



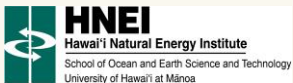
Hawaii Clean Energy Transformation

Policy, Challenges, and Opportunities

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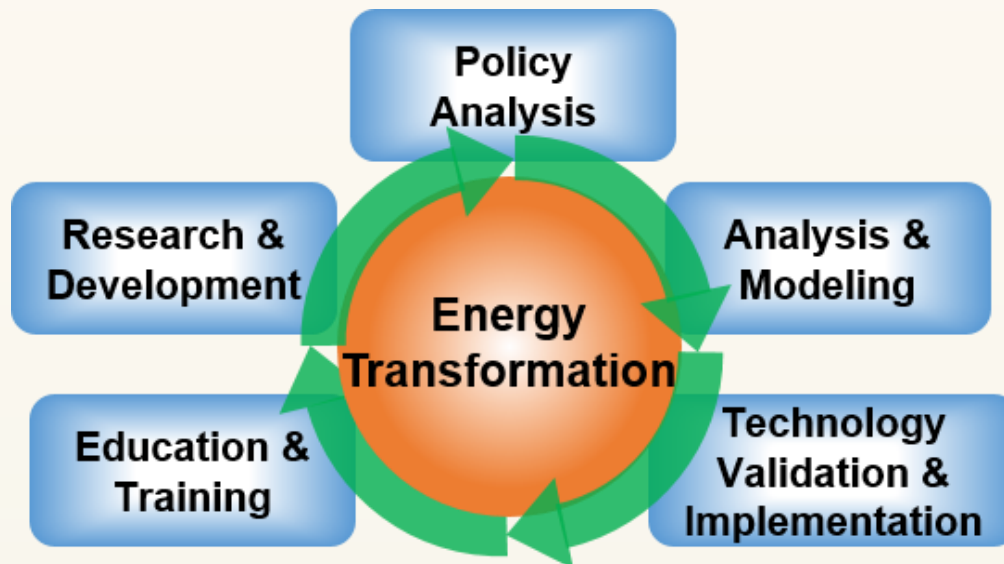
**Isolated Power Systems Connect
October 17 , 2018
Ka'anapali, Maui, Hawaii**



Hawaii Natural Energy Institute (HNEI)

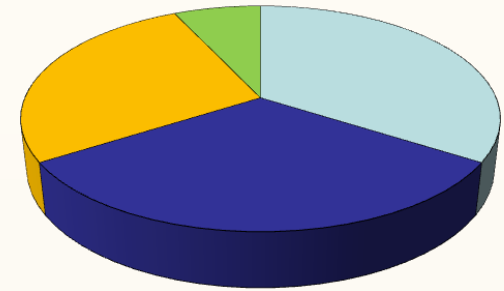
*Organized Research Unit in School of Ocean and Earth Science and Technology
Founded in 1974, established in statute in 2007 (HRS304A-1891)*

- Directed by statute to coordinate and undertake the development of Hawaii's abundant natural energy resources in order to ...diminish Hawaii's dependence on fossil fuels and to contribute to the technology base for finding solutions to the national and global energy shortage (ESDSF, Barrel Tax)
- Conducts research, development, testing and evaluation to accelerate and facilitate the use of resilient alternative energy technologies
- Building international collaboration to facilitate transfer of Hawaii's lessons learned to other Asia-Pacific regions (APRESA)



Energy Insecurity

- Hawaii is the most petroleum dependent state in the nation
- ~70% of electricity generated from oil
- Over 40 million barrels of petroleum imported for energy use every year
- Highest electricity prices in the nation



□ Jet Fuel	34%
■ Electricity	32%
■ Petrol/Marine Fuel	27%
■ Other	7%



Six Isolated Grids; Four Utilities

NIIHAU
KAUAI
80MW

OAHU
1200MW

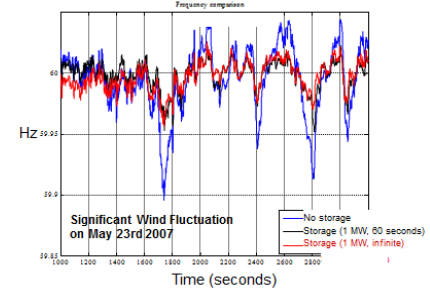
MOLOKAI
5MW

LANAI
5MW

KAHOOLAWE
MAUI
200MW

HAWAII'I
(Big Island)
190MW

Big Island Energy Storage - Fast Storage Mitigates Negative Effects of Increased Wind Penetration

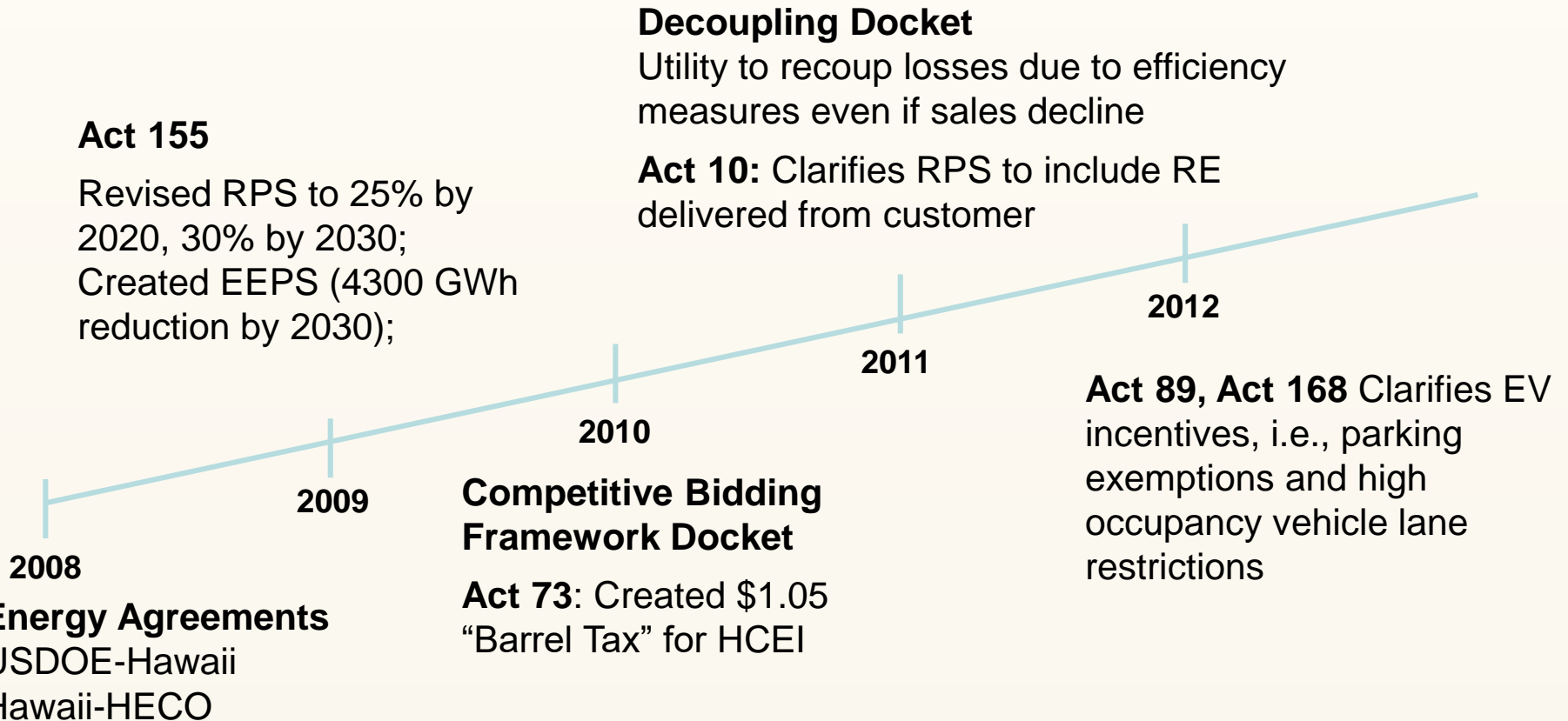


FORMIDABLE CHALLENGES

- >70% of energy use on Oahu
- No interconnections between islands
- Resource and population not co-located
- Intermittent resources dominate

Hawaii's Energy Transformation Policies

Early Drivers



Electricity rates and policy incentives have facilitated significant and rapid PV adoption.

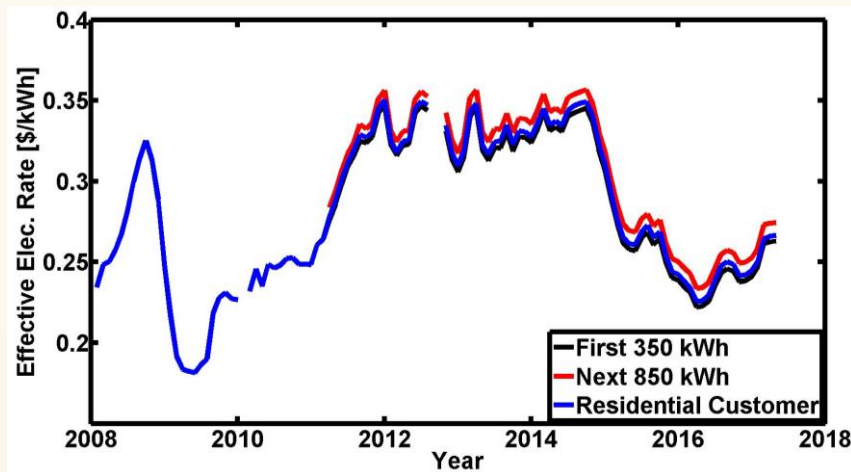
STATE POLICY

- **Tax Credits: 35% for each 5 kW “system” up to \$5000.**
- **Aggressive Renewable Portfolio Standards – 40% by 2030; 100% by 2045**
- **Preferential rate structures for distributed PV interconnection**

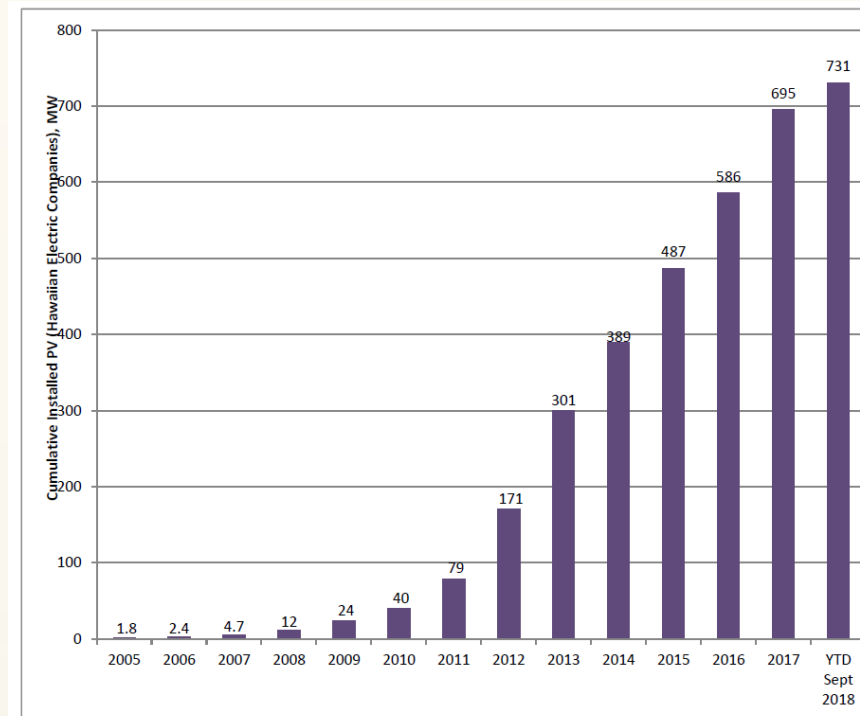
FEDERAL POLICY:

- **Tax Credits: 30% system cost.**

Oahu Residential Rates



High electricity price and volatility.



PV Systems are a Major Part of Hawaii's Power Systems



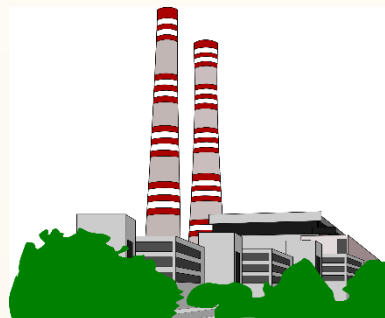
Distribution Wood Poles

Company	Count
HECO	59,000
HELCO	52,000
MECO	30,000
Total	141,000



Distribution Transformers

Company	Count
HECO	32,000
HELCO	24,000
MECO	12,000
Total	68,000



Largest Single

Company	kW
HECO	180,000
HELCO	20,000
MECO	14,000



PV Systems

Company	Count	kW
HECO	52,000	519,000
HELCO	12,000	93,000
MECO	12,000	110,000
Total	76,000	722,000

Hawaiian Electric Company RPS - 2017

2017 Renewable Energy Mix - HEI Companies

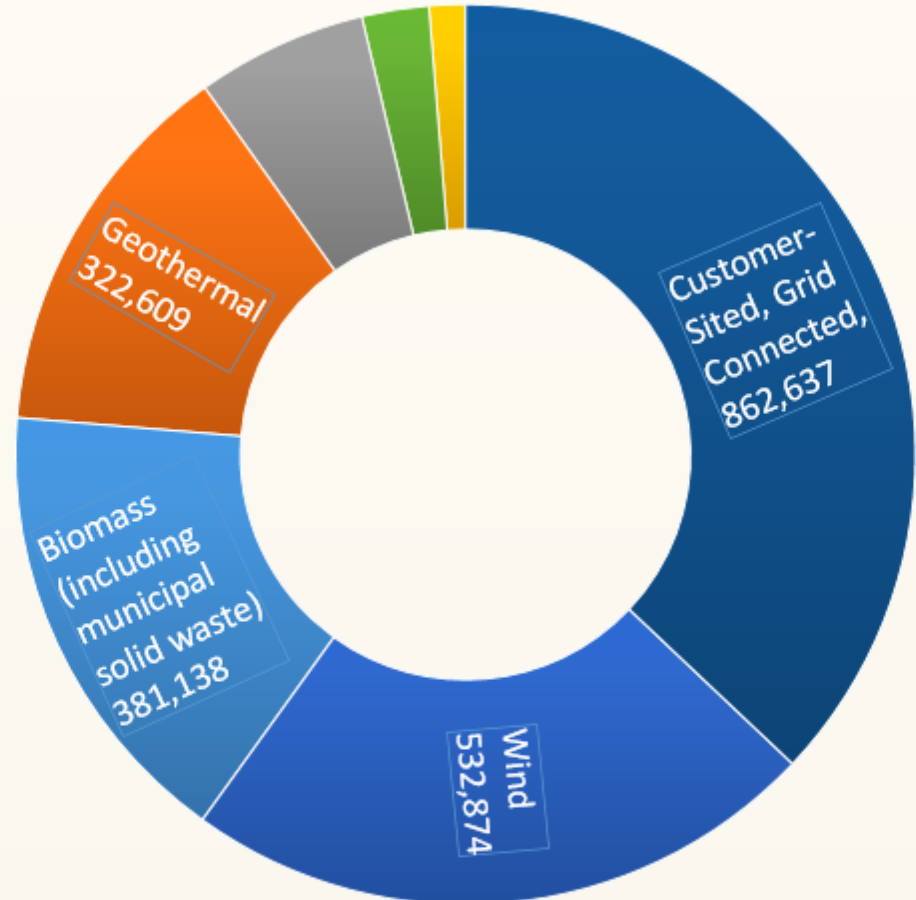
In Net Megawatt Hours

27% Statewide

21% HECO
(Oahu – Honolulu)

57% HELCO
(Hawaii Island)

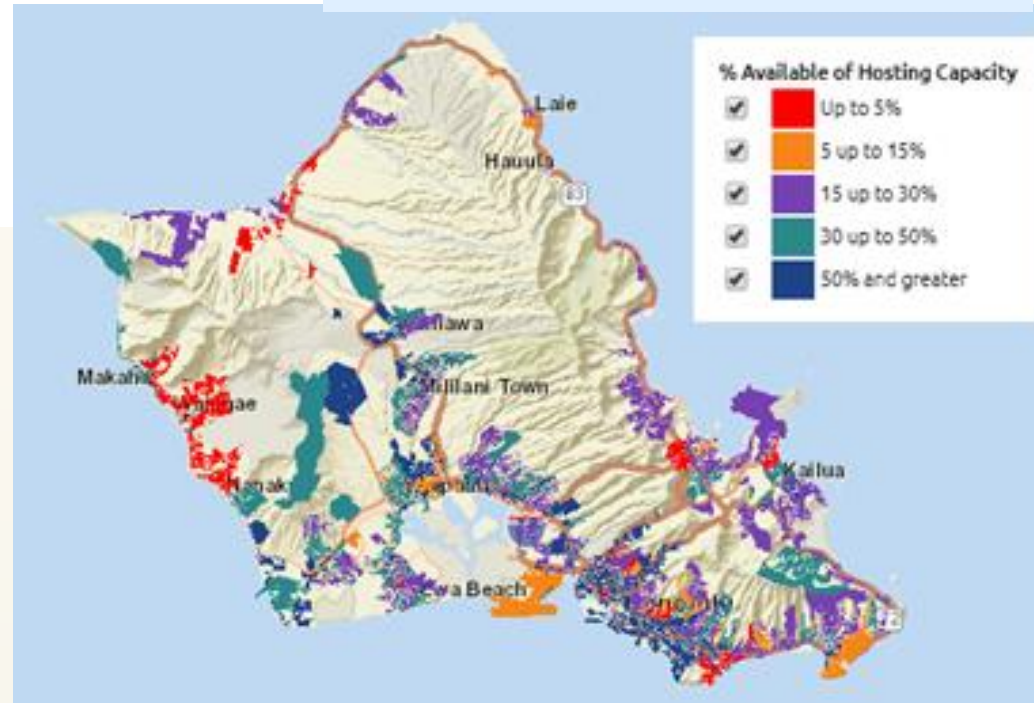
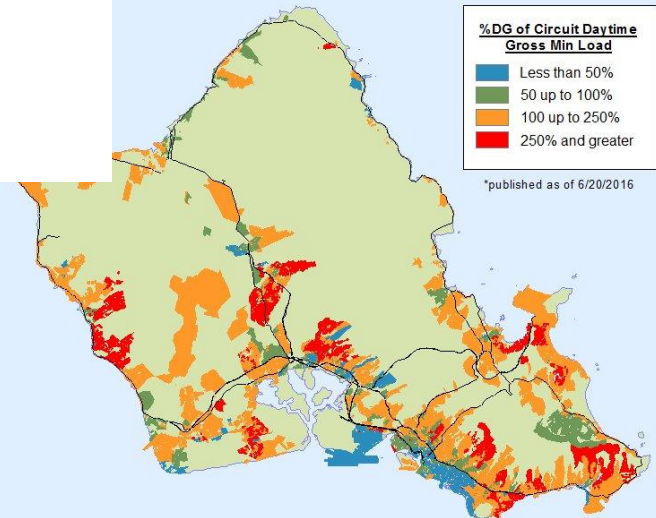
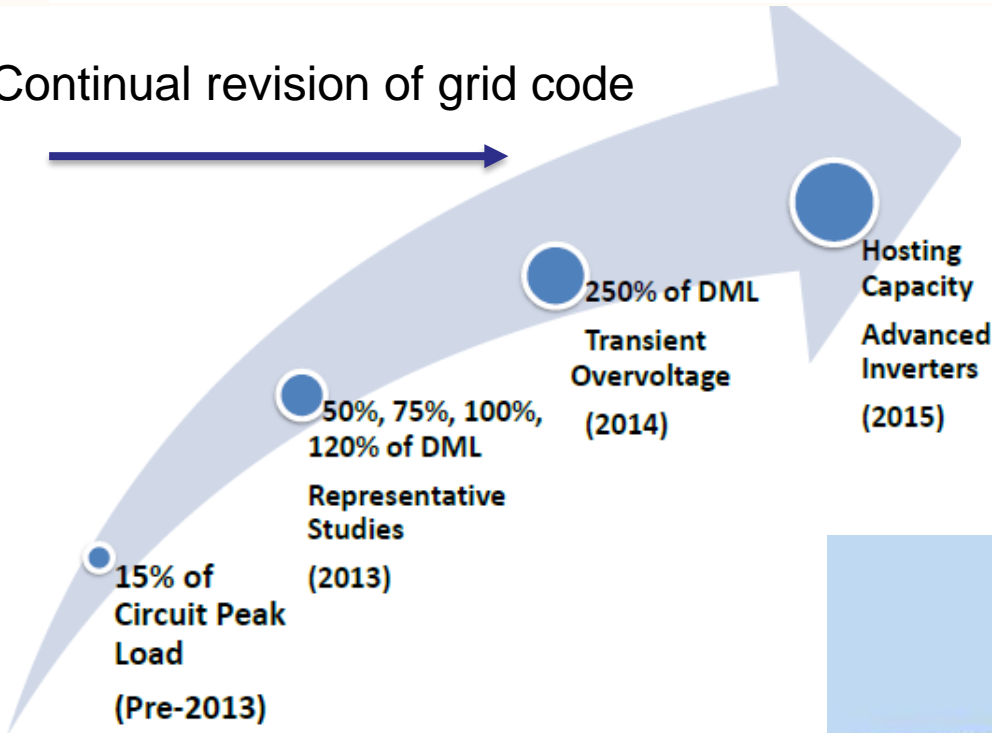
34% MECO
(Maui, Molokai, Lanai)



- Biomass (including municipal solid waste)
- Geothermal
- Photovoltaic and Solar Thermal
- Hydro
- Wind
- Biofuels
- Customer-Sited, Grid Connected

Distributed PV – Circuit Penetration and Hosting Capacity

Continual revision of grid code



- Many circuits now at greater than 250% of MDL
- Circuits across the state are ‘filling up’

Hawai'i Electric Systems –

4 Electric Utilities; 6 Separate Grids; % Renewable Energy

Kaua'i Island Utility Cooperative

System Peak: 78 MW

66 MW PV / 7 MW Biomass / 9 MW Hydro

Installed PV: 85% of System Peak

20 MW Solar Construction

Maui Electric

Maui System Peak: 202 MW

116 MW PV / 72 MW Wind

Installed PV & Wind:

93% of Sys. Peak

Lana'i System Peak: 5.1 MW

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

Moloka'i System Peak: 5.6 MW

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

Hawaiian Electric

System Peak: 1,206 MW

526 MW PV* / 99 MW Wind
/ 69 MW WTE / 168 MW
Biofuel

Installed PV & Wind:

52% of System Peak

130 MW Solar Under
Construction

Hawaii Electric Light

System Peak: 192 MW

98 MW PV / 31 MW Wind /
38 MW Geothermal / 17 MW
Hydro /

Installed PV & Wind:

64% of System Peak

21.5 MW Biomass Under
Construction

Kaua'i

44%

O'ahu

80% of state population

21%

Moloka'i

Maui

34%

Lana'i

Hawai'i

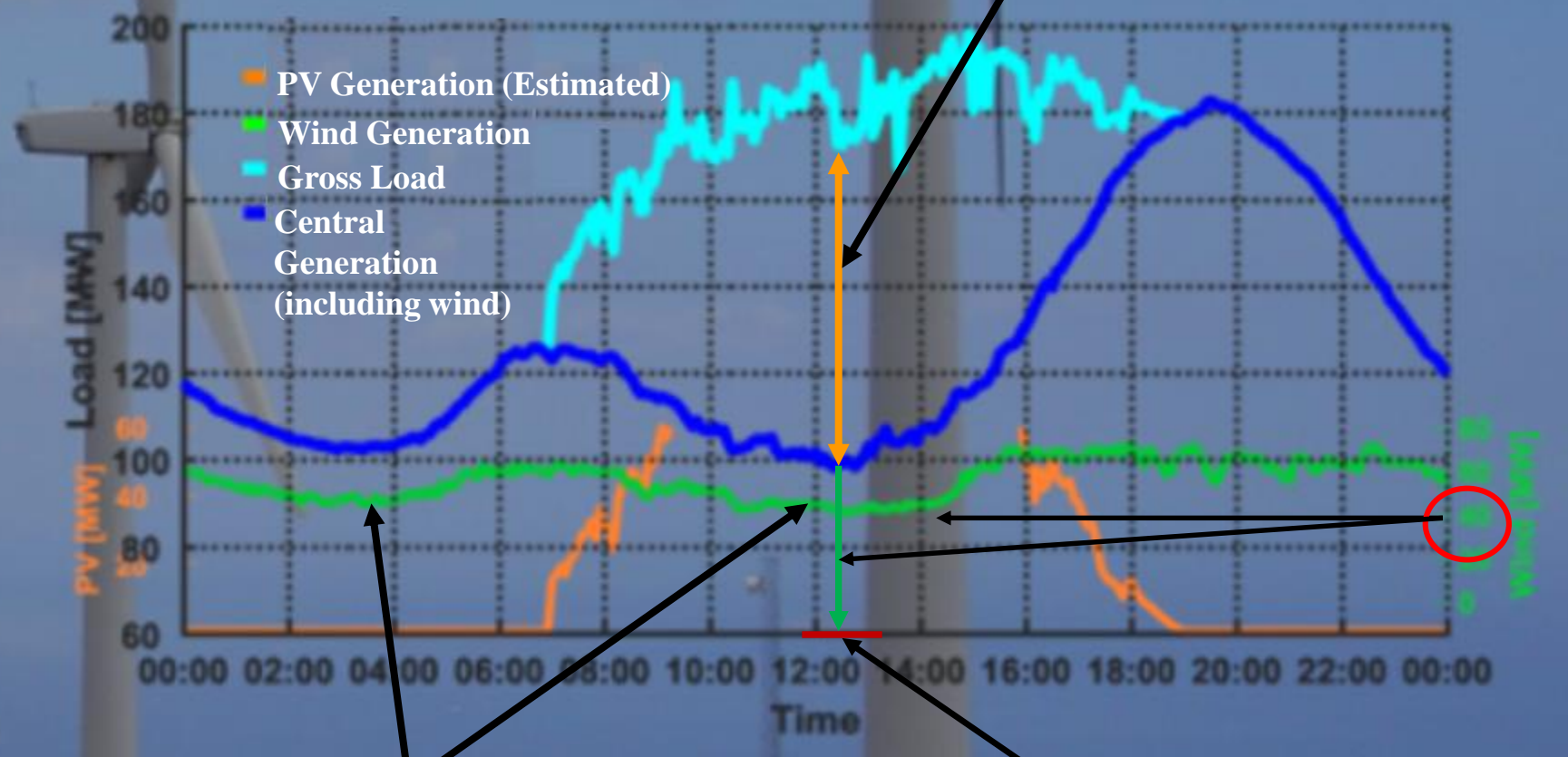
57%



27.6 %
Renewable Energy
Statewide
2017



Renewable Watch - June 4, 2018



Estimated Distributed Rooftop PV

Wind Curtailment
 automatically adjusted every 4 seconds
 Maintaining curtailment priority

Minimum thermal unit dispatch level
 (~60MW Central Generation - 40 MW wind)

Maui Island

Leading the way in Solar and Wind Power

Wind - 72 MW
PV - 201 MW
273 MW

116 MW Existing Distributed PV
5 MW PV Pre-approved
75 MW Renewable RFP
201 MW Total

Kaheawa I
(30 MW)

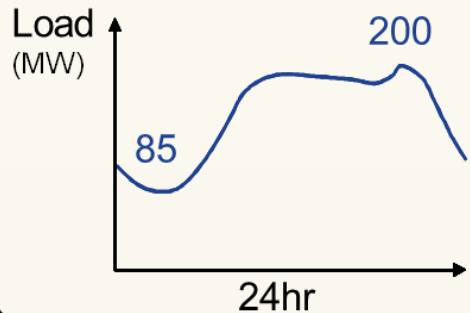
Kaheawa II
(21 MW)

Auwahi
(21 MW)



63,000 Customers

Daily Load Shape



Where do we go now?

- **Procurement of utility scale dispatchable renewable generation**
- **Integration of transportation with the power grid**
- **Reliability and resiliency**
- **In-depth understanding of the use and value of storage for energy shifting, arbitrage, and grid services**
- **Real-time use of solar forecasting**
- **Integrated Grid Planning**
- **Grid Modernization (e.g. smarter grids, distributed resources)**
- **Demand side management**
- **Grid Services**
- **New Economic Models**
- **Innovation**

Mahalo!

(Thank you)



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