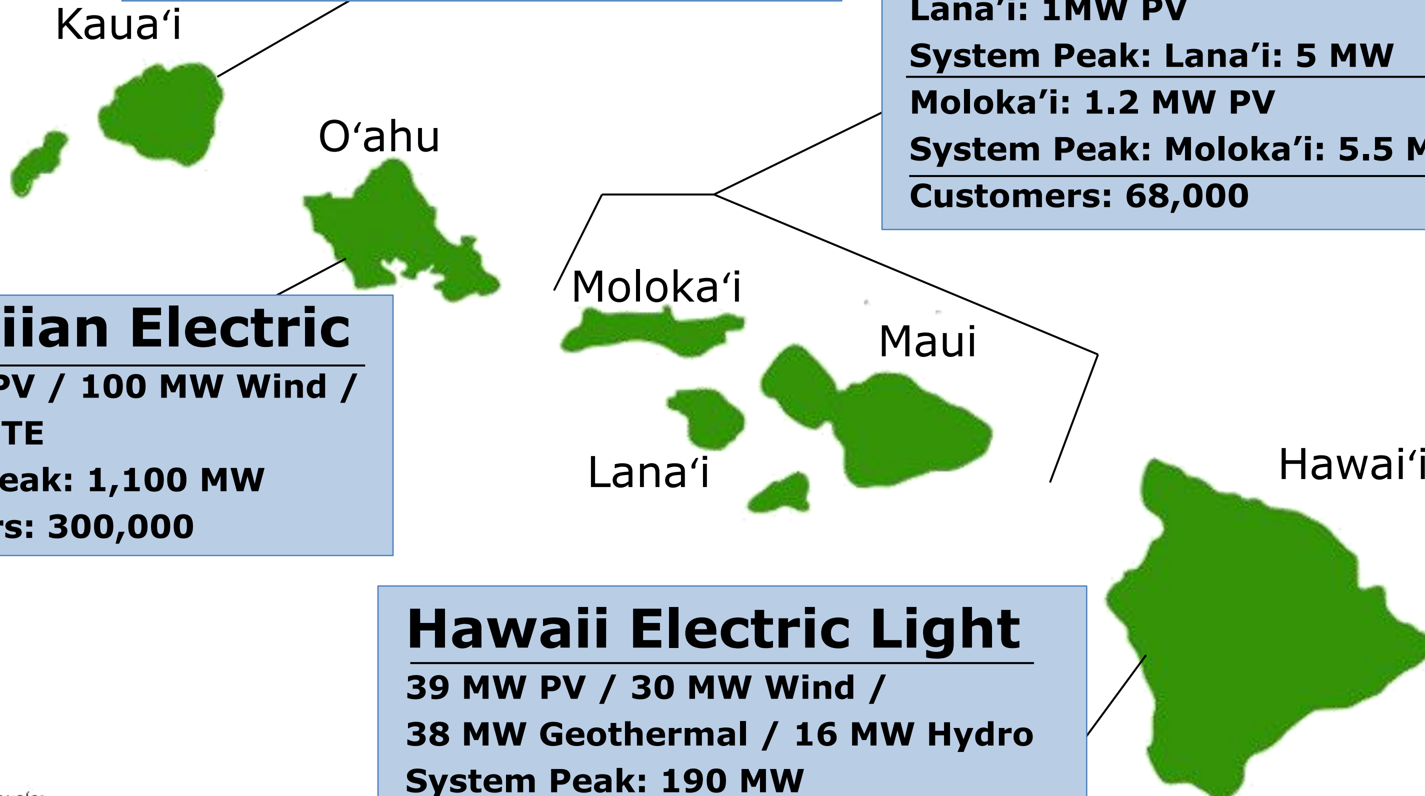
What’s Up in Hawaii?

Pacific Northwest Demand Response Project
February 25, 2015

Hawaii Electric Systems

4 electric utilities; 6 separate grids



Kauai Island Utility Cooperative

27 MW PV (24 MW in development)
System Peak: 78 MW
Customers: 32,700

Maui Electric

Maui: 60MW PV / 72MW Wind
System Peak: Maui 200 MW
Lana'i: 1MW PV
System Peak: Lana'i: 5 MW
Moloka'i: 1.2 MW PV
System Peak: Moloka'i: 5.5 MW
Customers: 68,000

Hawaiian Electric

221 MW PV / 100 MW Wind / 69 MW WTE
System Peak: 1,100 MW
Customers: 300,000

Hawaii Electric Light

39 MW PV / 30 MW Wind / 38 MW Geothermal / 16 MW Hydro
System Peak: 190 MW
Customers: 81,000

UNIVERSITY of HAWAI'I MĀNOA

Source: Hawaii Natural Energy Institute

A Tiny Bit of History

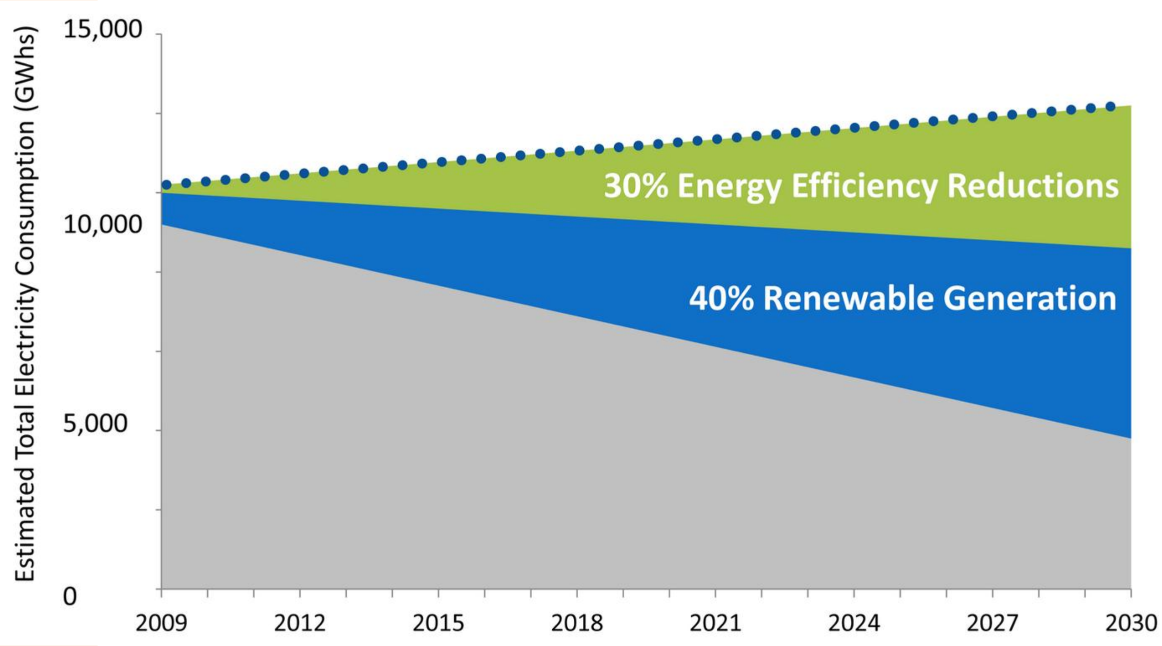
- Oahu: centralized power since 1891
- Other islands originally sugar mill based systems; island-wide after WWII.
- IRP process and EE Funding created 1992
  - Cost Recovery, LRAM, Shareholder Incentive; Gamed by HECO from 1994 to 2006
- Hawaii Energy Regulation and Taxation Report (2003)
- Decoupling plus third-party EE in 2011.

1996-1998 Big Island Crisis

- Puna CT failed; 2 years to reconstruct
- Negative reserve margin
- Consumer Advocate engaged me
  - Hotel, water, sewer standby generators
  - Install diesels at wind projects
  - Replace all light bulbs and shower heads

Hawaii Clean Energy Initiative
USDOE / Hawaii MOU 2008

- High oil costs devastating to state economy.
- 35% state solar tax credit.
- 40% RPS by 2030.
- Step up of EE



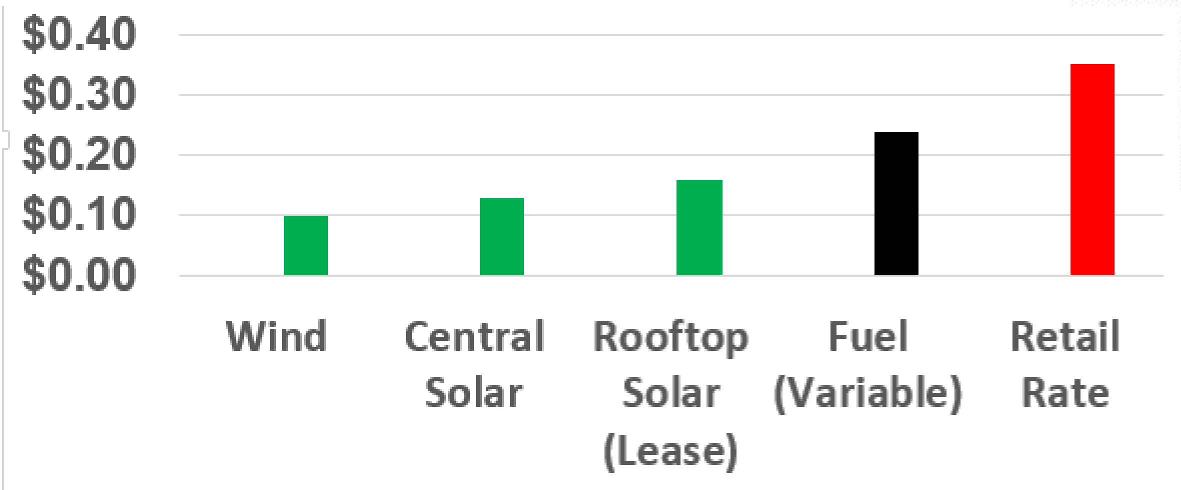
Cost Drivers In Hawaii

Highest rates and bills in USA

$.35 - $.40/kWh; $200/month

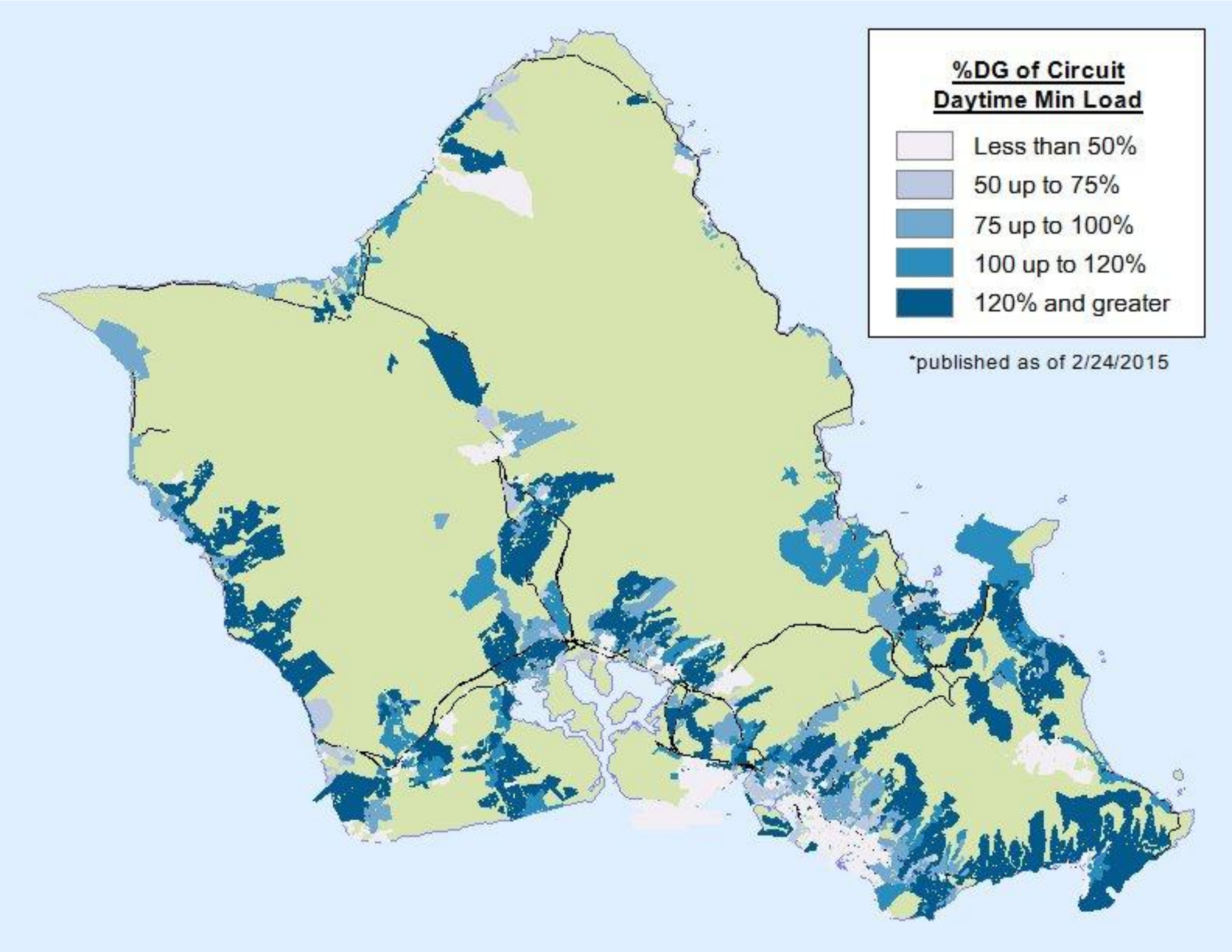
vs: $.125/kWh; $100/month

30% Federal + 35% State Tax Credit



Grid Parity in Hawaii: We're A Little Past That Point!

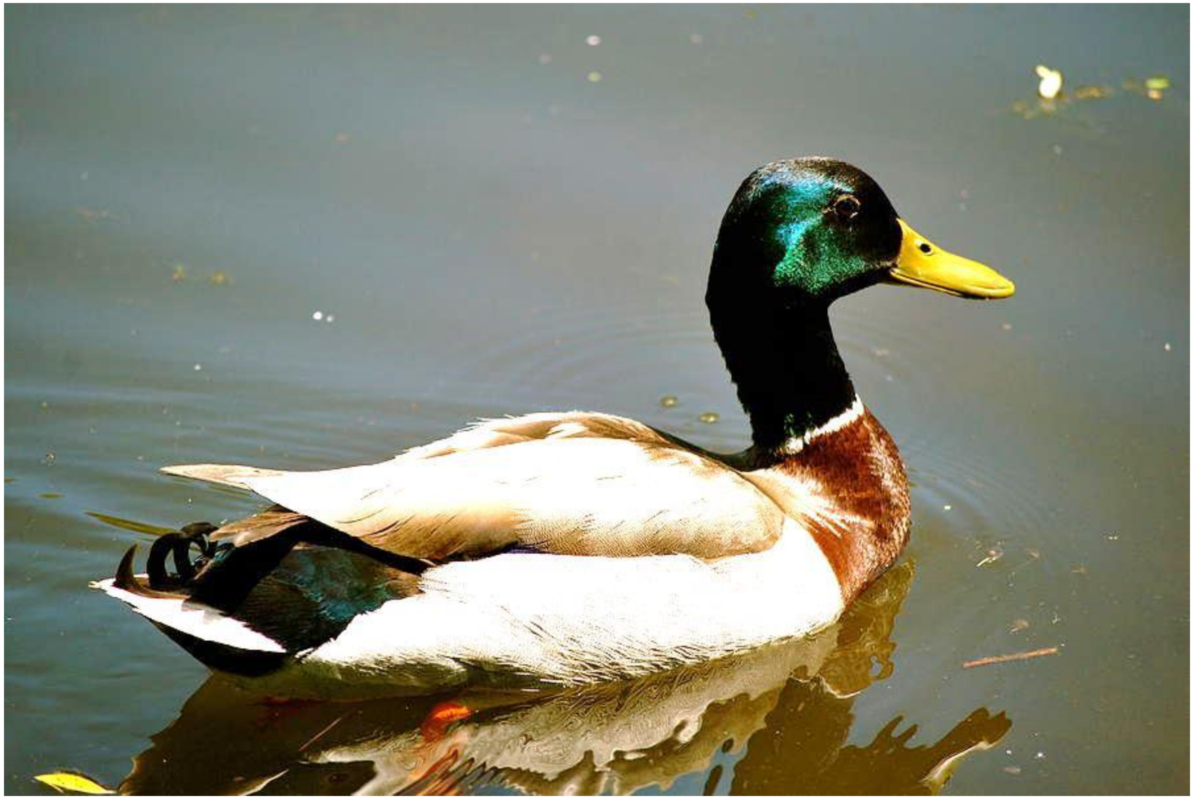
Solar Saturation



Residential Solar PV

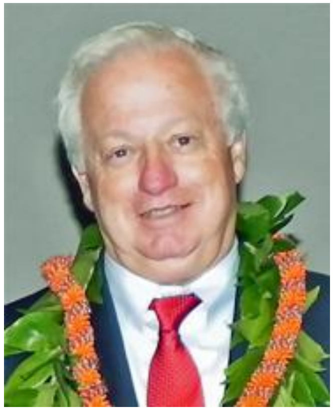
- Currently 11% saturation
  - ~20% in Single Family
- IEEE Limits Long Passed
  - 85% of Min Load
  - 100% of Min Daytime Load
  - 120% of Min Daytime Load
- Proposed: 250% of Min Daytime Load
  - With smart inverters

Ramping Issues Becoming Severe



April 30, 2014:
Four Orders of the Apocalypse

- Integrated Resource Plan **rejected**.
- Renewable Standards Working Group
- DSM Program Review
- MECO Rate Case - Decoupling



Commissioner's Observations
Exhibit A: 30 pages

The Commission has not observed an "acceptable course correction" and there is not sufficient evidence, at this time, of progress by the HECO Companies towards developing and implementing a sustainable business model. By contrast, the Commission does note that the state's other electric utility has clearly articulated a strategic vision and made substantial progress in achieving their goals over the same time period.[3]

- Creating a 21st Century Power System
- Creating Modern T&D Grids
- Policy and Regulatory Reforms
- Focus on Performance Incentive Measures
- Revise rate design to address PV issues

Demand Response Direction

- Can benefit company and customers, by enabling capital avoidance and lower cost
- Develop detailed estimates for 5, 10, 20 yrs
- Evaluate third-party implementation
- Wide range of benefits: peak reduction, load shifting, frequency management, spinning reserves, ramping.

Existing Demand Response Programs

- Residential (RDLC):
  - 32,350 water heaters
  - 3,750 AC units
  - 15 MW
- Commercial
  - Large C&I with Generators
  - Small C&I water heat and AC
  - 13 MW

Existing DR Programs (cont'd)

- Fast DR (Oahu and Maui)
  - 38 / 4 customers
  - 6 MW

Program	Participating Load (customer level impact)[1] (MW)	2013 Load Impact Estimate (MW)	2013 number of events and tests	2013 Duration
RDLC	14.8[2]	7.2[3,4]	58 events + 19 tests	75 hr 30 min
CIDLC	12.8	12.3[3]	3 events + 2 tests	1 hr 13 min
Fast DR (Hawaiian Electric)	6.1	0.7[3]	54 tests	33 hr 15 min
Fast DR (Maui Electric)	0.2	0.15[5]	29 tests	19 hr 30 min

Maui Wind

- 200 MW peak demand
- Night load ~80 MW
- 72 MW wind
- Minimum thermal load
- Spilling ~15%

DR Report:

6,200 water heaters

What Needs Can DR Provide?

Grid Service Requirements	Response Speed* (Mainland)	Response Speed* (Hawaii)	Response Duration	Potential for DR?
Capacity				
Capacity Used to meet demand plus reserve margin; supplied by on-line and off-line resources, including interruptible load	Minutes	scheduled in advance by system operator	If called, must be available for at least 3 hours	✓
Ancillary Services				
Contingency Reserve** Reserves to replace the sudden loss of the single largest on-line generator; supplied from online generation, storage or DR	Seconds to <10 min	Within 7 cycles of contingency event	Up to 2 hours	✓
Regulating Reserve Maintain system frequency; supplied from on-line capacity that is not loaded	<1 min	2 seconds, controllable within a resolution of 0.1 MW	Up to 30 min	✓
Non-Spinning Reserve Used to restore regulating reserves and contingency reserves; supplied by off-line fast start resources or DR	10-30 min	<30 min	2 hours	✓
Non-AGC Ramping Resources that can be available prior to quick start generation and can add to system ramping capability	N/A	<2 min	Up to 2 hours	
Black Start Capability The ability of a generating unit to start without system support	N/A	<10 min	Duration of system restoration time	✗
Inertial Response Local (i.e. at a generator) response to a change in frequency; supplied by rotational mass of generators, or power electronics of inverter-based resources	N/A	2-3 seconds	2-3 seconds	✗
Other				
Accelerated Energy Delivery*** Shifting the demand for energy from high demand evening peak periods to lower demand midday periods, or higher demand morning periods to lower demand overnight periods	N/A	N/A	N/A	✓

What Services From Which Programs

Grid Service Requirements	Current Demand Response Programs			
	RDLC	CIDLC	Fast DR (Hawaiian Electric)	Fast DR (Maui Electric)
Capacity	✔	✔	✔	✔
Regulating Reserve	✖	✖	✖	✖
Contingency Reserve*	✔	✔	✖	✖
Non-Spinning Reserve	✔	✖	✔	✔
Non-AGC Ramping	✔	✖	✖	✖
Accelerated Energy Delivery	✖	✖	✖	✖

* Under-frequency response provided by RDLC and CIDLC can provide system protection but is not fast enough to be substituted for spinning reserves under the Companies' contingency reserve requirement.

Alternative Communication Networks

Function	Paging	AMI	Gateway	Cellular	Wi-Fi
Effective Throughput Speed	High*	Low	High	High	High
Network Availability	Always on	Always on	Dependent on customer	Always on	Dependent on customer
Endpoint Online Status	None	Post-event analysis	15 minutes	15 minutes	Immediate
Load Control	Immediate	Scheduled	Immediate or scheduled	Immediate or scheduled	Immediate or scheduled
Acknowledgement	None	Next meter read	15 minutes	Immediate	Immediate
Commissioning	Simple	Complex	Complex	Plug and play	Low
Consumption Display	None	Local real-time	From meter read	From meter read	From meter read
Remote Device Telemetry	No	No	Yes	Yes	Yes
Remote Device Configuration	Some	No	Yes	Yes	Yes

Proposed Future Programs

Program	Grid Service Requirement	Resource
RBDLC	Capacity	Water Heaters, central A/C
	Non-AGC Ramping	Water Heaters, central A/C
	Non Spinning Reserve	Water Heaters, central A/C
R&B Flexible	Regulating Reserve	GIWH, central A/C
	Accelerated Energy Delivery	GIWH
CIDLC	Capacity	C&I Curtailable
C&I Flexible	Regulating Reserve	Central A/C, Ventilation, Refrigeration
	Non-AGC Ramping	Central A/C, Ventilation, Refrigeration, Lighting
Water Pumping	Regulating Reserve	Pumps
	Non-AGC Ramping	Pumps
Customer Firm Generation	Capacity	Generators
Dynamic and Critical Peak Pricing	Capacity	Unspecified Customer Load
	Accelerated Energy Delivery	Unspecified Customer Load

Pilot Programs

- Grid Integrated Water Heating
  - Two technologies deployed
- EV Charging TOU Pilot

Power Supply Improvement Plan

Retire Old Steam

Build Marine Diesels

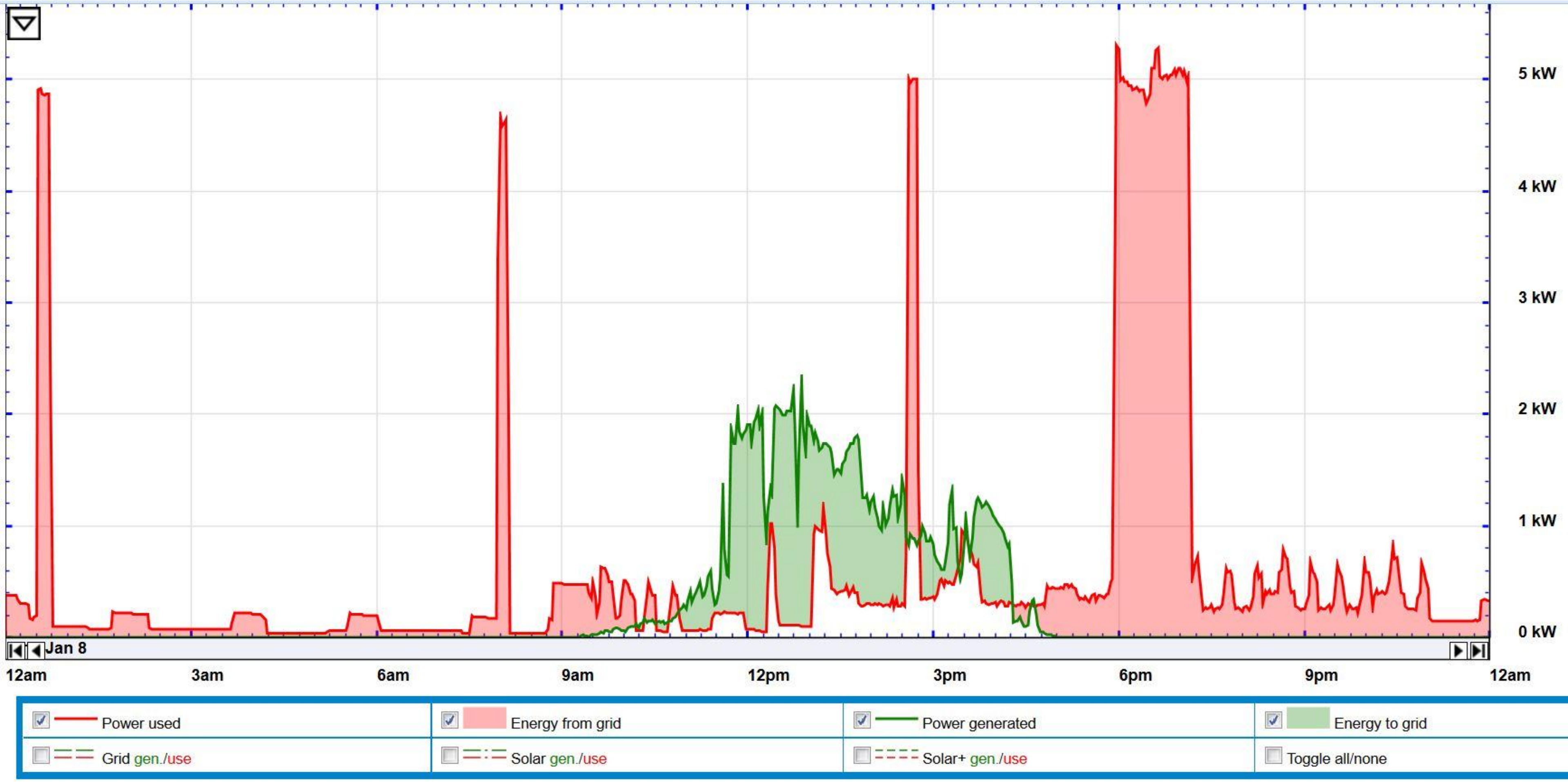
Some Things NOT Happening

- Full deployment of GIWH
- Water Pumping Controls: Not accepted by water agencies.
- Deployment of Air Conditioning thermal storage
- TOU pricing

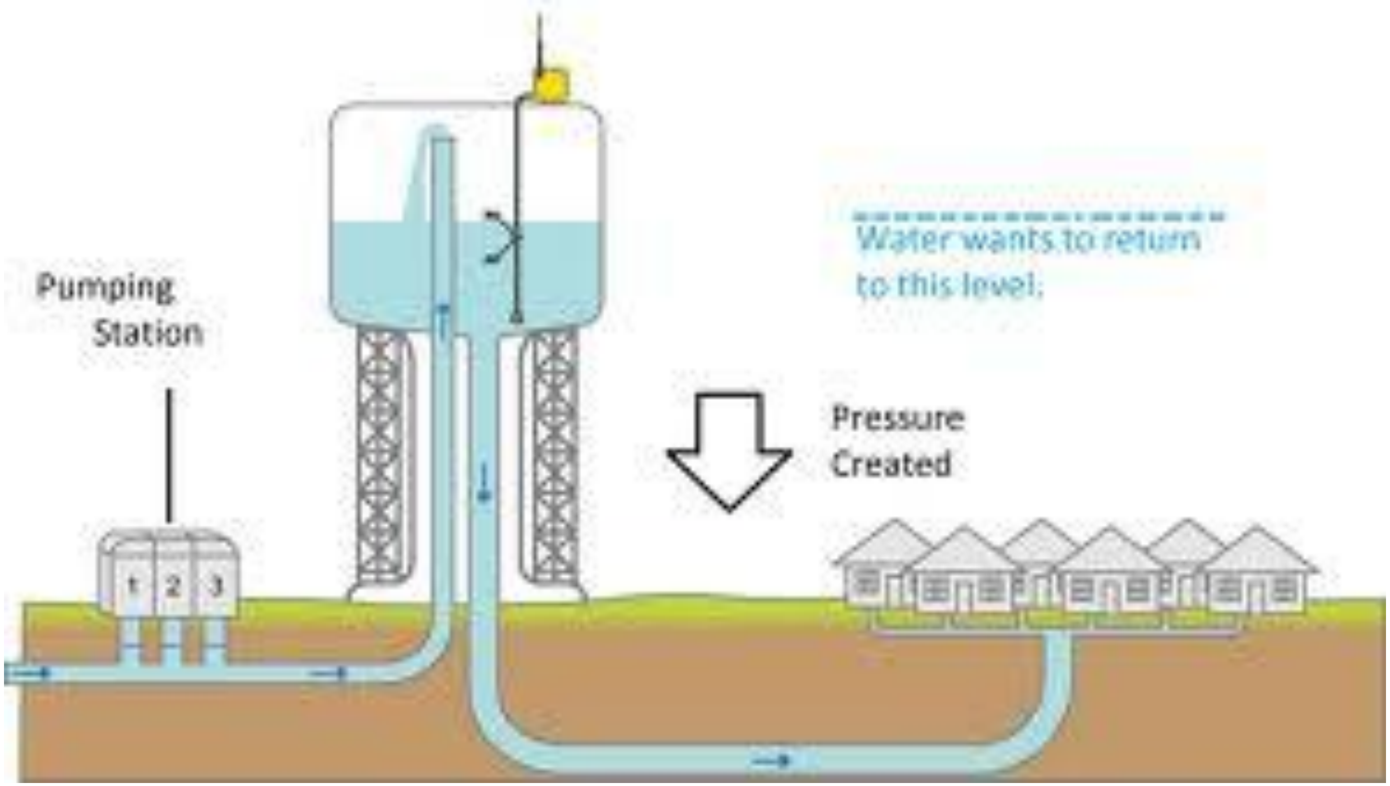
Potential for GIWH

- ~150,000 electric water heaters; 70% in multi-family
- ~600 MW of potentially dispatchable load (40%)
- ~75 MW of potential peak load reduction (6%)
- Incremental cost <$100/kW if integrated at manufacturing.

It’s Easy To Spot a Water Heater



Water Pumping Uses ~5% of Hawaii kWh

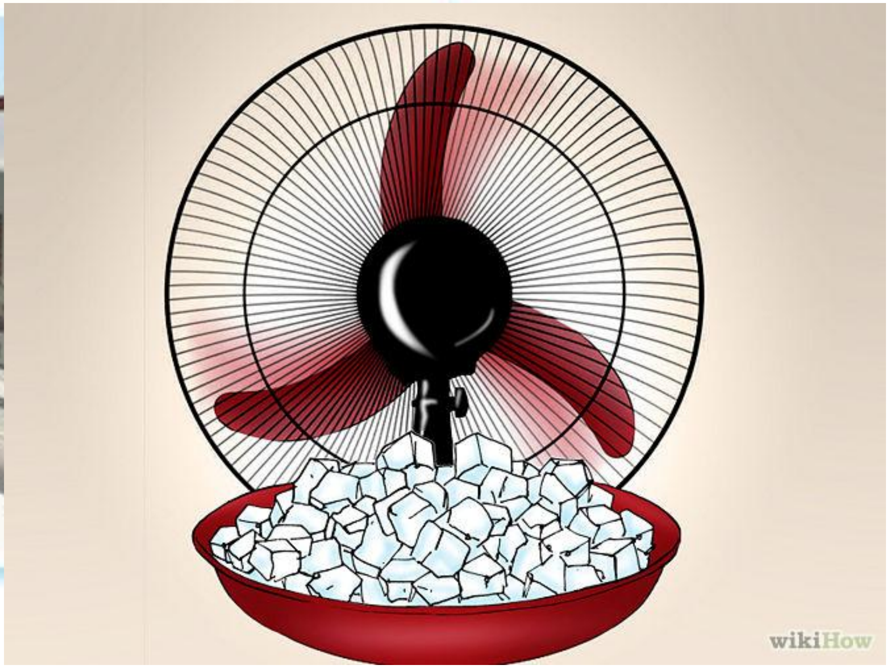


$0.20/kWh when power is "cheap"
$0.50/kWh when power is "expensive"

AC Storage

Simple technology; great peak relief.

No programs to deploy



CALMAC IceBank® Tank Farm

Current Rate Design Options

- **No AMI**; all require special metering
- Rider I: Interruptible 4 custs; 3 MW
- Rider M: 2 Hours Curtailable >10 MW
- Rider T: 2-Period TOU Rate
  - + 3 cents on-peak; -2 cents off peak
- Schedule U: 3-Period TOU Rate
  - 5 – 9 PM Priority Peak

- EV Charging TOU Pilot

Residential Rate Design

Current HECO Residential Rate	
Customer Charge	$9.00/month
First 350 kWh	$0.34
Next 850 kWh	$0.35
Over 1,200 kWh	$0.37

Principles-based Residential Rate		
Customer Charge	$9.00/month	
	Off-Peak	On-Peak
Power	$0.10	$0.30
Delivery	$0.05	$0.15

ONLY the "Power" rate credited for power fed to the grid.

Large Commercial Rate Design

Current:

Customer: $60/mo

Demand: $11.69/kW

Energy: $.216/kWh

Alternative

Customer: $60/mo

Demand:

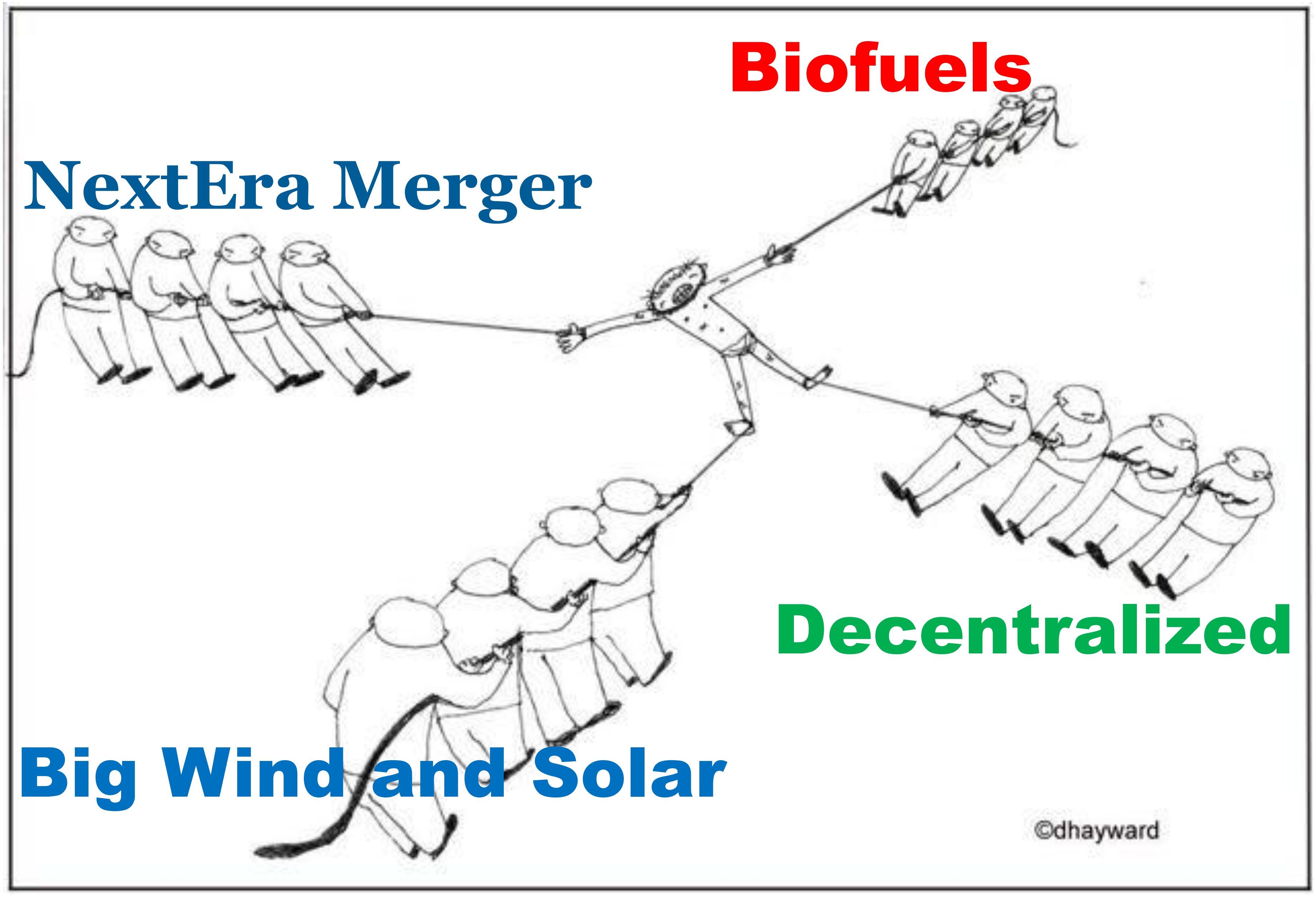
- NCP: $2.00/kW
- 4 – 8 PM: $9.00/kW

Energy:

- Off-Peak: $.12/kWh
- On-Peak: $.25/kWh
- Critical: $.75/kWh

Current Chaos

- Dockets Underway:
  - Decoupling
  - Renewable Interconnection / Net Metering
  - HECO Rate Case
- New Chairman
- Acquisition of HEI by NextEra
- Longstanding tension between energy future scenarios


Biofuels
NextEra Merger
Decentralized
Big Wind and Solar
©dhayward

Will Hawaii Ride The Wave of Change?

Or Wipe-Out?

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- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

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