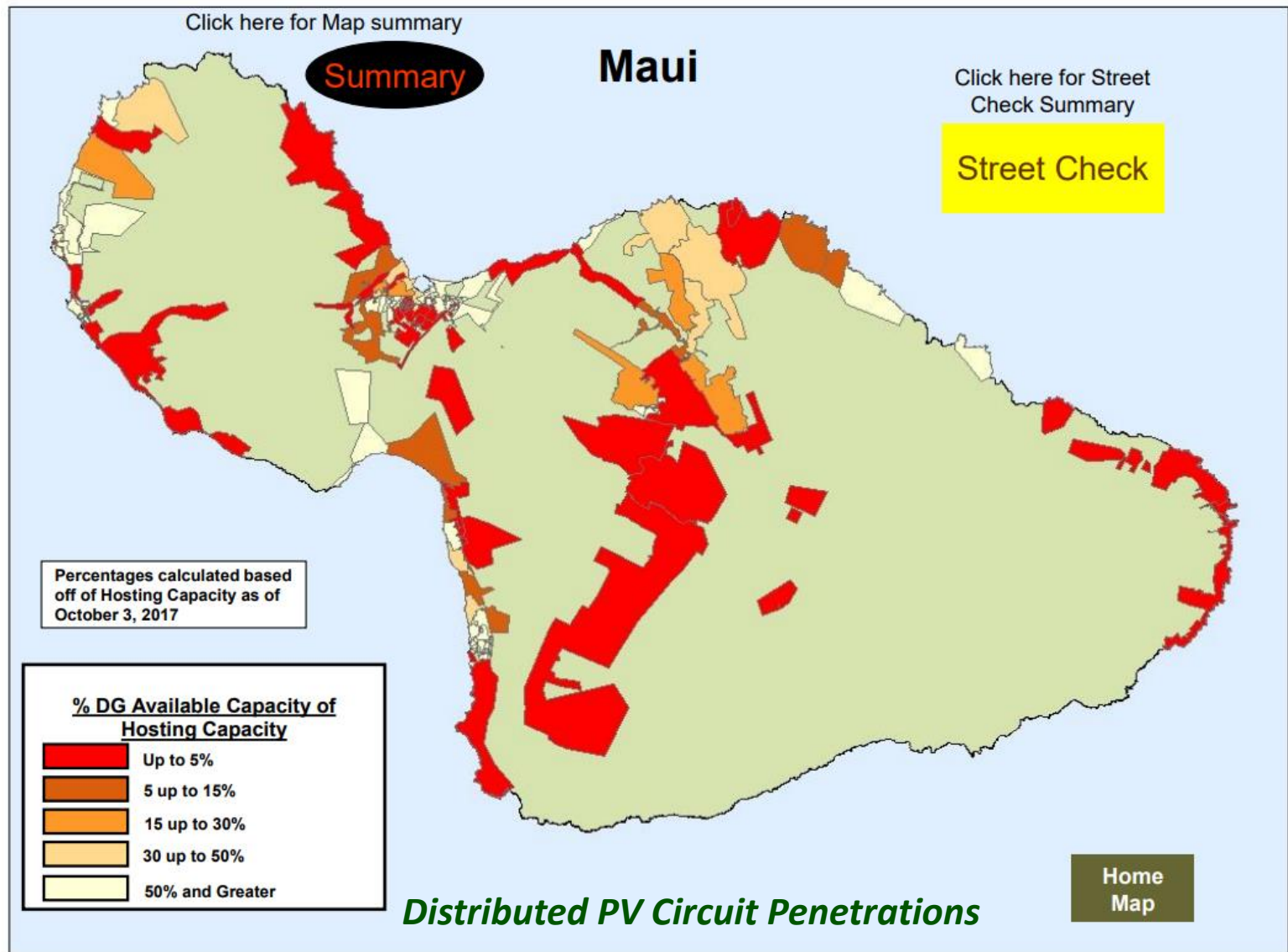
**Estimated time for the system to pay for itself:** 6 years, 0 months

**Is solar worth it in Hawaii?** Based on the price of electricity in Hawaii (an average of 0.37 per kW) and high amounts of sun (8% more than average) compared to other states, solar power is 238% more cost effective than the rest of the nation.





# Distributed PV Circuit Penetrations



# DG PV Programs

## Our Customer Renewable Programs

- **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 for grid stability.
- **Smart Export** 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.
- **Customer Self-Supply (CSS)** is intended only for private rooftop solar installations that are designed to not export any electricity to the grid. Customers are not compensated for any export of energy.
- X ▪ **Customer Grid-Supply (CGS)** participants receive a PUC-approved credit for electricity sent to the grid and are billed at the retail rate for electricity they use from the grid. The program remains open until the installed capacity has been reached.
- X ▪ **Net Energy Metering (NEM)** is closed to new applicants.
- **Standard Interconnection Agreement (SIA)** is designed for larger customers who wish to offset their electricity bill with on-site generation.

Program	Grid Export Rate*	Battery Storage Typical?	Grid Export Window	Controllable?	Wireless Availability Required?
Customer Grid-Supply Plus	10 cents/kWh	No	Daylight	Yes	Yes
Smart Export	15 cents/kWh	Yes	4 p.m. to 9 a.m.	No	Yes
Customer Self-Supply	N/A	No, but usually installed	N/A	N/A	No
Customer Grid-Supply**	15 cents/kWh	No	Daylight	No	No

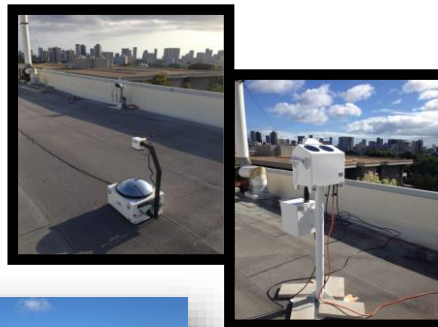


# Moloka'i Island 100% RE Grid Initiative

- **100% Renewable Goal by 2020**
- Battery Storage
  - 2MW, 375kW-hr, Li-ion Titanate
- System Data Collection
- Load Flow & Midterm Dynamics Modeling
- Production Modeling
- Dynamic Load Bank
- PV Forecasting
- Island Grid Controller



- **Peak Load: 5.4 MW (2013)**
- **Daytime Min Load: 3 MW**
- **PV Installed: 1.07 MW (with 59.3Hz drop-out)**
- **PV Installed: 1.23 MW (with 57Hz drop-out)**
- **PV Planned: 0.6 MW in que**



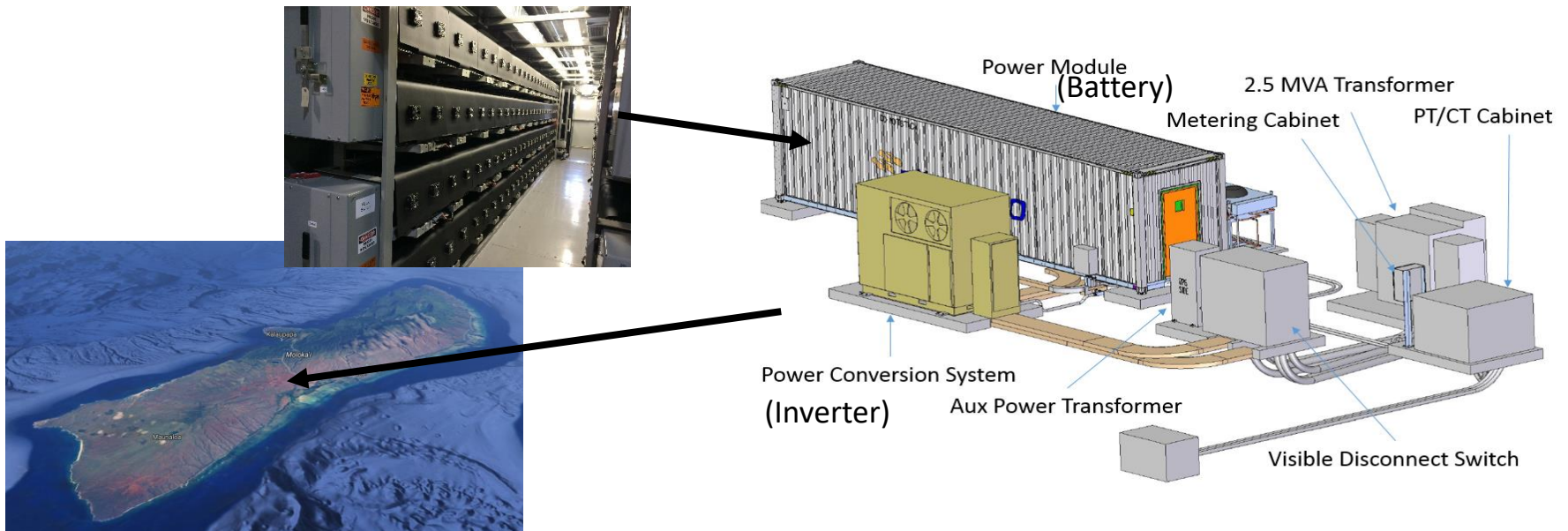
**Hawaii ranks #1 in U.S.  
electric energy costs:**

<b>47.1 cents/kWh</b>	<b>Molokai</b>
45.9 cents/kWh	Lanai
41.9 cents/kWh	Hawaii
37.8 cents/kWh	Maui
35.5 cents/kWh	Oahu
(Avg. residential rates for 2014)	
11 - 12 cents/kWh	U.S. avg.

**Opportunity to extend this initiative as a scalable model  
to other Asia-Pacific regional sites**

# Molokai Grid Stability

- Even relatively small disturbances can trip PV units, increasing automatic load shedding customer outages on the system.
- **Proposed solution** to increase grid reliability: a 2MW fast-acting BESS.
- **The challenge:** standard 250 ms response destabilizing to grid (models)
- **The solution:** re-engineer the way the BESS and the inverter computers collaborate to share computational burden





# Molokai Island BESS Project

## Altairnano Li-ion Titanate

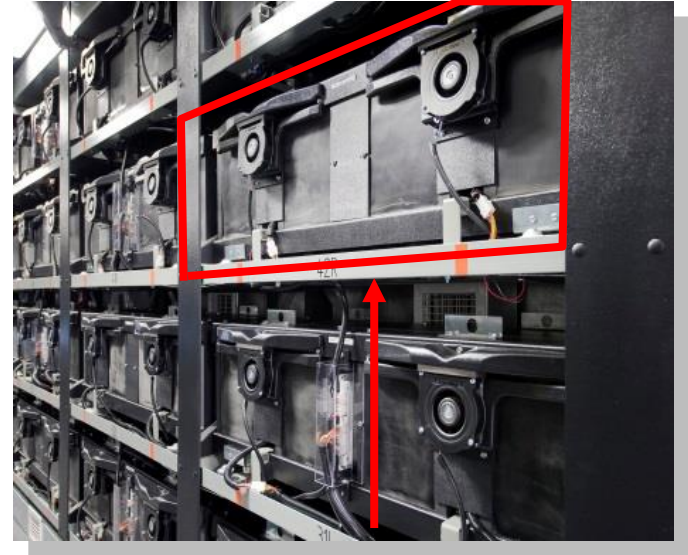


Power Module

- Power module produces  $\pm 2$  MW
- Capacity of 375 kW-hr
- Inverter rated  $> \pm 2$  MVA
- Over 12,000 full charge / discharge cycles with minimal degradation in cell capacity



Power Conversion System



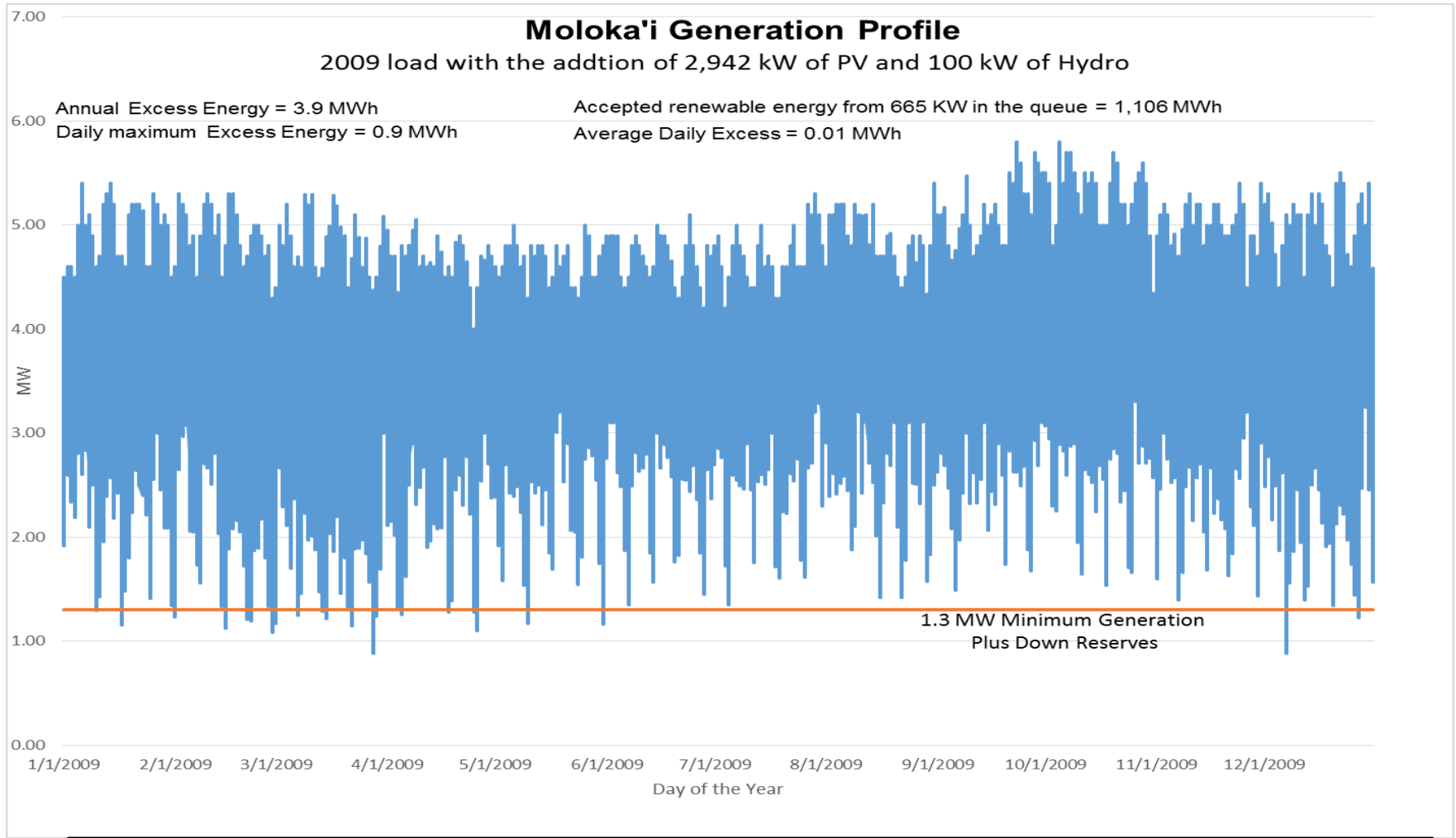
Interior View

- Li-Ion Titanate 50 A-Hr Cells
- BESS has 2688 cells in 96 LRU

Designed for rapid charging and discharging

# Alternatives to Storage

## Dynamic Load Bank



Small to moderate amount of excess RE curtailment is a sound integration strategy

# ***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 (HRS304A-1891)

- Conduct RDT&E to accelerate and facilitate the use of resilient alternative energy technologies; and to reduce Hawaii's dependence on fossil fuels.
- Diverse staff includes engineers, scientists, lawyers; students and postdoctoral fellows; visiting scholars

## **Areas of Interest**

- **Policy and Innovation**
- **Grid Integration (GridSTART)**
- **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 enabling policies.**

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

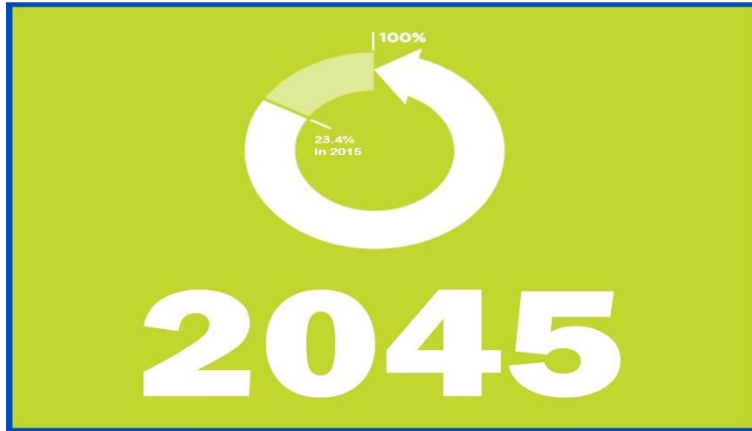


Asia-Pacific  
Economic Cooperation

**Lead for many public-private  
demonstration projects**



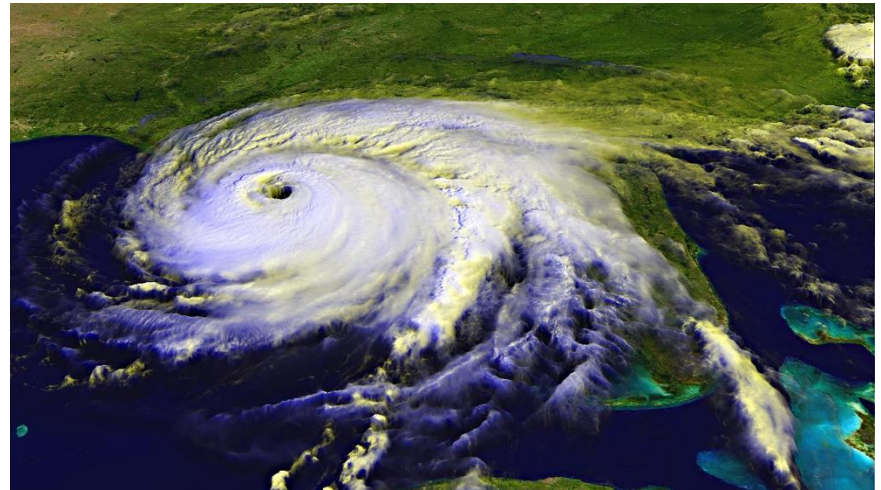
# *Leadership in Energy Policy & Innovation*



Jobs, Energy Security



Environment, Climate Change



Economic Development & Innovation



# ***Mahalo!***

***(Thank you)***



For more information, contact:



Hawaii Natural Energy Institute | University of Hawaii

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