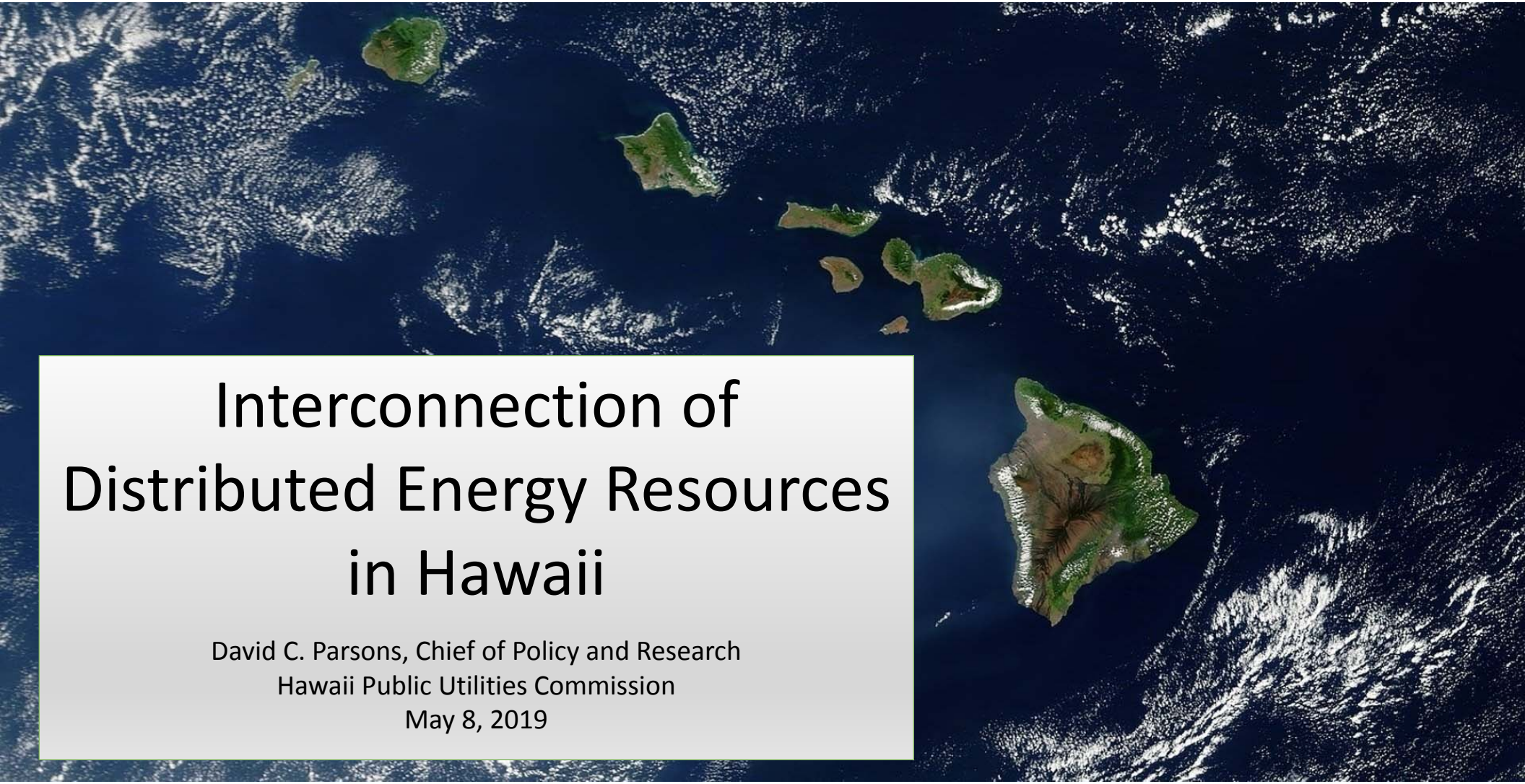
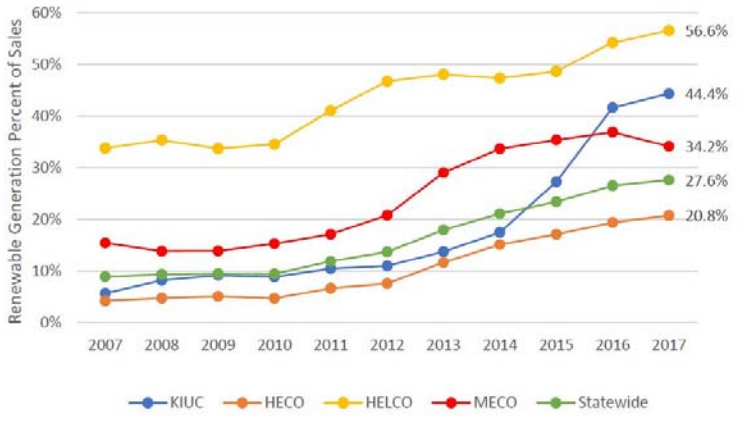


Interconnection of Distributed Energy Resources in Hawaii

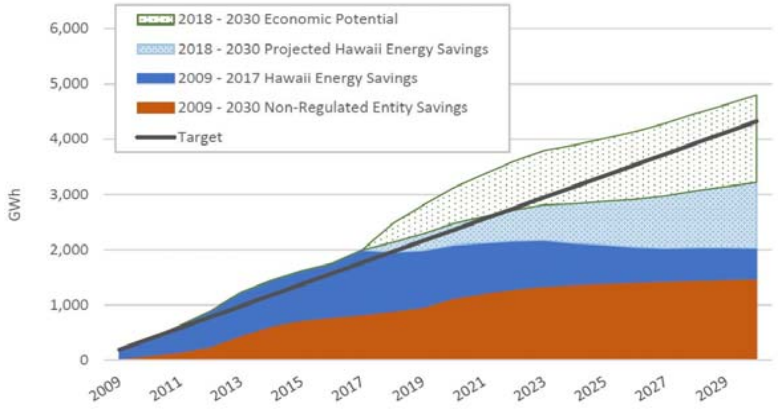
David C. Parsons, Chief of Policy and Research
Hawaii Public Utilities Commission
May 8, 2019

Hawaii's Clean Energy Policies

- Hawaii has some of the most aggressive clean energy policies in the country
  - 100% Renewable Portfolio Standard by 2045
  - 4,300 GWh Energy Efficiency Portfolio Standard by 2030
- Each of the islands is rapidly advancing towards these overarching policy objectives
- Success will represent a dramatic transformation of the electricity sector in Hawaii

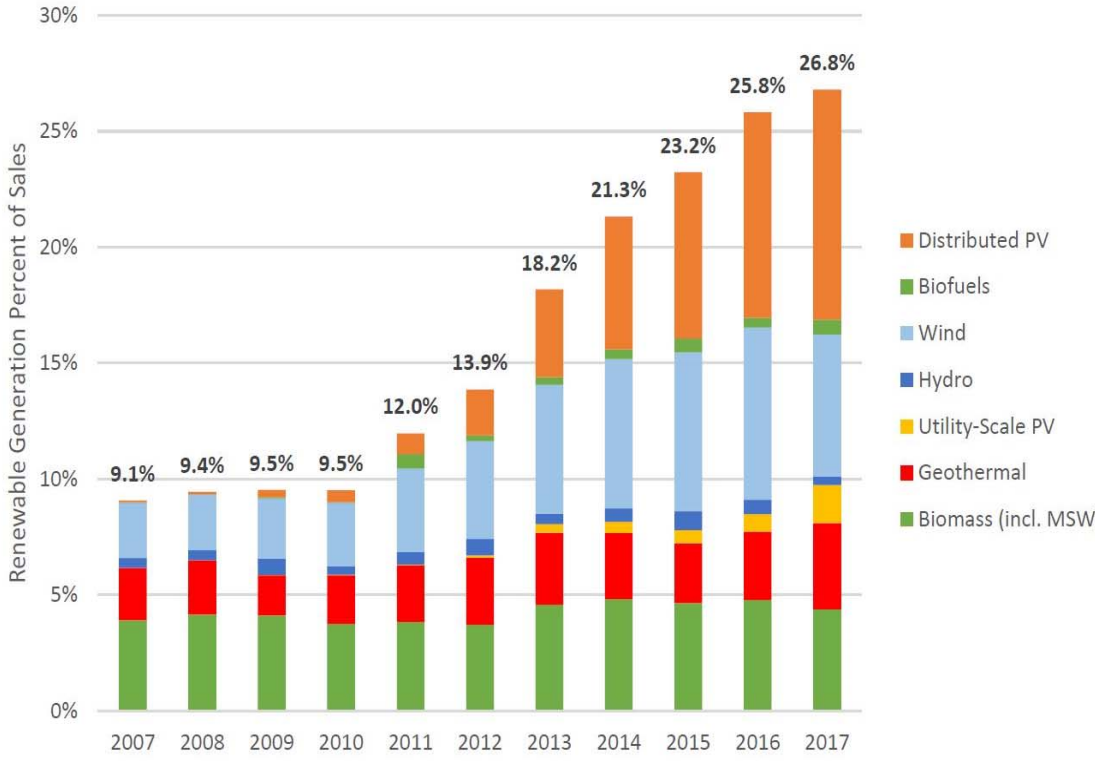


Source: Hawaii PUC 2018 RPS Report

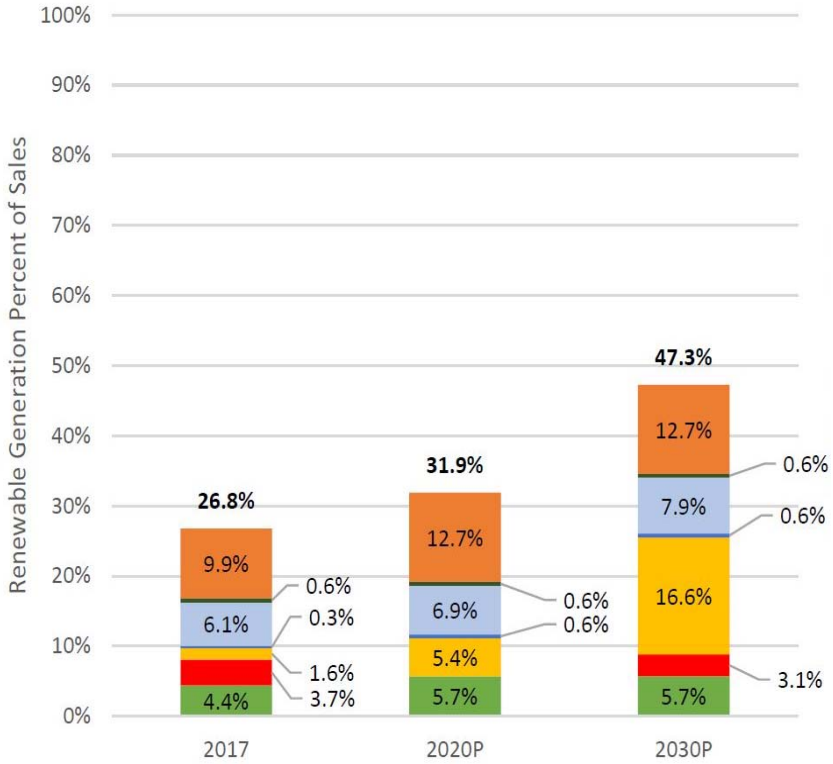


Source: Hawaii PUC 2018 EEPS Report

HECO Companies Historical Renewable Growth and Projected Future Achievement

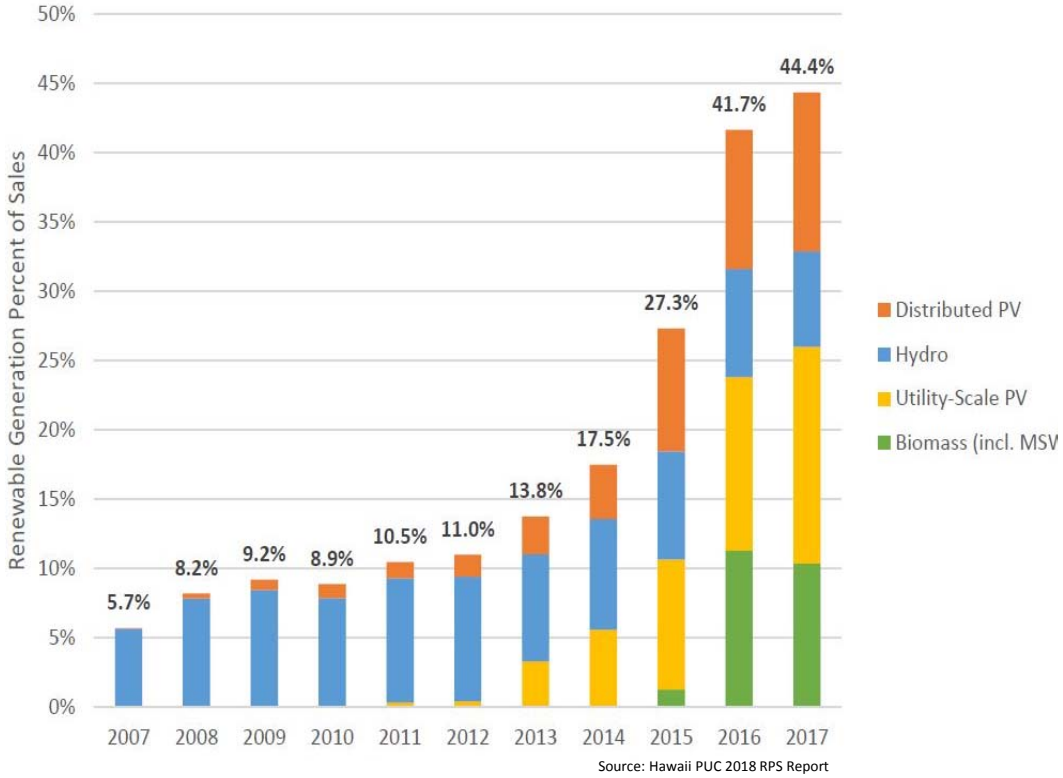


Source: Hawaii PUC 2018 RPS Report

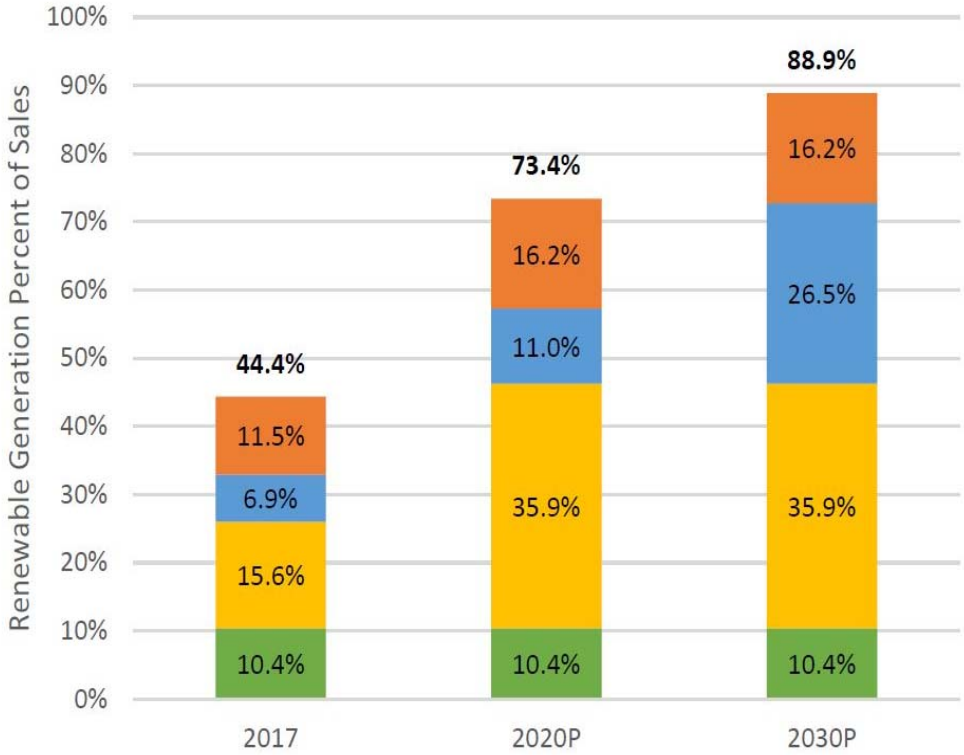


Source: Hawaii PUC 2018 RPS Report

Kauai Island Coop Historical Renewable Growth and Projected Future Achievement



Source: Hawaii PUC 2018 RPS Report



Source: Hawaii PUC 2018 RPS Report

Recent Projects Suggest High Levels of RE May Be Possible Sooner

- PUC approved 6 new solar + storage projects for Hawaiian Electric Cos.
  - Totaling nearly 250 MW of generation and 1 GWh of storage
  - Across Oahu, Maui, and Hawaii islands
- KIUC recently announced it has passed 50% renewable generation with it's latest solar + storage project
  - Anticipate achieving more than 70% renewable by as early as 2020

JANUARY 4, 2019 SOLAR-PLUS-STORAGE

Hawaiian Electric Announces 'Mind-Blowing' Solar-Plus-Storage Contracts

by Emma Foehringer Merchant 342

Source: Greentech Media 1/4/19

Demand Side Resources Critical for Cost-effective Renewable Achievement

- Demand side of the equation is a critical part of achieving broader policy objectives, especially as we progress closer towards 100% renewable
  - Includes energy efficiency, distributed storage, flexible/controllable demand, electric vehicles, etc.
- Increasingly, Hawaii will rely on "supply" from demand-side resources, which limits the usefulness of the distinction going forward

December 2016 PSIP Projections	2017-2021	2022-2045
New DG-PV	326 MW	2,086 MW
New Customer Self Supply (CSS) Energy Storage	89 MW-hr.	1,057 MW-hr.
New Demand Response Capacity	115 MW	442 MW
New Demand Response Energy Storage	104 MW-hr.	1,608 MW-hr.

- In addition to about 3,000 MW of new utility-scale renewable generation, HECO's plans by 2045 include more than:
  - 2,400 MW of distributed solar PV
  - 550 MW and 2.8 GWh of distributed energy storage

Source: Hawaiian Electric Grid Modernization Strategy

Distributed Energy Integration Challenges

	Examples of Technical Integration Challenges	
	Steady State Operations	**Contingency Events**
System-level	Over-generation and increasing variability in generation resulting in: • Curtailment of other renewable generation • Frequency regulation and ramping challenges for central generation	Behavior of aggregate DER fleet may exacerbate grid instability during emergencies: • Need grid-supportive frequency and voltage trip and ride through settings
Circuit-level	Over-generation resulting in: • Approaching or exceeding distribution system equipment capacity limitations	Behavior of DER systems during circuit-level contingencies may result in: • Unintentional islanding • Temporary load rejection overvoltage

Source: Table 2, Staff Report and Proposal, Docket No. 2014-0192, March 31, 2015

DER Policy Dockets in Hawaii

Distributed Energy Resources (2014-0192)	• Interconnection requirements for DER, including advanced inverter functions • New tariff options (e.g., Smart Export) for customers to deliver energy and other services to the grid, alongside dynamic rate designs (e.g., time-of-use)
Demand Response Portfolio (2015-0412)	• Market-based procurement of grid services from DER, including aggregated loads, distributed generation, and storage • Enables customers to provide ancillary services (e.g., frequency response, regulation) more cost-effectively than conventional solutions
Grid Modernization (2018-0141)	• Advanced grid technologies and software systems to enable DER integration and utilization • Includes operational dispatch of customer loads, distribution system sensing, communications, automation, control, and metering infrastructure
Integrated Grid Planning (2018-0165)	• Integrated planning process across generation, transmission, and distribution • Competitive sourcing mechanisms for grid infrastructure and services, including non-wires solutions

DER Tariffs and Interconnection Standards

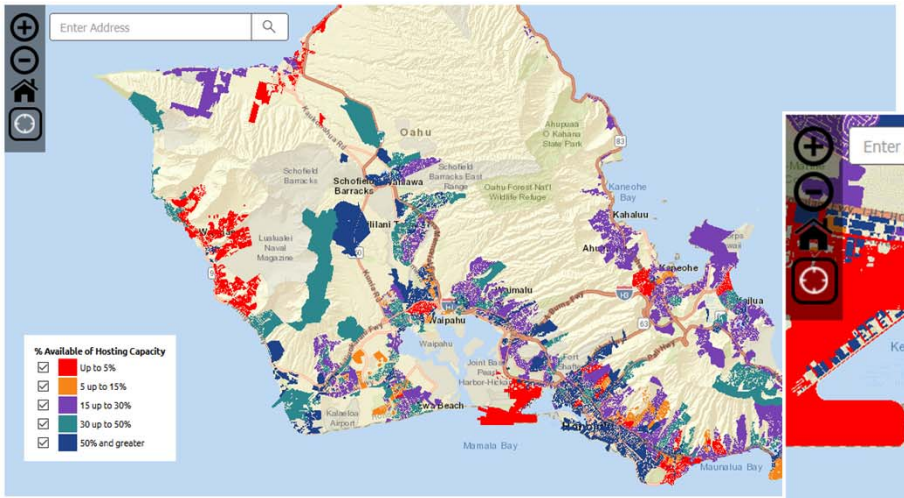
DER Program Options

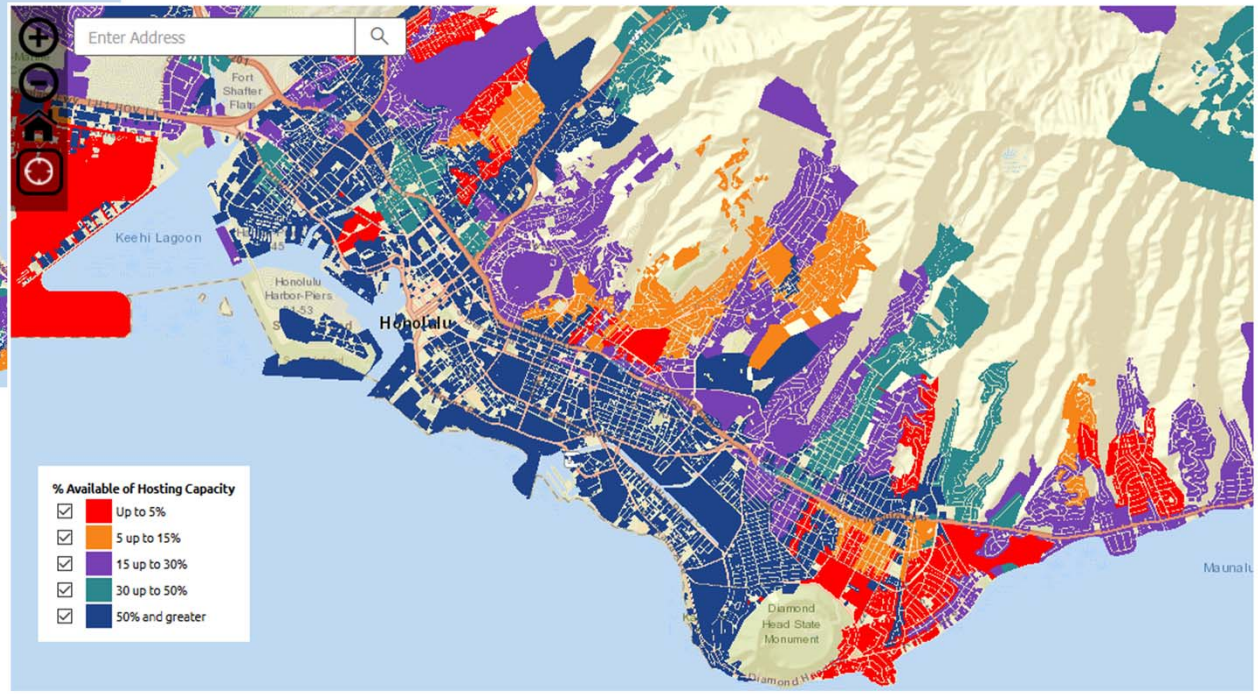
- Self-Supply (non-export)
- CGS+ (utility control when needed)
- Smart Export (time-varying export prices)

Rule 14H (DER Interconnection)

- Frequency and Voltage Ride Through
- Volt-var and Volt-Watt
- Frequency-Watt

Hosting Capacity Analysis





Source: HECO Companies

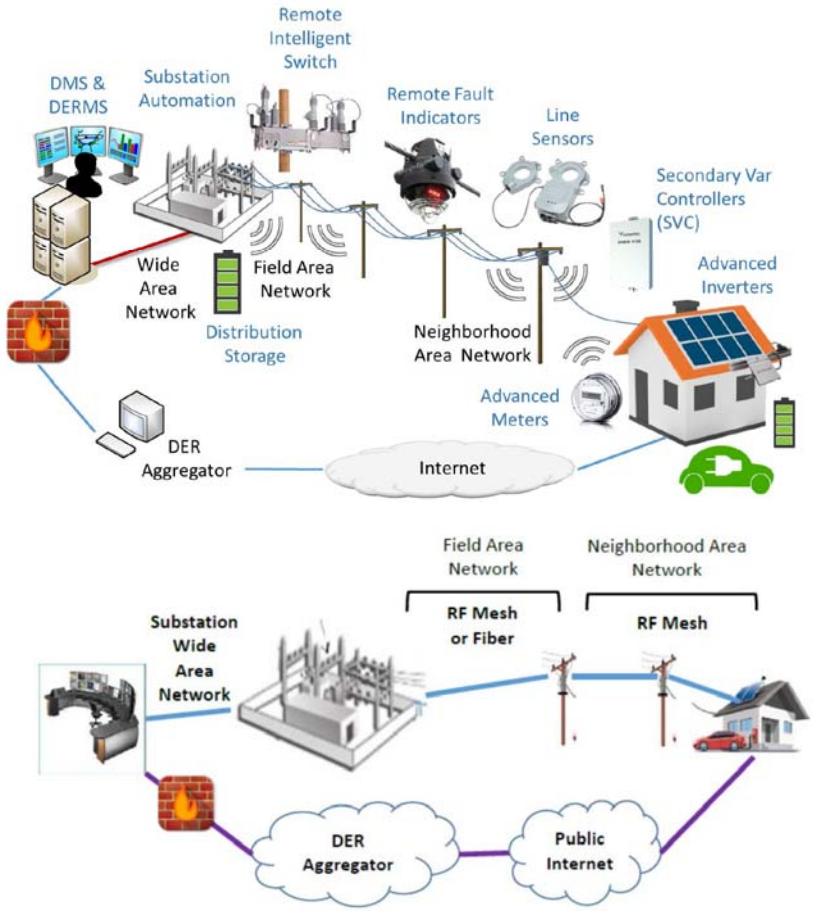
Interconnection Queue

Filter | Search | Clear | Items per page 100 | Apply

Queue Position	Agreement ID	Procurement	Project Developer ID	System Size	Circuit	Review Status	Date Interconnection Application Received	Date Determined Complete and Valid	IRS Start	IRS Complete	Date Project Must Be Complete
20141211182400	T3-015-02	PII	An alphanumeric number assigned by the Company	00	KAPOLEI 2	CAR	12/11/2014	01/30/2015	07/21/2015	07/20/2017	
20150925092700	SIA-280	SIA	2740	924.8	DOLE 1	PI	02/23/2015	03/16/2015	01/29/2016	06/28/2017	
20150925092700	SIA-348	SIA	#	27	DOLE 1	CAR	07/22/2015	07/22/2015	01/29/2016	06/28/2017	
20140702132000	SIA-230	SIA	2740	471.45	HELEMANO	PE	07/02/2014	07/14/2014	01/29/2016	06/28/2017	
20150223151052	SIA-281	SIA	2740	8632	WAHIAWA-MIKILUA	CAR	02/23/2015	04/03/2015	01/29/2016	06/28/2017	
20140703115500	SIA-243A	SIA	3765	2295	WAHIAWA-WAIALUA 1	CAR	06/11/2014	08/04/2014	01/29/2016	06/28/2017	
20150925092700	SIA-339	SIA	3765	858	WAHIAWA-WAIALUA 1	CAR	07/22/2015	07/22/2015	01/29/2016	06/28/2017	
20150925092700	SIA-282	SIA	2740	2099.15	zsub WHEELER	CAR	02/23/2015	03/09/2015	01/29/2016	06/28/2017	
20150925092700	SIA-350	SIA	#	250	zsub WHEELER	CAR	08/06/2015	09/28/2015	01/29/2016	06/28/2017	

Grid Modernization Essential to Integrating Additional Renewables

- PUC Approved HECO Companies Phase 1 Grid Modernization Project in March 2019
- $86 M investment in advanced grid technologies to enable DER integration and utilization
- Includes distribution system sensing, communications, automation, control, and metering infrastructure



Source: HECO Grid Modernization Strategy

Mahalo!

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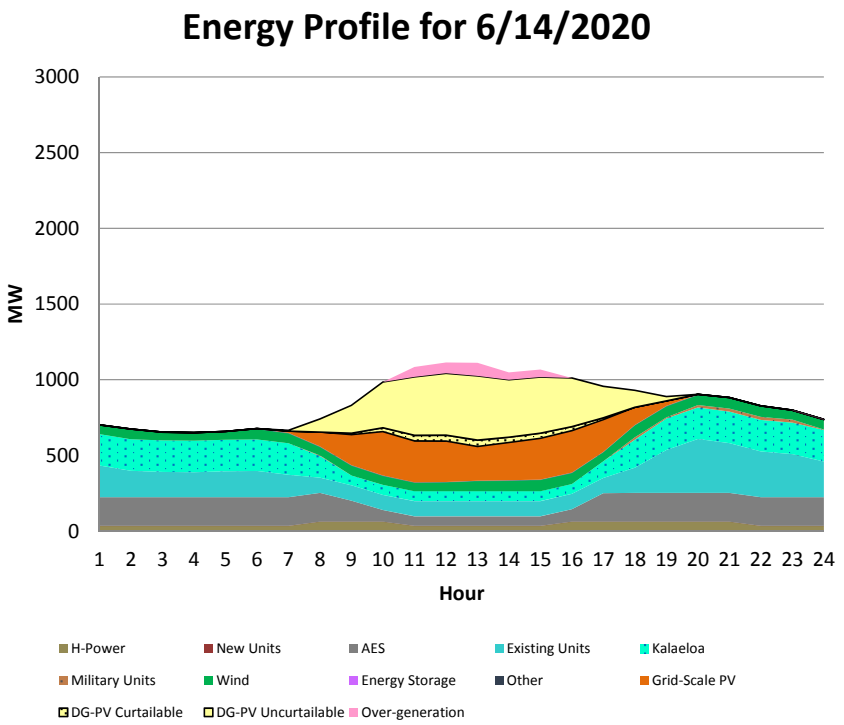
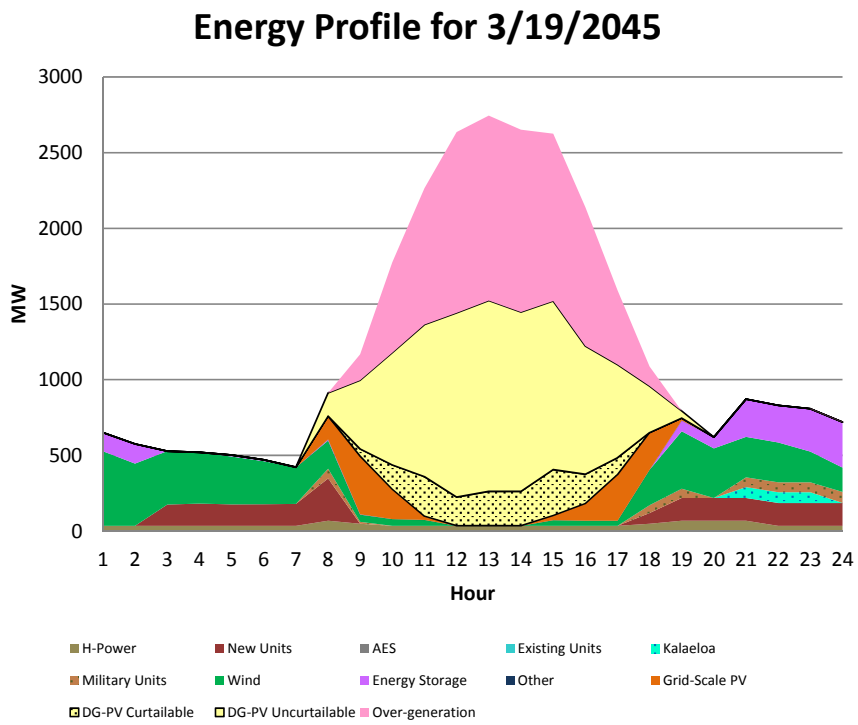
808-586-2020

Daily Load Profiles in 2020 and 2045





Source: Hawaiian Electric 2016 PSIP Update