Hawaii Feed-in Tariff Development and Electricity Reliability Programs

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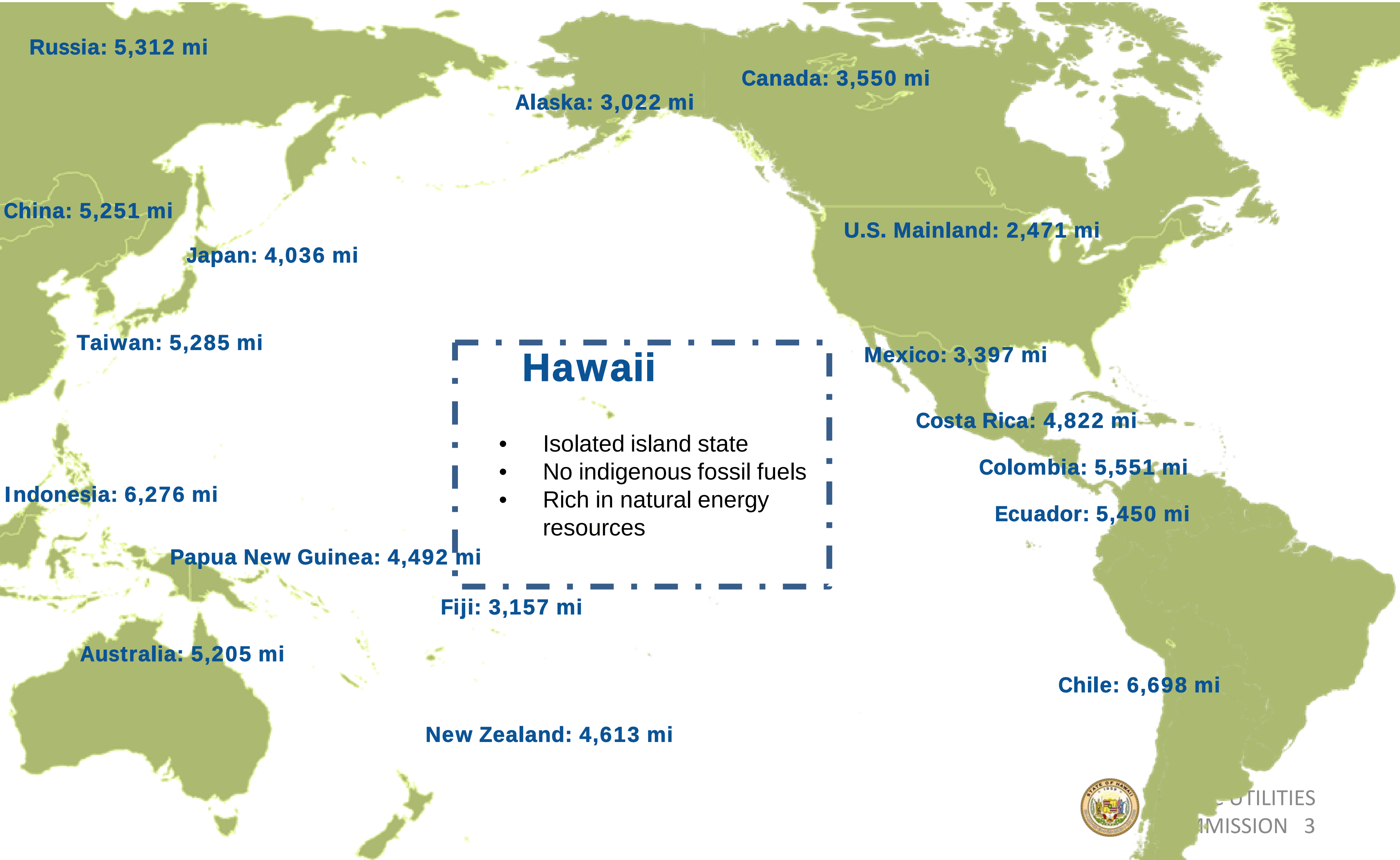
James "Jay" Griffin, Ph.D.
Chief of Policy and Research
Hawaii Public Utilities Commission

Presentation Overview

- **Hawaii overview**
- Feed-in Tariff Program Development and Status
- Future directions
- Electric Reliability-Related Activities

Most Isolated Population Center on Earth



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

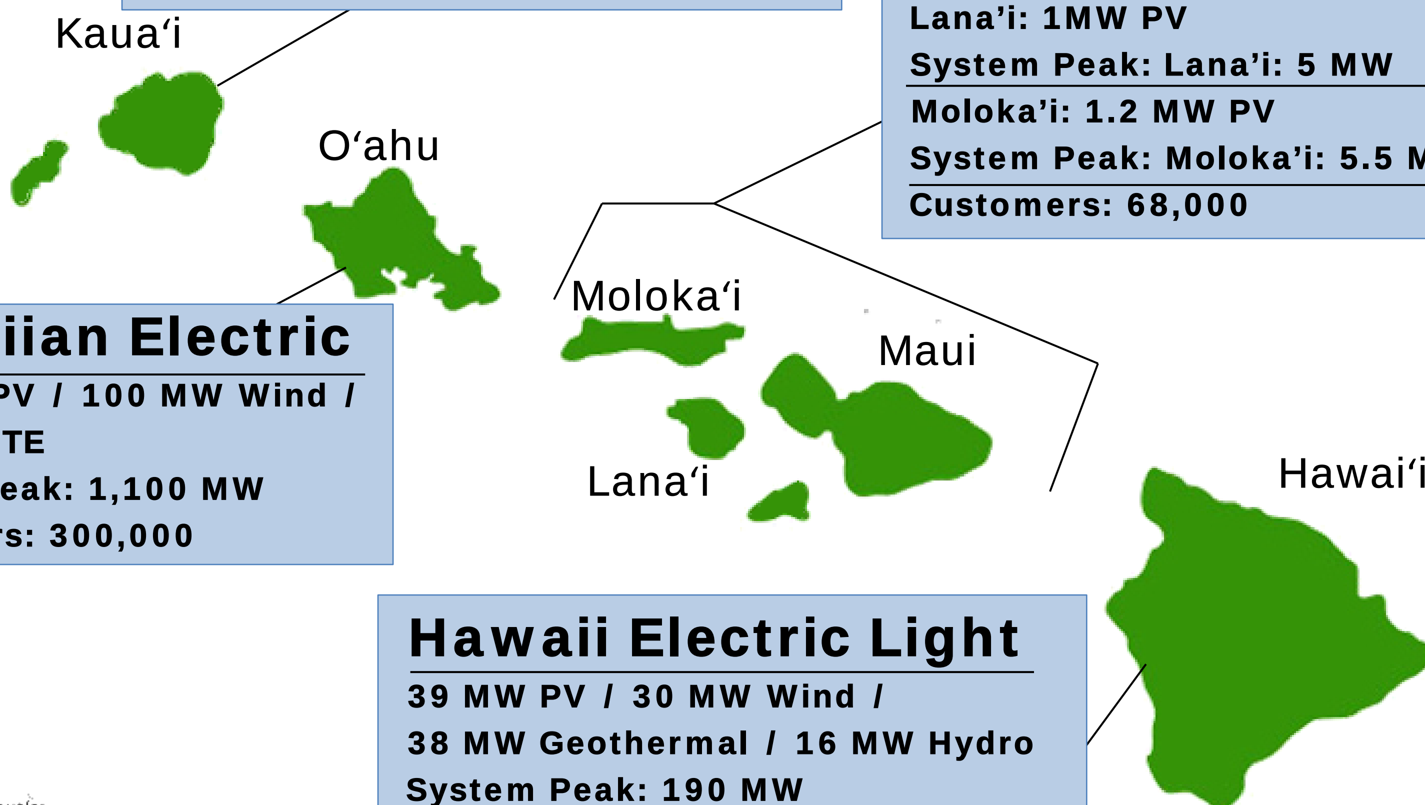
Maui Electric

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

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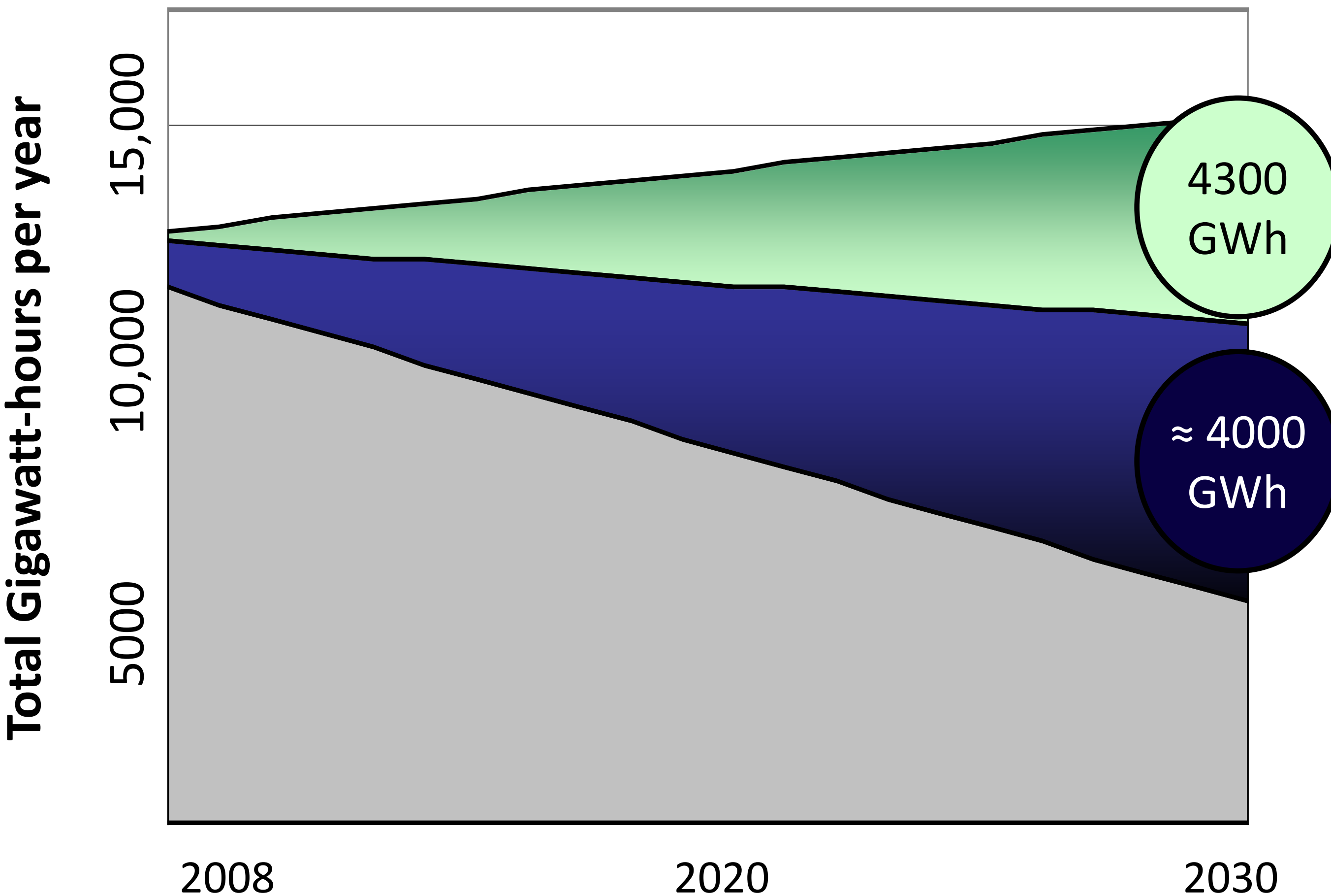
Source: Hawaii Natural Energy Institute

Hawaii Clean Energy Initiative

Enacted in 2008, the Hawaii Clean Energy Initiative (HCEI) is leading the way in relieving our dependence on oil by setting goals and a roadmap to achieve 70% clean energy by 2030



30% reduction

Energy Efficiency Portfolio Standard

Public Benefits Fee

40% clean generation*

Renewable Portfolio Standard

- **Net metering**
- **FiT**
- **Comp. bidding**

*** 40% calculated on remaining demand**

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Feed-in-Tariff in Hawaii

Overview and Policy Development

- Established in 2009 to complement (rather than replace) the NEM program

- Feed-in-Tariff program offers standardized payment contract, schedule, and interconnection agreement for 20 years
  - Eligible technologies include solar PV, concentrating solar, wind, and hydroelectric
  - "Baseline" rates established for non-eligible technologies
  - System size limits vary based on technology and island
  - System caps set at 5% of 2008 peak demand
    - Oahu – 54.9 MW, Maui – 9.1 MW, and Big Island – 9.5 MW

- Includes 3 tiers based on system size
  - Tier 1: 0-20 kW
  - Tier 2: 20 – 500 kW (250 kW- Maui and Big Island, 100 kW - Molokai and Lanai)
  - Tier 3: 500 kW – 5 MW (2.72 MW on Maui and Big Island)

Feed-in-Tariff in Hawaii

Overview and Policy Development

Table 11 - Feed-In Tariff (FIT) Rates, Hawaiian Electric Companies' Service Areas[35]

Tier	Island	Photovoltaics (PV)		Concentrating Solar Power (CSP)		On-Shore Wind		In-line Hydro	
		rate (¢/kWh)	size limit	rate (¢/kWh)	size limit	rate (¢/kWh)	size limit	rate (¢/kWh)	size limit
1	All Islands	21.8 [a] 27.4 [b]	20 kW	26.9 [a] 33.1 [b]	20 kW	16.1	20 kW	21.3	20 kW
2	Oahu	18.9 [a] 23.8 [b]	500 kW	25.4 [a] 27.5 [b]	500 kW	13.8	100 kW	18.9	100 kW
	Maui & Hawaii	18.9 [a] 23.8 [b]	250 kW	25.4 [a] 27.5 [b]	500 kW	13.8	100 kW	18.9	100 kW
	Lanai & Molokai	18.9 [a] 23.8 [b]	100 kW	25.4 [a] 27.5 [b]	100 kW	13.8	100 kW	18.9	100 kW
3	Oahu	19.7 [a] 23.6 [b]	5 MW	31.5 [a] 33.5 [b]	5 MW	12.0	5 MW	--	--
	Maui & Hawaii	19.7 [a] 23.6 [b]	2.72 MW	31.5 [a] 33.5 [b]	2.72 MW	--	--	--	--

[a] With tax credit of 35%. [b] With tax rebate of 24.5%.
Rates may also be modified if Federal or State tax laws change.

Source: PUC 2013 Annual Report

- Payment rates developed in stakeholder-based technology cost evaluation overseen by the PUC in 2010
- Lower payment rates for larger projects (Tiers 2 and 3)

FIT Reexamination

Recommendations of the Independent Observer (IO)

IO stated FIT program was less successful than expected:

- Some developers attempted to “game” the program by proposing projects that were not ready for installation in order to obtain a favorable position on the interconnection queue

- Significant amount of delay in project installation the result of utility mismanagement of the application and interconnection review process

Feed-in-Tariff in Hawaii

Overview and Policy Development

Table 12 - Feed-In Tariff (FIT) Capacity In Place, Under Development, and on Reserve List as of June 30, 2013[36]

Utility	FIT Capacity limit (kW)	Tier	In Place (kW)	Under Active Development (kW)	In Place + Active (Total, kW)	Projects on Reserve List (kW)
HECO	54,911	1	428	176	604	0
		2	8,909	20,398	29,307	3,242
		3	0	25,000	25,000	11,249
HELCO	9,519	1	20	20	40	25
		2	1,147	8,332	9,479	5,557
		3	0	0	0	8,710
MECO	9,131	1	117	249	366	90
		2	1,925	4,080	6,005	1,425
		3	0	2,750	2,750	6,480
TOTAL	**73,561**		**12,546**	**61,005**	**73,551**	**36,778**

Source: PUC 2013 Annual Report

FIT Reexamination

Recommendations of the Independent Observer

IO urged PUC to continue the FIT program, with modifications to improve process:

- Need for strict adherence to standardized contracts and review process
  - FIT program should not involve bilateral negotiations between utility and project developers
- Need for milestones to track progress of each project, hold utility and developers accountable for any delays
- Need for increased transparency in overall project review process and distribution circuit status (ability to accept new projects)
  - System maps should be updated and improved using Southern California Edison's example

Next steps for program currently under consideration by PUC

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- **Future directions**
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Future Outlook for NEM and FIT (1)

Long-term challenges: compensation rates, system- and circuit-level integration

Feed-in-Tariff

Cost-based compensation outdated and uncompetitive with NEM compensation

- Costs for most renewable technologies, especially solar, but also including wind, are much lower today (FIT payment rates established in 2010)

- Attractiveness of FIT currently limited given superior economic value of NEM program (due to NEM compensation at retail rates)

- Bigger picture: Need to more clearly establish how FIT and NEM programs can cost-effectively complement each other, given overall resource plan for each island

For both programs: <u>system-level integration challenges</u> (daytime over-generation, ramping capability, etc.) emerging as the limiting factor for future growth

Future Outlook for NEM and FIT (2)

Next steps for Hawaii PUC: integrate and harmonize distributed generation programs

Develop updated interconnection standards

- Incorporate advanced inverter functionality into interconnection standards
  - Avoid German experience with expensive retrofits of inverters
- Encourage use of new technology (energy storage, demand response) to expedite interconnection
- Develop transparent interconnection queue
- Consider cost allocation for system upgrades

Develop new rate structures

- Fixed costs vs. variable charges
- Bi-directional pricing (exporting energy to the grid vs. consuming energy from the grid)

Develop fair compensation rates

- Fair to NEM/FIT customers
  - Compensate NEM/FIT customers for all benefits provided to system, especially advanced grid support services (for system stability) over and above those required for interconnection
- Fair to non-participating customers
  - Ensure all customers receiving electric service pay fair share of fixed grid infrastructure costs

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Policy Design and Technical Issues

Small Electrical Systems Require Specialized Policy Consideration

- During development of FIT program, PUC determined that system reliability constraints could affect amount, type, and location of renewable projects that could be safely interconnected
- PUC established the Reliability Standards Working Group (RSWG) to transparently develop reliability standards
- RSWG consisted of broad range of affected stakeholders who met informally over two years
- RSWG was instrumental in educating stakeholders on complex issues, building trust and improving relationships, and developing workable solutions to renewable integration challenges facing small islanded grids in Hawaii

Policy Design and Technical Issues

Small Electrical Systems Require Specialized Policy Consideration

RWSG work product included over 700 pages of recommendations for PUC consideration on:

- Relevant studies and analyses on renewable development potential and integration in Hawaii
- Coordination of RSWG work product with electric utility resource planning efforts
- Reliability Definitions and Metrics – for common understanding and appropriate measurement of technical characteristics
- Reliability Standards – including standards for safe and reliable electric service and interconnection standards for larger systems
- Curtailment – analysis of curtailment of renewable generation and methods to reduce it
- PV and Distributed Generation – share data on PV production patterns and develop improved interconnection processes
- Demand Side Options – identify energy efficiency, demand response, and energy storage options to increase renewable integration and maintain grid reliability

PUC Final Ruling on RSWG Work Product

Hawaii PUC directed immediate action on a number of high priorities:

- **Fix interconnection process** - utility required to file and implement action plans to improve transparency and develop technical solutions to integration challenges

- **Create transparent queuing process** - consolidate interconnection applications from NEM, FIT, and other programs

- **Improve power supply system to integrate renewable generation** – utility required to file and implement plan to integrate higher levels of renewables

- PUC will create independent Hawaiʻi Electric Reliability Administrator

Mahalo!

Relevant HI Feed-in Tariff Dockets #'s:
2008-0273 and 2013-0194

For any questions, please contact:
James.P.Griffin@Hawaii.gov
(808) 586-2020

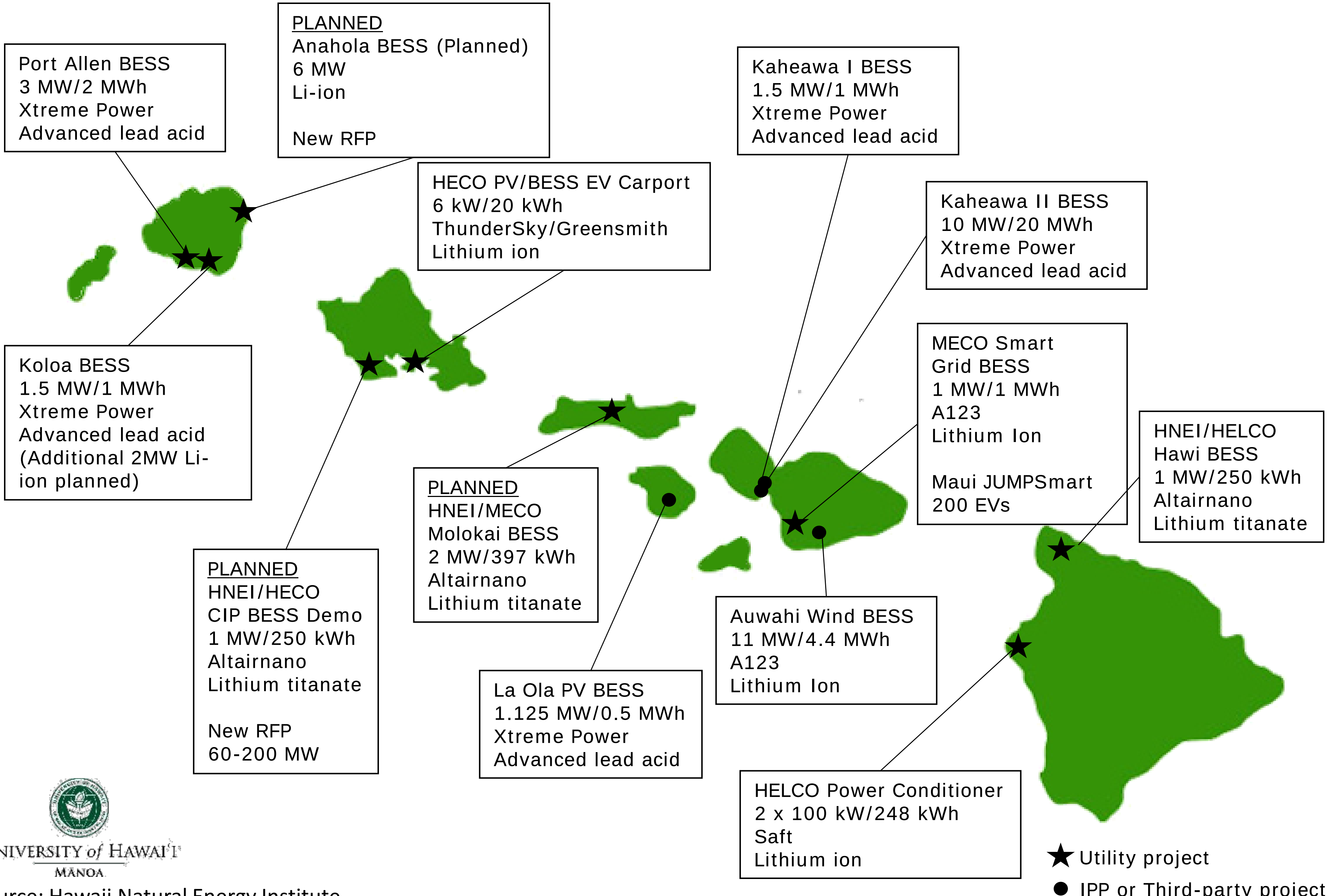
Energy Storage in Hawaii Today

- Important resource to enable high levels of renewables on grids
  - Flexible tool to meet grid operating needs
  - Non-generation substitute for ancillary services vs. shifting energy
  - Kauai, Lanai, and Maui grids operating with significant levels of variable renewables supported by energy storage systems

- Promising tool to integrate distributed generation
  - Significant interest in customer-sited storage
  - Demonstrations looking at distribution-level applications

- Broad range of applications, siting, and ownership models
  - Ancillary services, peak load mgmt., customer-demand mgmt.
  - Mix of R&D, IPP, utility, and customer projects
  - Transmission, distribution, and customer-side applications

Energy Storage Projects



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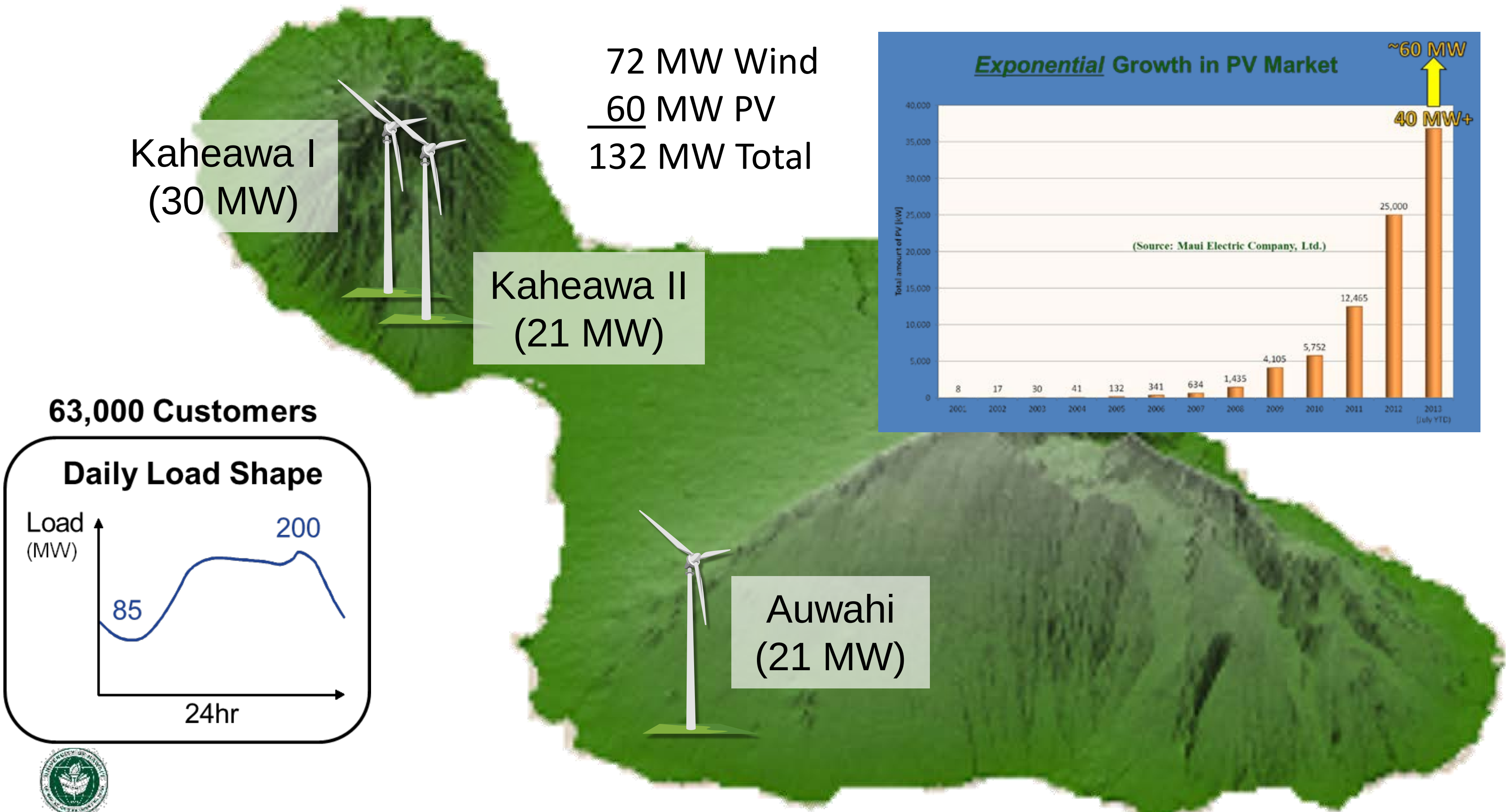
Source: Hawaii Natural Energy Institute

Storage Helping Integrate Wind and Solar Power Today

Maui Island Case

72 MW Wind
60 MW PV
132 MW Total

63,000 Customers



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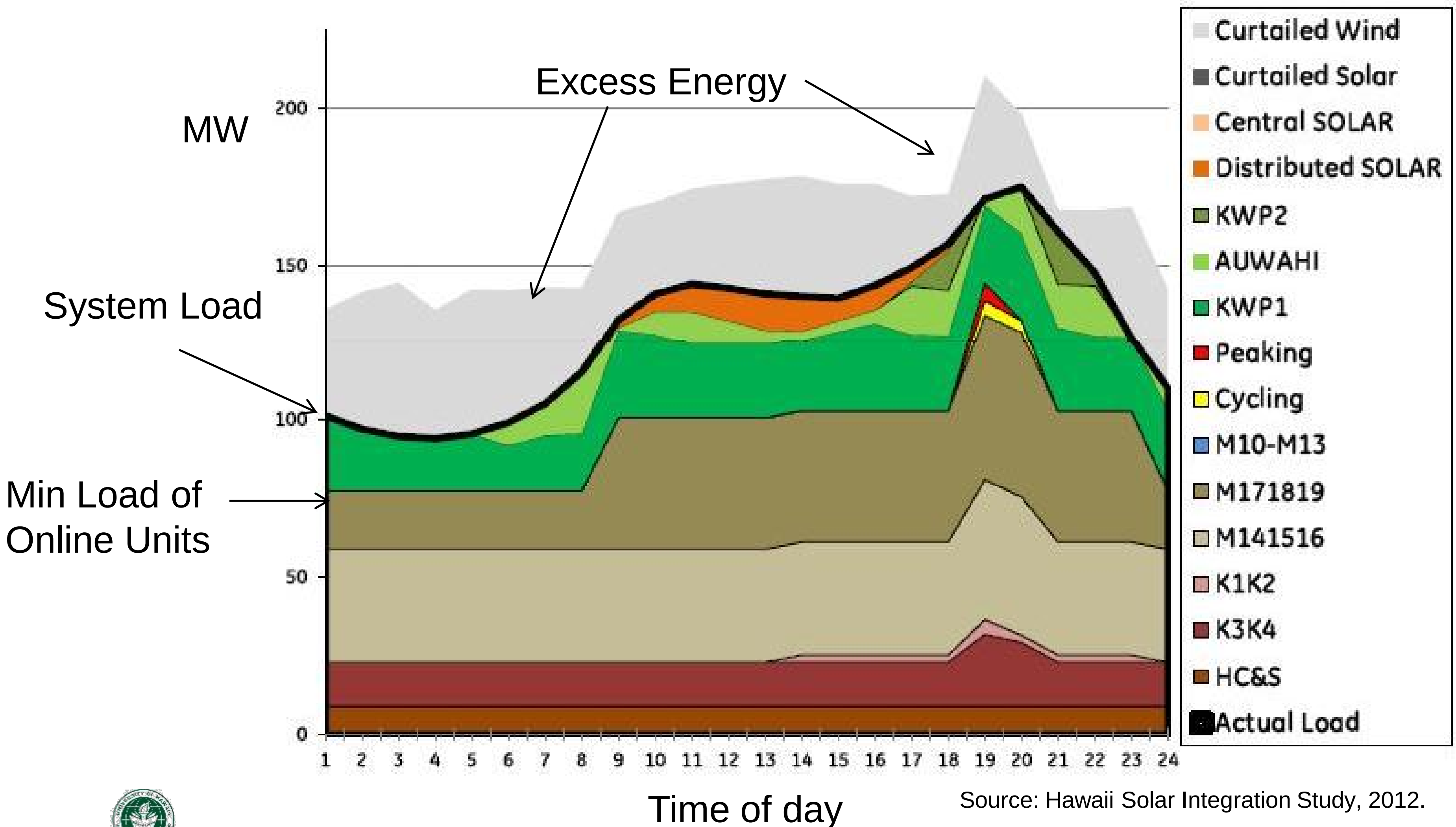
Source: Hawaii Natural Energy Institute

Storage Installed at Wind Plants to Reduce Variability and Operate as "Virtual" Generation Unit



Source: Hawaii Solar Integration Study, 2012.

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Effectiveness of Mitigation Measures to Increase Wind Energy Delivered

Facility	**Percent of available energy delivered** (% before / % after)	**% increase in delivered energy**
Plant 1	97% / 99%	2%
Plant 2	72% / 84%	17%
Plant 3	27% / 45%	68%

<u>BESS Function</u>

- 10MW / 20MWh
- Manual and AGC Dispatch
- Aggressive frequency Response
- Ramp Rate Limit within a limited SOC Range

<u>MECO Operations</u>

- Include 10MW of BESS in Up Reserve
- Reduce Down Reserve of M14 & M16 by 1.5MW
- Reduced Operation of K1 and K2
- 50MW Up-Reserve Limit

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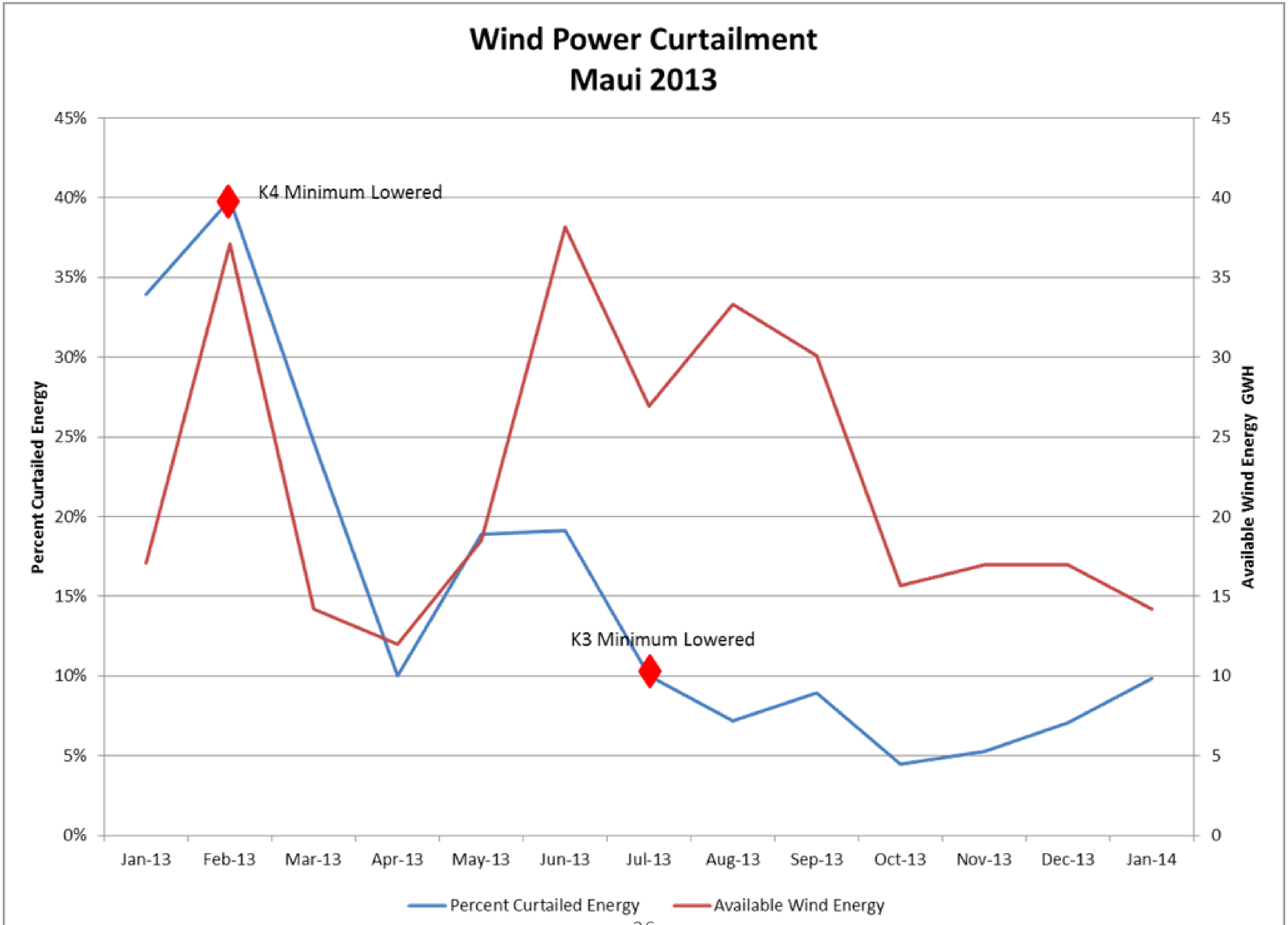

Wind Power Curtailment
Maui 2013
K4 Minimum Lowered
K3 Minimum Lowered
Percent Curtailed Energy
Available Wind Energy GWH
45%
40%
35%
30%
25%
20%
15%
10%
5%
0%
45
40
35
30
25
20
15
10
5
0
Jan-13
Feb-13
Mar-13
Apr-13
May-13
Jun-13
Jul-13
Aug-13
Sep-13
Oct-13
Nov-13
Dec-13
Jan-14
Percent Curtailed Energy
Available Wind Energy

BESS Demonstration Project Highlights

Haw'i 10 MW Wind farm at Upolu Point Hawaii Island

- 1MW, 250kW-hr at wind and utility interface; Li-ion Ti
- Control algorithms for frequency regulation and wind smoothing

Photo courtesy of HECO

NEDO Maui JUMPSmart Demonstration Project

- 200 Evs with charge management
- Control algorithms to match renewable energy supply and DR applications

photos courtesy of Altairnano

Molokai Secure Renewable Microgrid

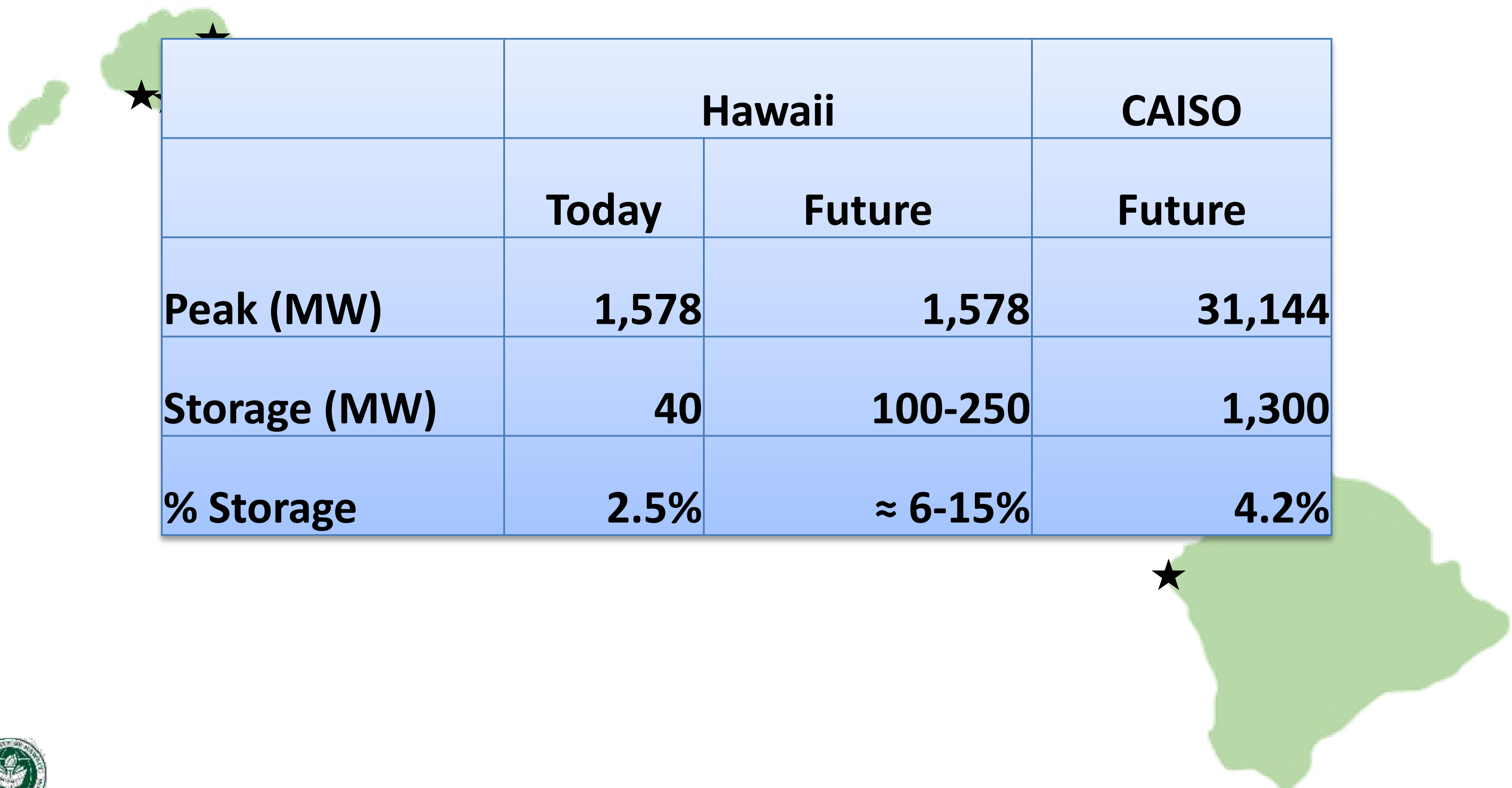
- 2MW, 333kW-hr, Li-ion Titanate;
- Control algorithms for managing operating reserves, (fault management, frequency regulation)

CIP industrial feeder with high penetration (~3 MW of distributed PV)

- 1MW, 250 kW-hr at substation; Li-ion Ti
- Control algorithms for power smoothing, voltage and VAr support, and frequency regulation

Hawaii Energy Storage Project Summary

	Hawaii		CAISO
	Today	Future	Future
Peak (MW)	1,578	1,578	31,144
Storage (MW)	40	100-250	1,300
% Storage	2.5%	≈ 6-15%	4.2%



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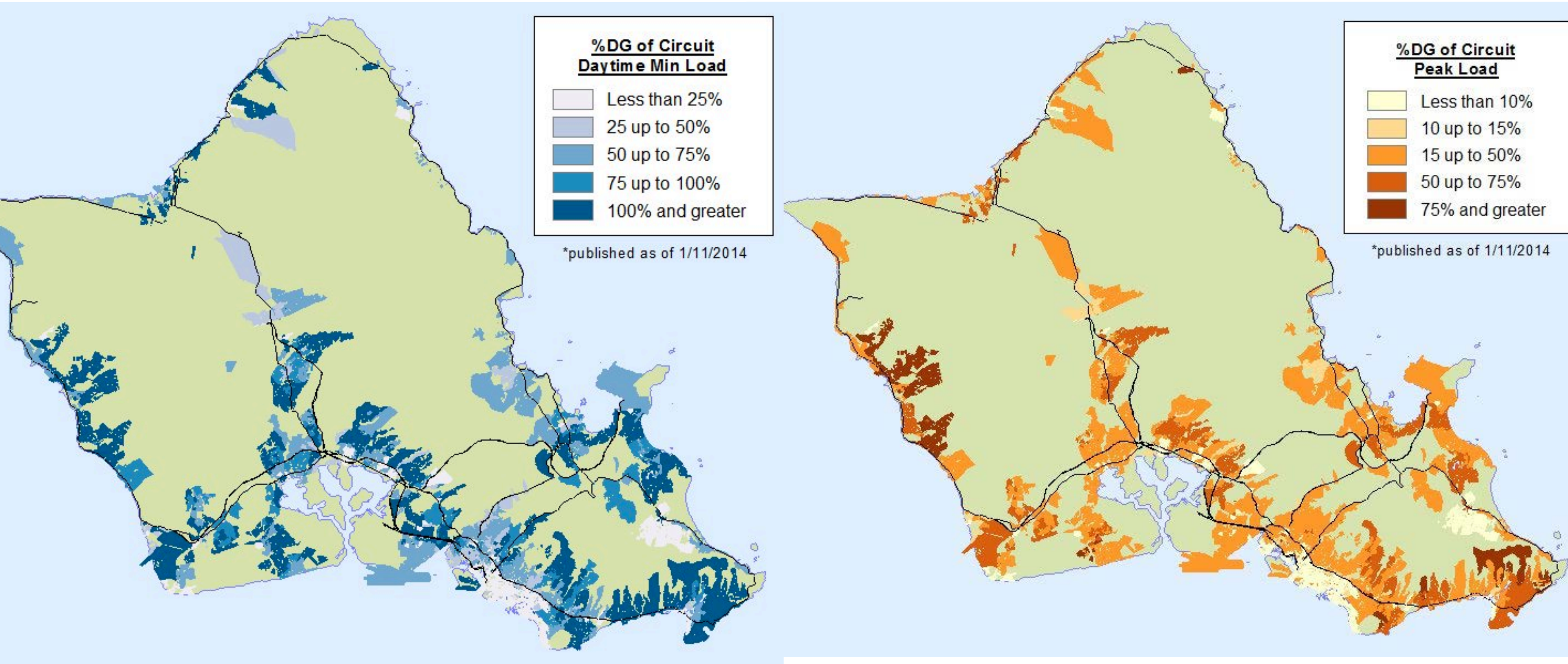
Source: Hawaii Natural Energy Institute

Next Frontier: Breaking through Distribution System Boundaries



Current grid limits have slowed DG interconnection significantly

Source: Hawaiian Electric Co.

- Active demonstrations evaluating distribution-level storage applications
- Utilities and stakeholders drafting tariff language for customer-sited storage
- Commission white paper envisioned active market for distributed storage
- Aggregated distributed storage can help address system integration constraints