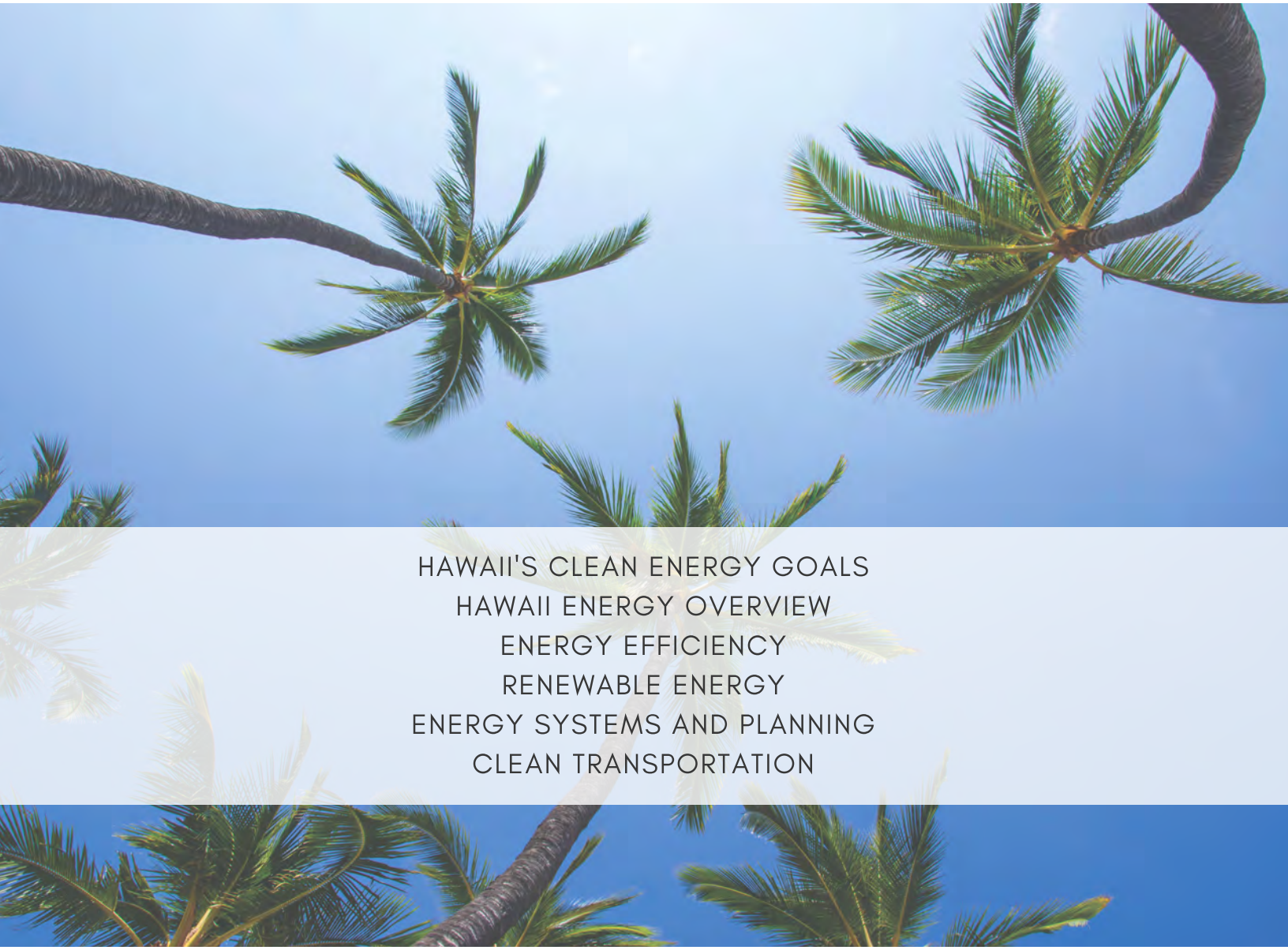
HAWAII STATE
Energy Office

ENERGY.HAWAII.GOV

JUNE 2018

Hawaii Energy Facts & Figures



HAWAII'S CLEAN ENERGY GOALS
HAWAII ENERGY OVERVIEW
ENERGY EFFICIENCY
RENEWABLE ENERGY
ENERGY SYSTEMS AND PLANNING
CLEAN TRANSPORTATION

PREPARED BY THE
HAWAII STATE ENERGY OFFICE
DEPARTMENT OF BUSINESS, ECONOMIC
DEVELOPMENT, AND TOURISM

Hawaii's Clean Energy Goals

Aiming for 100 percent renewable energy in Hawaii's electricity sector by 2045 was big news in 2014 and Hawaii has been putting those words into action. Achieving the state's bold commitments will require perseverance and action – a combination of hard work, innovative thinking, and continued collaboration that distinguishes Hawaii's clean energy transformation to date.

As a community of isolated islands, we drain our economy with costly payments of billions of dollars annually for imported fuel - dollars which should remain in our economy to grow our economy. We pay, yet we are richly endowed with a wealth of natural resources. Our challenge is to work together to accept these blessings while balancing environmental, cultural, and economic considerations.

At the same time, technology and innovation are advancing at such a rapid pace that we share another challenge: to foresee the advancements, even on a five-year horizon. Yet, we must choose and act with alacrity if we are to be the beneficiaries of these advances, or else remain locked in obsolete infrastructure and mindsets. Decisions and choices today may prove less than anticipated tomorrow, despite doing as much due diligence as possible to mitigate less than stellar outcomes. Nevertheless, decisions must be made today, as best that we are able, given the best that we have. When outcomes are not exactly as we anticipated, we must all continue to work together and look to the future.

We have met our challenges head on with determination and commitment. We have many more challenges before us. By commitment and continued collaboration, we shape our energy future.

ENERGY EFFICIENCY PORTFOLIO STANDARDS

The energy efficiency portfolio standards (HRS 269-96) mandates a 4,300-gigawatt-hour reduction in electricity use by 2030 through efficiency and conservation measures. Hawaii surpassed its 2015 interim energy efficiency portfolio standards target thanks in part to the robust issuance of energy performance contracts.

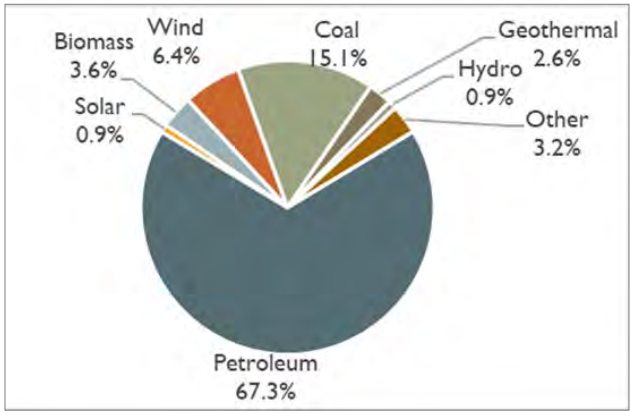
RENEWABLE PORTFOLIO STANDARDS

The renewable portfolio standards (HRS 269-92) mandates 100 percent renewable energy in the electricity sector by 2045. In 2017, the renewable portfolio standards stood at 27.6 percent, more than 12 percent ahead of the interim statutory 2015 target of 15 percent.

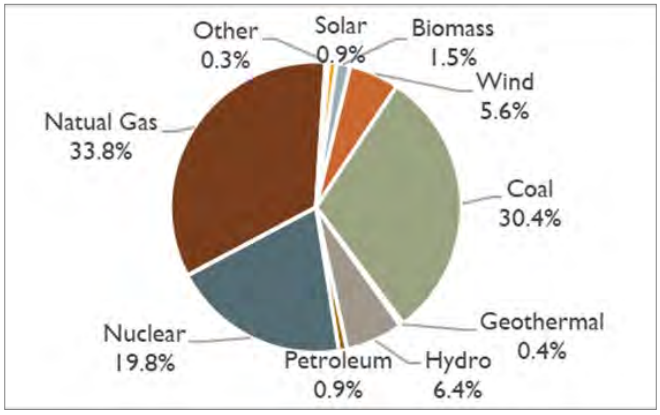
Hawaii Energy Overview

Hawaii depends more on petroleum for its energy needs than any other state. Less than 1% of electricity in the United States is generated using oil. By contrast, Hawaii relied on oil for 67.3% and on coal for 15.1% of its electricity generation in 2015.[1]

Hawaii Electricity Production by Source (2015)

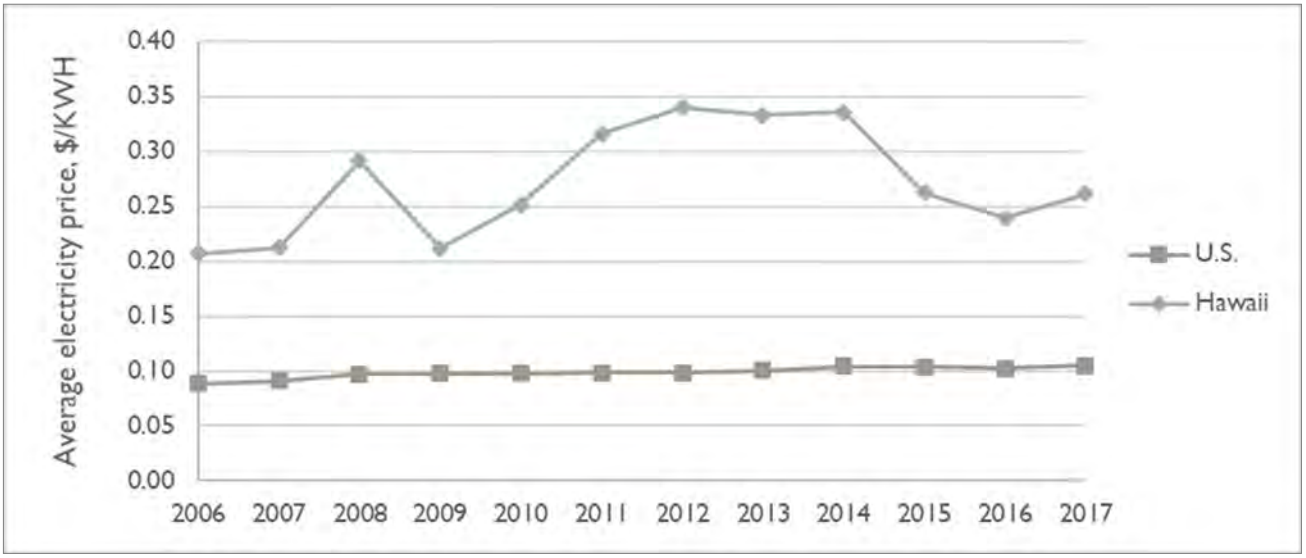


U.S. Electricity Production by Source (2015)

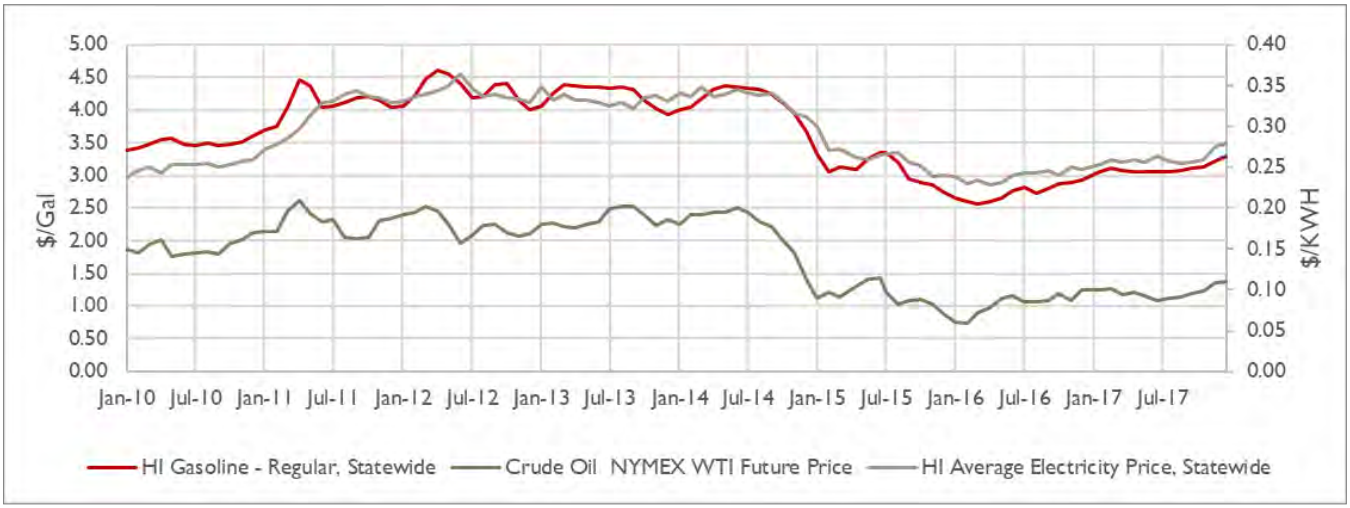


ELECTRIC UTILITES

Hawaii's electricity prices are more than double the U.S. average.

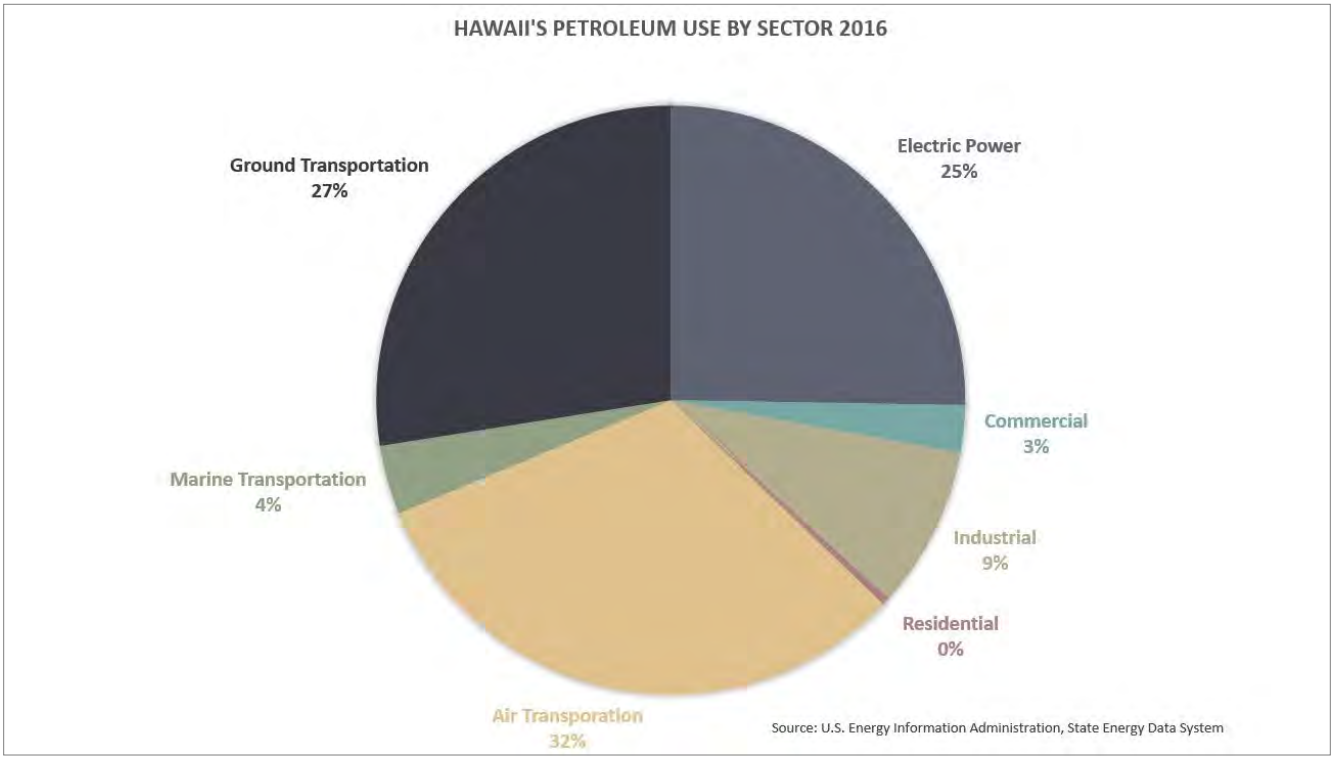


In Hawaii, both electricity and gasoline prices correlate closely with the price of petroleum. This graph shows the prices of crude oil, gasoline, and electricity.[2]



Hawaii Energy Overview

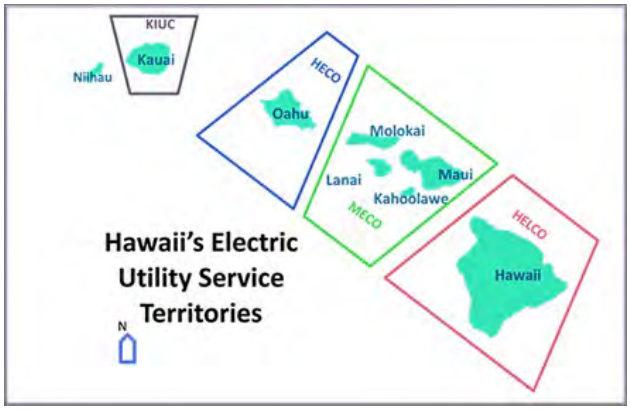
Electricity production and motor gasoline are just part of Hawaii's fossil fuel usage. Large quantities of jet fuel are also used in the state. In Hawaii, the air transportation sector accounts for the highest percentage of petroleum use, followed by ground transportation and electricity production, with the remainder used for marine transportation, commercial, industrial and residential uses.[3] The figure below represents 2016 petroleum use, as reported by the U.S. Energy Information Administration (EIA).



2017 total foreign crude oil imports (million barrels)[4]	25.9	2017 fuel for electricity production (million gallons)[5]	380
2017 total foreign petroleum imports (million gallons)[6]	1,442	2017 impacted foreign fuel for air transportation (i.e. jet fuel) (million gallons)[7]	269
2017 Hawaii's rank among 50 states for energy prices[8]	1	2017 fuel for ground transportation (million gallons)[9]	516

Hawaii Energy Overview

The two primary electric utilities that service the power needs of the state are Hawaiian Electric Industries Inc. (HEI) and Kauai Island Utility Cooperative (KIUC).



HEI is the largest supplier of electricity in the state and serves the majority of Hawaii's population. Under HEI are three electric utilities: Hawaiian Electric Company, Inc. (HECO) serves Oahu; Maui Electric Company, Limited (MECO) serves Maui, Molokai, and Lanai; and Hawaii Electric Light Company, Inc. (HELCO) serves Hawaii Island.

KIUC operates as a cooperative and is not structured in the same manner as HEI. However, both companies are committed to the adoption and integration of renewable sources of energy in the effort to reduce the state's dependency on oil and both are regulated by the Public Utilities Commission (PUC).

RESIDENTIAL ELECTRICITY USE, RATES, AND MONTHLY BILLS

In general, the residential electricity use, rates, and bills have declined since 2011.

RESIDENTIAL, AVERAGE MONTHLY USE (KWH)

Year	State Total	Oahu	Hawaii	Kauai	Lanai	Maui	Molokai
2011	**584**	609	520	473	435	612	373
2012	**543**	561	494	465	413	574	345
2013	**514**	523	473	464	430	557	329
2014	**496**	501	458	464	443	545	312
2015	**497**	504	454	474	424	541	306
2016	**484**	488	450	478	425	517	312
2017	**482**	486	451	491	417	510	324

Source: State of Hawaii Data Book

RESIDENTIAL, AVERAGE RATE ($/KWH)

Year	State Total	Oahu	Hawaii	Kauai	Lanai	Maui	Molokai
2011	**$0.35**	$0.32	$0.42	$0.43	$0.44	$0.36	$0.43
2012	**$0.37**	$0.35	$0.42	$0.45	$0.47	$0.39	$0.46
2013	**$0.37**	$0.35	$0.42	$0.44	$0.46	$0.38	$0.46
2014	**$0.37**	$0.35	$0.42	$0.43	$0.46	$0.38	$0.47
2015	**$0.30**	$0.28	$0.35	$0.34	$0.38	$0.31	$0.38
2016	**$0.28**	$0.26	$0.32	$0.34	$0.34	$0.29	$0.33
2017	**$0.30**	$0.28	$0.34	$0.35	$0.36	$0.31	$0.36

Source: State of Hawaii Data Book

Hawaii Energy Overview

RESIDENTIAL, AVERAGE MONTHLY BILL							
Year	**State Total**	**Oahu**	**Hawaii**	**Kauai**	**Lanai**	**Maui**	**Molokai**
2011	**$202**	$195	$218	$205	$192	$219	$161
2012	**$203**	$197	$210	$209	$192	$222	$159
2013	**$189**	$181	$199	$205	$199	$211	$153
2014	**$185**	$178	$192	$199	$203	$206	$147
2015	**$149**	$141	$157	$163	$159	$168	$115
2016	**$135**	$127	$142	$163	$142	$147	$102
2017	**$145**	$137	$154	$170	$150	$157	$115
Source: State of Hawaii Data Book							

COMPETITIVE BIDDING

Hawaii's electric utilities deliver electricity generated with their own units as well as power generated by Independent Power Producers (IPPs). If new or replacement generation is required, HECO, MECO, and HELCO are required to follow the "Competitive Bidding Framework" for new generation with capacities greater than 5 MW (Oahu) or 2.72 MW (MECO, HELCO), or receive a waiver of the competitive bidding requirements from the Hawaii Public Utilities Commission (PUC). As noted on HECO's Competitive Bidding for New Generation webpage, current procurement activities include:

Oahu Variable Renewable Dispatchable Generation RFP: On June 6, 2016 HECO requested that the PUC open a docket and appoint an Independent Observer to allow HECO to solicit proposals for new renewable energy generation to be in service by the end of 2020, consistent with the Five-Year Action Plan proposed in HECO's Power Supply Improvement Plan (PSIP) update report filed with the PUC on April 1, 2016. PUC opened the related docket number 2017-0352 on October 6, 2017. Subsequently, PUC issued order 35286 approving with certain modifications HECO's Proposed Final Variable Request for Proposals (RFP). HECO's final Proposed Final Variable Request for Proposals were then filed with the PUC on February 27, 2018. Specifically, HECO's RFP is soliciting for a total amount of variable renewable dispatchable generation of 485,000 megawatt hours ("MWh") annually delivered to Oahu, over a preferred term of 20 years. Bids were due on April 30, 2018. The RFP process in ongoing.

Hawaii Island Variable Renewable Dispatchable Generation RFP: On June 6, 2017 HELCO requested that the PUC open a docket and appoint an Independent Observer to allow HECO to solicit proposals for new renewable energy generation to be in service by the end of 2020, consistent with the Near-Term Resource Plan proposed in HELCO's PSIP update report filed with the PUC in December of 2016. PUC opened the related docket number 2017-0352 on October 6, 2017. Subsequently, PUC issued order 35286 approving with certain modifications HELCO's Proposed Final Variable Request for Proposals (RFP). HELCO's final Proposed Final Variable Request for Proposals were then filed with the PUC on February 27, 2018. Specifically, HELCO's RFP is soliciting for a total amount of variable renewable dispatchable generation of 95,000 megawatt hours ("MWh") annually delivered to the Island of Hawaii, over a preferred term of 20 years. Bids were due on April 30, 2018. The RFP process in ongoing.

Maui Variable Renewable Dispatchable Generation RFP: On June 6, 2017 MECO requested that the PUC open a docket and appoint an Independent Observer to allow HECO to solicit proposals for new renewable energy generation to be in service by the end of 2020, consistent with the Near-Term Resource Plan proposed in MECO's PSIP update report filed with the PUC in December of 2016. PUC opened the related docket number 2017-0352 on October 6, 2017. Subsequently, PUC issued order 35286 approving with certain modifications MECO's Proposed Final Variable Request for Proposals (RFP). MECO's final Proposed Final Variable Request for Proposals were then filed with the PUC on February 27, 2018. Specifically, MECO's RFP is soliciting for a total amount of variable renewable dispatchable generation of 270,000 megawatt hours ("MWh") annually delivered to Maui, over a preferred term of 20 years. Bids were due on April 30, 2018. The RFP process in ongoing.

COMPETITIVE BIDDING (con't)

Maui Firm Capacity Renewable Dispatchable Generation RFP: On May 5, 2016, Maui Electric Company asked the PUC requested that the PUC open a docket to begin the process of acquiring approximately 40 megawatts (MW) of dispatchable, firm generation - about 20 MW from renewable resources and 20 MW from fuel-flexible resources - by 2022. On October 6, 2017, the PUC issued Order No. 34856 opening docket number 2017-0352 to receive filings related to the Hawaiian Electric Companies' (Companies) plans to proceed with competitive procurement to acquire firm generation and new renewable generation. In accordance with Order No. 34856, on October 23, 2017, the Companies submitted a Draft Firm Capacity Renewable Dispatchable Generation RFP, Draft Variable Renewable Dispatchable Generation RFP, and respective supporting documentation to the commission for their review. On January 12, 2018, the PUC issued Order No. 35224 "Providing Guidance on the Hawaiian Electric Companies' Proposed Request for Proposals for Dispatchable and Renewable Generation." The Order appoints Independent Observers (IO) and advises that further guidance from the PUC and IO regarding the Maui Firm Capacity Renewable Dispatchable Generation RFP will be provided in the first quarter of 2018.

NET ENERGY METERING (NEM)

NEM is now closed to new applicants. Previously, the NEM program was available to permanent customers who own (or lease from a third party) a solar energy generating facility, that was located on their own property, and had a capacity of 100 kWh or less. Under the NEM program:

- Customers receive a credit at retail rate for electricity exported to the grid.
- If a customer uses more electricity than is exported (net-consumer), the customer is charged for that net amount of electricity used.
- If a customer exports more electricity than is used (net-producer), the customer is charged a minimum bill (e.g. $17 for Oahu residential customers), and is allowed to carry any excess credits forward to the next month.
- At the end of the customer's 12-month billing cycle any excess credit are forfeited or used to reimburse any energy charges previously paid.

CUSTOMER GRID-SUPPLY (CGS)

When the PUC established this interim program, they established a cap for each of the HECO Companies' service territories: 25 MWac for HECO, 5 MWac for MECO, and 5 MWac for HELCO. These caps were established as the PUC concluded that it was not in the public interest to allow unconstrained growth in the grid-supply option, particularly if such growth comes at the expense of future opportunities to acquire even lower-cost renewable energy from other sources, or prevents the HECO Companies from offering community-based renewable energy options for their customers. By September 2016, all three HECO Companies met their designated cap limits.

Subsequently, additional capacity was added to CGS from capacity available from Net Energy Metering applications that were cancelled or withdrawn.

Program Capacity Remaining			
Island	**Original Capacity MWac**	**Added Capacity**	**Total Capacity MWac***
Hawaiian Electric	25.00	26.31	51.31
Maui Electric**	5.00	9.12	14.12
Hawaii Electric Light	5.00	4.91	9.91

* *As of Nov. 7, 2017, the CGS program reached the total capacity allotted.*

** *Includes Maui, Molokai and Lanai*

Hawaii Energy Overview

Fixed Rates for Electricity Exported to the Grid Under the CGS Program	
Island	**Credit*** **
Oahu	15.07¢/kWh
Hawaii	15.14¢/kWh
Maui	17.16¢/kWh
Molokai	24.07¢/kWh
Lanai	27.88¢/kWh

*** *Export credits may only be used during the month they are generated. Excess monthly credits expire with the utility cost reductions benefiting all customers.*

CUSTOMER GRID-SUPPLY PLUS (CGS+)

The CGS+ program is the next iteration of the original CGS program. Similar to CGS program, the CGS+ program allows customers to install private rooftop solar or other renewables that export energy to the electric grid throughout the day. However, the CGS+ program does differ from the CGS program:

- The CGS+ requires the use of equipment that allows the utility to manage output to maintain safe, reliable grid operations.
- The CGS+ program changed the export rates to the following fixed rates through October 20, 2022:

Island	CGS Plus Credit Rate*
Oahu	10.08 cents/kWh
Maui	12.17 cents/kWh
Lanai	20.80 cents/kWh
Molokai	16.77 cents/kWh
Hawaii Island	10.55 cents/kWh

- The CGS+ program has capacity limits that varies by utility and will remain open until the following installed capacity is reached:

CGS Plus Program Capacity	
Oahu	35 MW
Maui County	7 MW
Hawaii Island	7 MW

CUSTOMER SELF-SUPPLY (CSS)

The CSS program 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.

CSS systems are also eligible for expedited review and approval of applications in areas with high levels of PV. Under the CSS program:

- Customers are not compensated for electricity exported to the grid.
- Customers pay for the amount of electricity used from the grid.
- A residential customer is charged a minimum monthly bill of $25 for residential customers.

Hawaii Energy Overview

SMART EXPORT

Smart Export allows customers to install a private rooftop solar or other renewable system and a battery energy storage system. Customers are expected to charge the battery storage system from the rooftop solar or other renewable system during the daylight hours (9:00 a.m. – 4:00 p.m.) and use that energy to power their home in the evening.

However, customers are able to receive a credit for any energy exported to the grid during the evening, overnight and early morning hours. Energy exported to the grid during the daylight hours is not compensated. Under Smart Export, customers receive a monthly bill credit for energy delivered to the grid, which helps to offset the cost of energy pulled from the grid when the customer's system is not producing enough energy to meet the household demand. The export credit is fixed through October 22, 2022.

Island	12 a.m. to 9 a.m.	9 a.m. to 4 p.m.	4 p.m. to 12 a.m.
Oahu	14.97 cents/kWh*	No Credit	14.97 cents/kWh*
Maui	14.41 cents/kWh*	No Credit	14.41 cents/kWh*
Lanai	20.79 cents/kWh*	No Credit	20.79 cents/kWh*
Molokai	16.64 cents/kWh*	No Credit	16.64 cents/kWh*
Hawaii Island	11.00 cents/kWh*	No Credit	11.00 cents/kWh*

**Export credits will be trued-up on an annual basis and any remaining credits left over at the end of the year will expire with the utility cost reduction benefitting customers.*

QUICK COMPARISON OF HECO'S EXISTING CUSTOMER RENEWABLE PROGRAMS

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

**Standard retail rates applied for energy used when rooftop solar or other renewable system is not exporting to the grid. Customers on rates other than retail should contact us to verify whether those options will apply in coordination with these programs.*

***Customer Grid-Supply remains open until installed capacity is reached. New applications are placed into queue for processing if and when space in the program becomes available. There is no guarantee that space will become available. New applications may be submitted via mail and are not supported in the Customer Interconnection Tool.*

STANDARD INTERCONNECTION AGREEMENT (SIA)

All permanent customers are eligible to interconnect a renewable or non-renewable energy generating facility through the SIA program. These systems are not compensated for any power exported to the grid, and in some cases, are restricted from exporting power. Lastly, there are no capacity restrictions for SIA systems.

Hawaii Energy Overview

FEED-IN TARIFF (FIT)

The FIT queue is now closed. Prior to this, renewable electricity suppliers with generators smaller than 5 MW were eligible to participate in the HECO Companies' FIT Program, supplying as-available power to the utility at constant, contracted rates over 20 years.

Hawaiian Electric Companies' Feed-in Tariff Rates

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	21.8* 27.4**	20 kW	26.9* 33.1**	20 kW	16.1	20 kW	21.3	20 kW
,2	Oahu	18.9* 23.8**	500 kW	25.4* 27.5**	500 kW	13.8	100 kW	18.9	100 kW
	Maui & Hawaii		250 kW		500 kW				
	Lanai & Molokai		100 kW		100 kW				
3	Oahu	19.7* 23.6**	5 MW	31.5* 33.5**	5 MW	12.0	5 MW	--	--
	Maui & Hawaii		2.72 MW		2.72 MW	--	--	--	--

*With tax credit of 35% **With tax rebate of 24.5%

FIT aggregate limits: Oahu 60 MW; Hawaii Island 10 MW; Maui, Lanai, Molokai (combined) 10 MW
In December 2014, the PUC accepted HECO and the Independent Observer's joint plan to administer the FIT queues. Future revisions or modifications to the FIT Program will be addressed in Docket No. 2014-0192 or 2014-0183.

Energy Efficiency

ENERGY EFFICIENCY PORTFOLIO STANDARDS (EEPS)

Under HRS 269-96, the EEPS statute, the Public Utilities Commission is responsible for establishing standards that will maximize cost-effective energy-efficiency programs and technologies. The goal for EEPS is a reduction of electricity consumption by 4,300 gigawatt-hours by 2030. To assist with the planning for the achievement of EEPS, HSEO held a second Hawaii Clean Energy Initiative Energy Efficiency Charrette on September 26 and 27, 2017. The objective of the charrettes is to give stakeholders a forum to discuss how we can support the achievement of greater energy efficiency than the current programs and plans support. The second charrette built on the discussion from the previous charrette which included an update of energy efficiency in Hawaii, insights about energy efficiency programs throughout the U.S., and the importance or public engagement, collaboration, and coordination to help the state achieve its energy efficiency goals.

Hawaii Energy (HE) continues to be a major contributor to the state's EEPS goals. Hawaii Energy encourages and rewards smart energy decisions which will allow our state to reach 100 percent clean energy faster and cheaper through energy efficiency and conservation. As the Public Benefit Fee Administrator, HE serves all of the islands except for Kauai. From July 1, 2017 through March 31, 2018, the program invested over $22 million to deliver more than 1.8 billion kWh in estimated lifetime customer-level energy savings at a rough cost of one-cent per kWh. This is the equivalent to building a 92 MW solar farm, enough to power 288,000 homes for a year. In addition, this will reduce greenhouse gas emissions by nearly 1.5 million tons.

Energy Performance Contracts

Energy Performance Contracts (EPC) finance improvements that reduce energy and water use with the future savings from the energy conservation measures (ECM) that are installed. ECM also include photovoltaic installations.

Under an EPC, the energy service company contracted to install the ECM will guarantee the savings or pay for the shortfall. EPC allow government agencies to maximize their energy investments because they can include deferred maintenance and performance period maintenance services under a single contract with guaranteed savings measures. The economic impacts of performance contracts are significant, providing great value to the state.

Performance contracts allows agencies to install ECM in a timely manner. ECM can take less than one year to up to three years to install. Therefore, energy savings occur sooner than later. Capital improvement projects can take from six to 10 years, resulting in missed opportunities for annual energy and water use savings. State and county agencies face increasing energy and water costs and the need to upgrade aging, inefficient, and obsolete energy- and water-consuming equipment. Capital improvement and operating budgets have been unable to keep up with the needed upgrades for ECM.

Hawaii surpassed the half-billion-dollar mark for investment in EPC in 2017. With $507.1 million in signed EPC to date, Hawaii became just the seventh state nationally to eclipse the half-billion-dollar threshold for EPC investment.

"Hawaii has long been the national leader for its investment in performance contracting projects on a per capita basis. But now they have joined a handful of states in the exclusive half-billion club for total investment in energy saving projects," said Jim Arwood, executive director of the Energy Services Coalition. "Other members include the states of Washington, Ohio, Kentucky, North Carolina, Colorado and Massachusetts."

Energy Performance Contracts

RACE TO THE TOP AWARD

For six consecutive years, Hawaii has garnered further national recognition with the Race to the Top award from the Energy Services Coalition (ESC)*. The award is given to the national leader with the highest per capita investment in performance contracting projects. With the Department of Transportation, Airports Division, performance contract for nearly $209.8 million, ESC recognizes Hawaii with the distinction of signing the single largest performance contract by a state agency. Since 2012 through 2017 the ESC has awarded Hawaii the *Race to the Top* award for its per-capita investment. In 2017 the ESC also recognized the State of Hawaii with its second Energy Stewardship Champion award for outstanding accomplishments leveraging performance contracting to achieve infrastructure modernization, environmental stewardship, and economic development. "Guaranteed energy savings performance contracting (GESPC) is a financial strategy leveraging guaranteed future energy savings to pay for energy efficiency upgrades today," said Jim Arwood, ESC Executive Director. "Hawaii has achieved considerable recent success in support of implementing energy efficiency projects in public buildings through the use of a GESPC."

Energy Services Coalition Ranking			
State	**Population**	**Performance Contracting**	**Dollars per Capita**
1. Hawaii	1,360,301	$507,133,904	$372.81
2. Washington	6,724,540	$1,288,925,725	$191.67
3. Kentucky	4,339,367	$750,000,000	$172.84
4. Delaware	897,934	$138,707,463	$154.47
5. Massachusetts	6,547,629	$865,349,091	$132.16

Since HSEO started the performance contracting program in 1996, state and local government agencies have signed a total of over $507 million in performance contracts that are estimated to save in excess of $1.1 billion over the life of the contracts. These savings are the equivalent of powering 388,210 homes for one year. The projects comprise over 112 million square feet in 295 existing buildings or facilities.

** ESC is a national nonprofit organization of experts working together to increase energy efficiency and building upgrades through energy performance contracting.*

State of Hawaii Agencies Lead By Example

STATE AND COUNTY ENERGY PERFORMANCE CONTRACTS

The chart below illustrates the number of EPC projects conducted by state and county agencies from 1996 through 2017. In addition, over $8 million in rebate incentives have been claimed from Hawaii Energy, reducing the cost of the energy efficiency improvements through performance contracting projects. Looking ahead, the state anticipates more EPC investments.

Agency	Year(s)	Contract Amount ($)	Estimated Savings Over Life of Contract ($)
U.H. Hilo	1996-2012	$6,402,695	$14,630,066
County of Hawaii	1997-2026	$2,215,546	$8,157,880
County of Kauai	1998-2012	$525,965	$1,205,990
C&C of Honolulu	2001-2025	$11,900,205	$36,066,761
Hawaii Health Systems Corporation	2002-2022	$21,936,997	$55,766,364
Judiciary	2003-2012	$1,474,406	$9,785,036
Dept. of Accounting & General Services Phase I	2009-2029	$36,873,266	$72,580,767
Department of Public Safety	2010-2030	$25,511,264	$57,211,112
University of Hawaii Community Colleges	2012-2032	$34,207,392	$37,000,000
C&C Honolulu Kailua Wastewater Treatment Plant	2013-2033	$6,054,178	$13,693,910
Dept. of Accounting and General Services Phase II	2013-2033	$17,400,000	$28,000,000
Department of Transportation	2013-2034	$309,506,592	$795,560,746
Honolulu Board of Water Supply	2016-2036	$33,125,398	$56,846,668
Total		**$507,133,904**	**$1,186,505,300**

For nearly 20 years HSEO has been leading the state's award-winning EPC efforts with a policy offering technical assistance to state agencies contemplating performance contracting. We've assisted the following entities:

- University of Hawaii at Hilo
- Hawaii Health Services Corporation
- City and County of Honolulu's four city buildings and Kailua Wastewater Treatment Facility
- County of Hawaii
- County of Kauai
- The Judiciary
- Department of Accounting and General Services (DAGS)-Phase I-10 large office buildings
- University of Hawaii Community Colleges
- Department of Public Safety's four large facilities
- Department of Transportation: Airports, Highways and Harbors
- DAGS Phase II - 33 buildings
- Honolulu Board of Water Supply

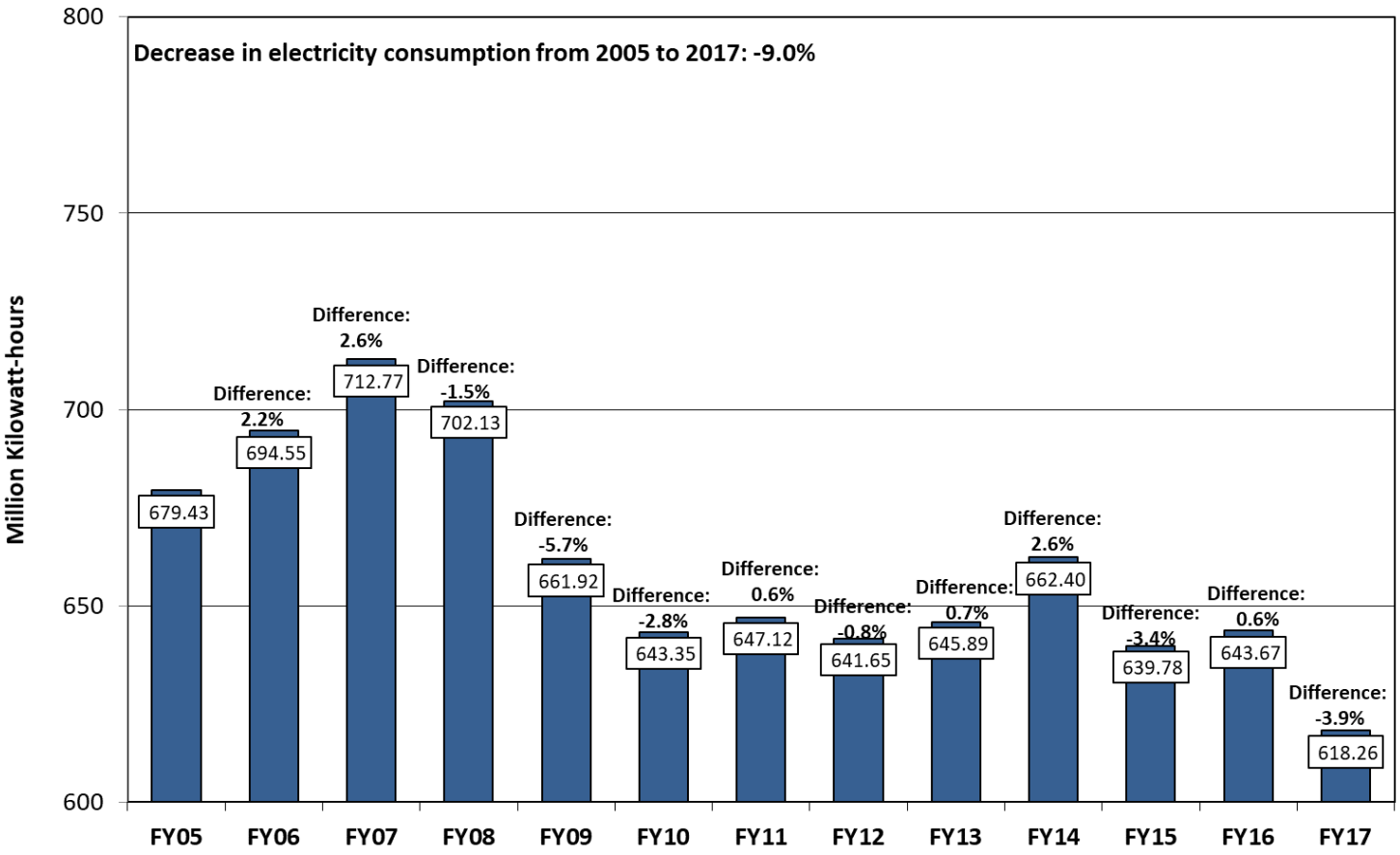
State of Hawaii Agencies Lead By Example

The types of technical assistance offered, pending funding, include:

1. Assisting an agency in compiling building plans and other information to use in solicitations
2. Reviewing draft solicitations
3. Evaluating proposed energy conservation measures, including renewable and water efficiency measures
4. Setting energy performance baselines
5. Reviewing methods for estimating energy savings (including formulas and simulation models); measurement and verification
6. Reviewing investment grade energy audits
7. Reviewing draft contract documents
8. Advising on commissioning
9. Advising on how project risks can be allocated and minimized for the state agency

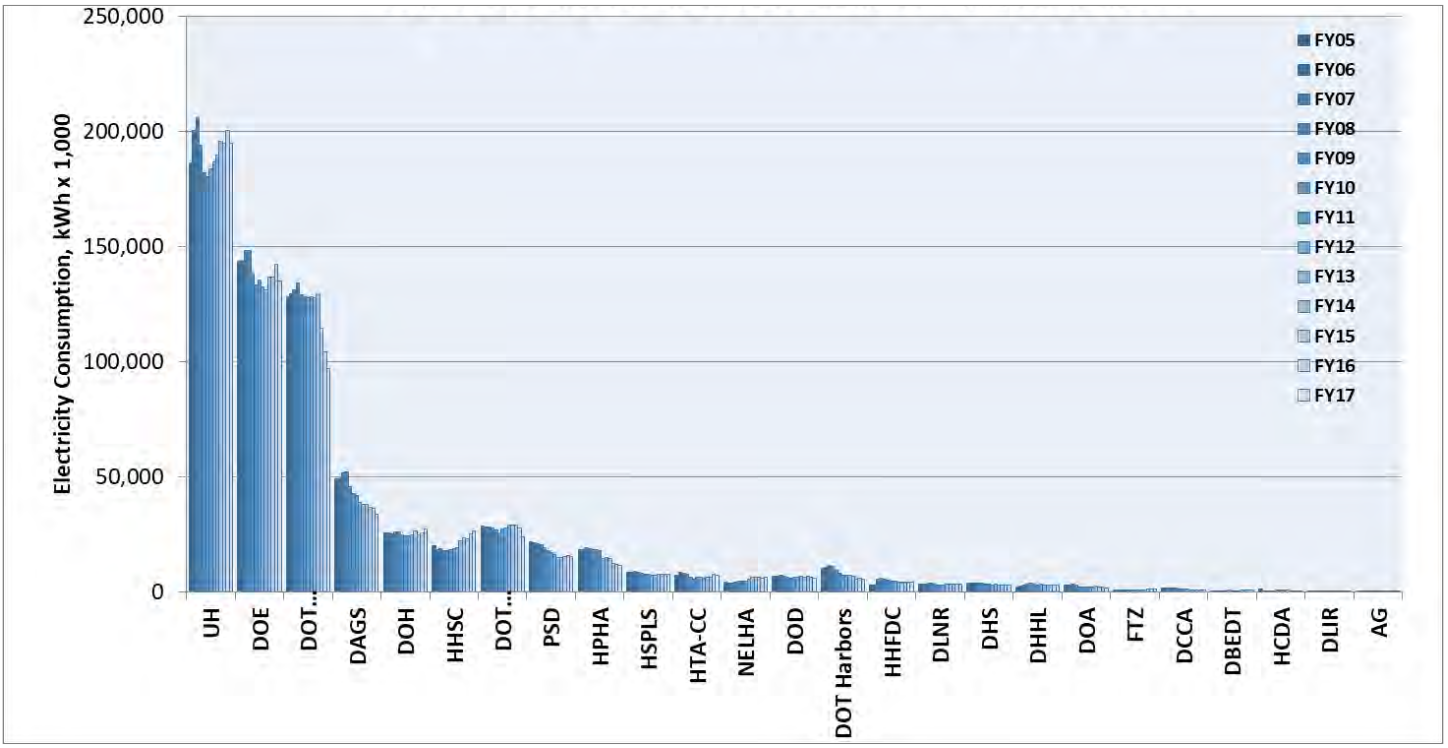
In 2006 legislative and executive mandates to incorporate energy and resource efficiency and conservation in government facilities, fleets, and personnel practices gave impetus to the state's Lead by Example (LBE) initiative to put state agencies at the forefront of energy independence efforts. As shown in the graph below, Hawaii state agencies' electricity purchased through 2017 has declined 9.0 percent from 2005 (the baseline year). Due to staff reductions, HSEO will no longer provide a special report on LBE, but we will continue to track and report electricity use by state agencies.

Comparison of State Agencies' Electricity Purchased in kWh: FY05 to FY17



State of Hawaii Agencies Lead By Example

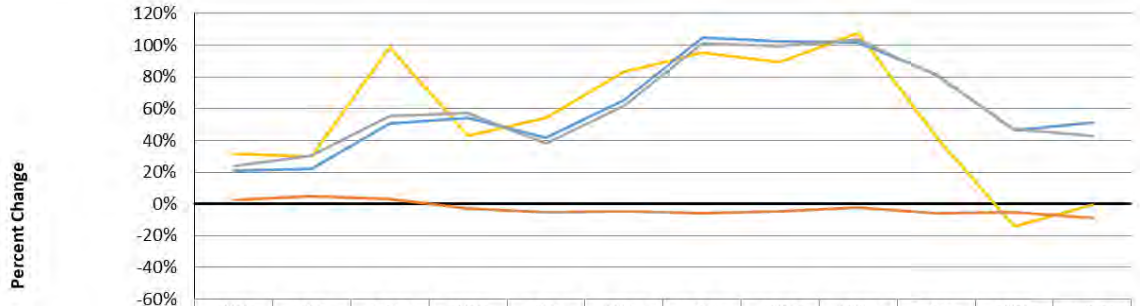
Comparison of kWh Purchased by Agency by Year



AG	Department of the Attorney General
DAGS	Department of Accounting and General Services
DBEDT	Department of Business, Economic Development & Tourism
DCCA	Department of Commerce and Consumer Affairs
DHHL	Department of Hawaiian Home Lands
DHS	Department of Human Services
DLIR	Department of Labor and Industrial Relations
DLNR	Department of Land and Natural Resources
DOA	Department of Agriculture
DOD	Department of Defense
DOE	Department of Education
DOH	Department of Health
DOT Airports	Department of Transportation/Airports Division
DOT Harbors	Department of Transportation/Harbors Division
DOT Highways	Department of Transportation/Highways Division
FTZ	Foreign-Trade Zone Division
HCDA	Hawaii Community Development Authority
HHFDC	Hawaii Housing Finance & Development Corporation
HHSC	Hawaii Health Systems Corporation
HPHA	Hawaii Public Housing Authority
HSPLS	Hawaii State Public Library System
HTA-CC	Hawaii Tourism Authority – Convention Center
NELHA	Natural Energy Laboratory of Hawaii Authority
PSD	Department of Public Safety
UH	University of Hawaii

State of Hawaii Agencies Lead By Example

Statewide Electricity Purchased Since 2005



	FY05 -06	FY05 -07	FY05 -08	FY05 -09	FY05 -10	FY05 -11	FY05 -12	FY05 -13	FY05 -14	FY05 -15	FY05 -16	FY05 -17
Price of Oil ($/bbl)	31.8%	30.0%	99.1%	43.0%	54.2%	83.1%	94.9%	89.1%	107.9%	42.3%	-14.4%	-0.5%
Total State Avg Retail Price (All Sectors; $/KWH)	20.9%	22.1%	50.5%	54.5%	41.8%	65.5%	104.6%	102.5%	101.5%	81.5%	46.7%	51.0%
Total SOH Building Electricity Cost ($)	23.7%	30.3%	55.4%	57.3%	38.2%	62.0%	101.3%	99.5%	103.4%	81.1%	47.2%	42.8%
KWH	2.2%	4.9%	3.3%	-2.6%	-5.3%	-4.8%	-5.6%	-4.9%	-2.5%	-5.8%	-5.3%	-9.0%

Sources: NYMEX WTI Future Price; EIA-826 ; Utilty (HECO, MECO, HELCO, & KIUC) Billing data

Percentage change in electricity purchased, from baseline (2005) and each following year. Shown are the price of oil, the average retail price of electricity*, total statewide electricity costs and electricity purchased (kWh).

Since 1996, state agencies have received nearly $11.9 million in efficiency rebates from Hawaii Energy, the Hawaiian Electric Company and its subsidiaries. Combined, these rebates have resulted in more than $250 million estimated cumulative dollar savings and 1.3 billion kWh electricity savings. Over the life of the equipment, these savings would be enough to power about 208,000 households for a year. From June 2017 through March 2018, state agencies received $424,700 in rebates.

*Based on U.S. Energy Information Administration-826 reporting, dividing utility total revenues by total kWh sold, including fuel adjustment cost.

State Energy Building Code Update

On July 14, 2015, the State Building Code Council (SBCC) unanimously voted to adopt the International Energy Conservation Code (IECC) 2015, with the Tropical Climate Zone Code for residential dwellings and other amendments appropriate for Hawaii's climate. After a public hearing which garnered full support of IECC 2015, Gov. Ige signed and approved IECC 2015 on March 20, 2017, to adopt Chapter 3-181.1, into Hawaii Administrative Rules.

HSEO serves on the SBCC, which was established by statute to update building codes. HSEO provided IECC 2015 technical assistance and staff training for 310 private and public-sector design professionals and county building officials. HSEO also will testify in support of IECC 2015 when the county councils hold public hearings on their adoption.

The estimated net savings from the 2015 IECC with Hawaii amendments is 12,962 MWh in 2019, 1,083,590 MWh in 2029 (year 10), 1,991,059 MWh in 2032 and 4,702,738 MWh in 2038 (year 20). These savings could power 732,514 homes in 2038, assuming the code is adopted by all counties.

Commercial Code Savings: Commercial buildings would achieve a 35-40 percent energy saving by adopting the base 2015 IECC with references to ASHRAE 90.1-2013 (compared to 2006 HEC with references to ASHRAE 90.1-2004). Amendments under consideration by HSEO will further increase potential energy savings.

Residential Code Savings: Fully conditioned 2015 IECC residences would achieve a 6 to 9 percent improvement in energy efficiency.

HSEO's website has more information on the updated energy code at energy.hawaii.gov/hawaii-energy-building-code, including a report on the analysis of the code amendments, FAQs gathered from the various training sessions statewide, presentation webinars, fact sheets and a report forecasting the energy savings for the updated code.

Leadership in Energy and Environment Design (LEED)

The U.S. Green Building Council (USGBC) released its State Market Briefs. The brief highlights the number of LEED certified and registered projects in the state, as well as the gross square footage. As of May 2018, Hawaii has 185 LEED certified projects and 245 registered projects. This totals 430 total projects for a gross square footage of over 50 million gross square feet. Utilizing less energy and water, LEED-certified spaces save money for families, businesses and taxpayers; reduce carbon emissions; and contribute to a healthier environment for residents, workers and the larger community. The certified buildings included numerous private developments, as well as federal, state, and county public buildings.

HSEO remains a member of the U.S. Green Building Council (USGBC), the non-profit entity which administers the LEED program. In 2018, Hawaii was back among the top 10 states for LEED certified project square footage per capita. With 4.5 million LEED-certified gross square footage, Hawaii rated 4th highest state in the U.S. this year.

The state requires all new construction and major renovation to meet LEED Silver standards, to the extent possible. HSEO continues to promote LEED training opportunities for state agency staff. Hookele Elementary School and the Moana Surfrider, Sheraton Waikiki, and The Royal Hawaiian were recently LEED-certified.

ENERGY STAR® Buildings

To help identify energy efficiency investment priorities, agencies and private sector building owners and managers can benchmark buildings to compare energy usage with other buildings in their portfolio or similar buildings nationally. If a building's performance, as reflected in its ENERGY STAR score, ranks in the top 25 percent of all buildings of its type, it can be certified as an ENERGY STAR building.

To qualify for certification, a building must meet ENERGY STAR requirements as verified by a licensed professional engineer or architect. The U.S. Environmental Protection Agency (EPA) then evaluates the verification submitted and, if approved, will officially certify the applicant as an ENERGY STAR building. Since 2000, 170 Hawaii buildings have received the ENERGY STAR certification, including 103 public and 67 private buildings. During this time, HSEO has helped benchmark 83 state facilities. Because energy use is constant, buildings should be verified and certified as ENERGY STAR annually to ensure optimum efficiency.

Hawaii Green Business Program

Hawaii's businesses are also contributing to the clean energy movement by improving their operations in an environmentally, culturally and socially responsible manner. To help businesses implement energy and resource efficiency practices, the state set up the Hawaii Green Business Program as a partnership between HSEO, the Department of Health, the Board of Water Supply and the Chamber of Commerce of Hawaii. When businesses embrace green business practices, they don't just enjoy utility cost savings – they also contribute to Hawaii's collective energy independence goals and, ultimately, a more sustainable environment.

From 2009-2017, over 100 business and government entities have benefited from the program, including sectors such as hospitality, commercial office, retail, restaurant, food services, grocery, venue and green events. Their savings amounts to:

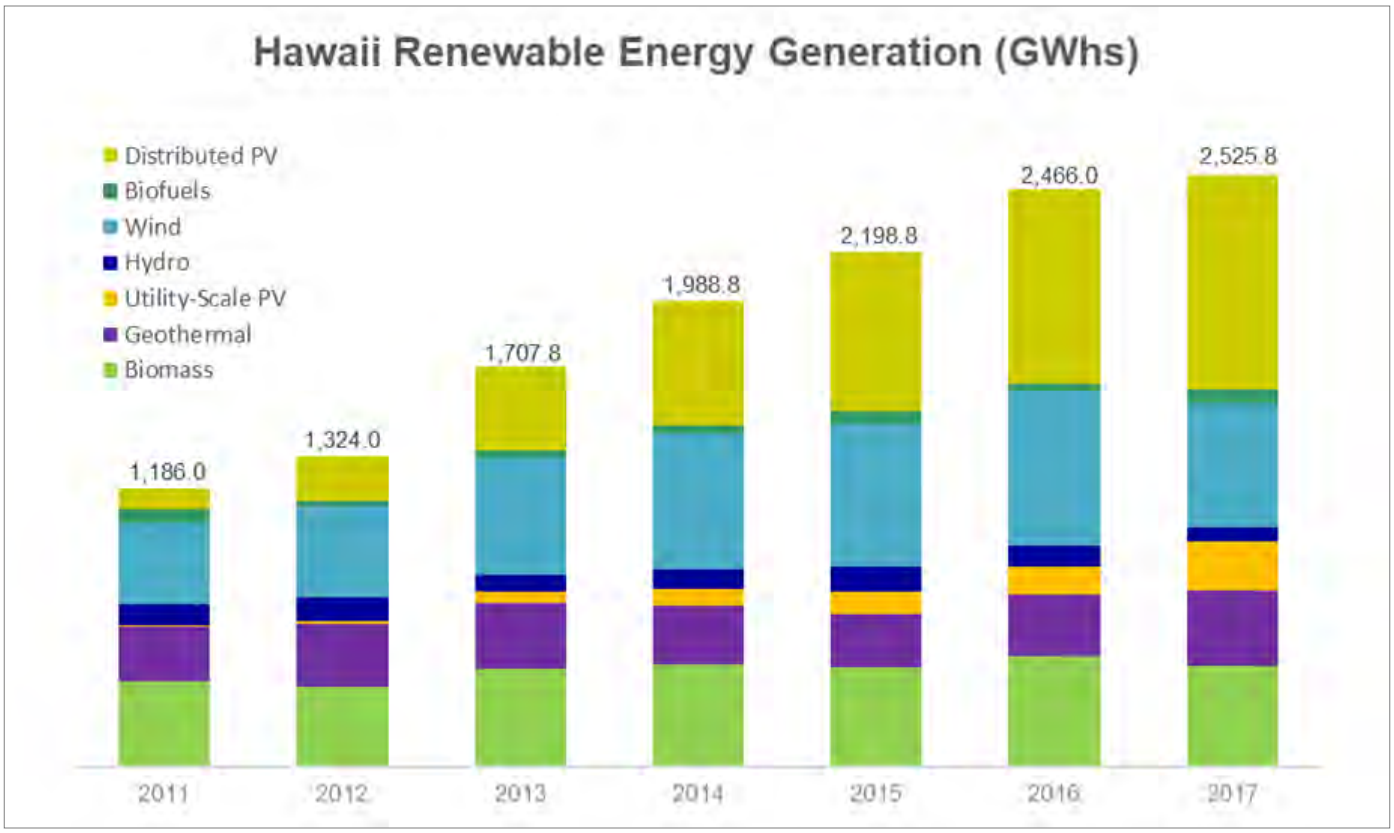
- 22.7 million kWh of energy (equivalent to powering 3,531 homes for one year in Hawaii)
- 203.2 million gallons of water
- $6.4 million in energy costs

For more information on the Hawaii Green Business Program, visit greenbusiness.hawaii.gov

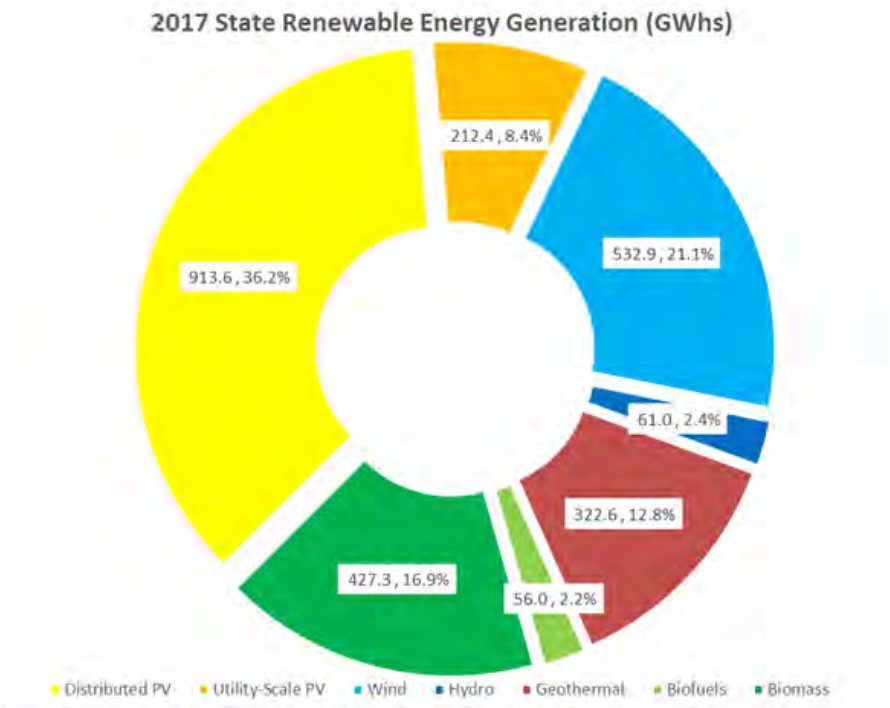
Renewable Energy

As defined by Section 269-91 Hawaii Revised Statutes (HRS), “renewable energy” means energy generated or produced using the following sources:

- Wind;
- Sun;
- Falling water;
- Biogas, including landfill and sewage-based digester gas;
- Geothermal;
- Ocean water, currents, and waves, including ocean thermal energy conversion;
- Biomass, including biomass crops, agricultural and animal residues and wastes, and municipal solid waste and other solid waste;
- Biofuels; and
- Hydrogen produced from renewable energy sources.



Renewable Energy



Source: *Renewable Portfolio Standard Annual Reports* (Hawaii Public Utilities Commission Docket No. 2007-0008)

Renewable Energy Resource	2016 Generation (GWh)	% of Renewable Energy	% of Total Sales
Distributed PV	826.8	33.5%	8.9%
Utility-Scale PV	121.8	4.9%	1.3%
Wind	656.7	26.6%	7.1%
Hydro	89.4	3.6%	1.0%
Geothermal	260.1	10.5%	2.8%
Biofuels	38.5	1.6%	0.4%
Biomass	472.8	19.2%	5.1%
Total	**2,466.0**	**100.0%**	**26.6%**

RENEWABLE PORTFOLIO STANDARDS (RPS)

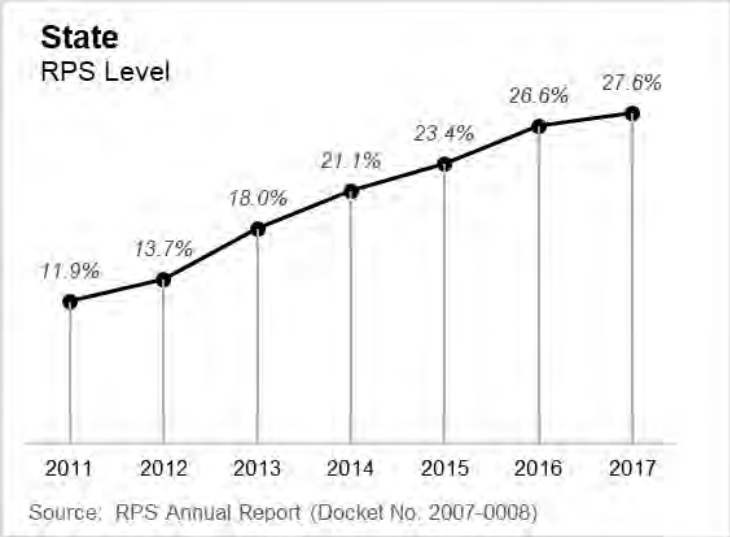
As required by Section 269-92 HRS, each electric utility company that sells electricity for consumption in Hawaii shall establish a renewable portfolio standard of:

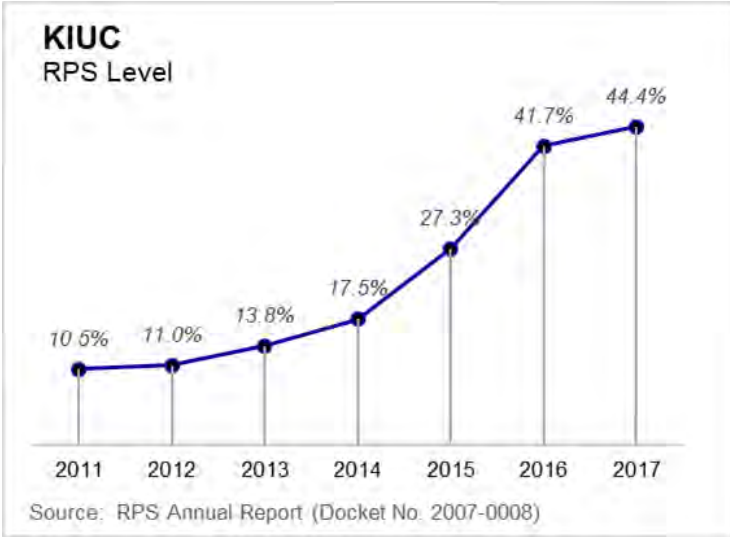
- 30% of its net electricity sales by December 31, 2020;
- 40% of its net electricity sales by December 31, 2030;
- 70% of its net electricity sales by December 31, 2040; and
- 100% of its net electricity sales by December 31, 2045.

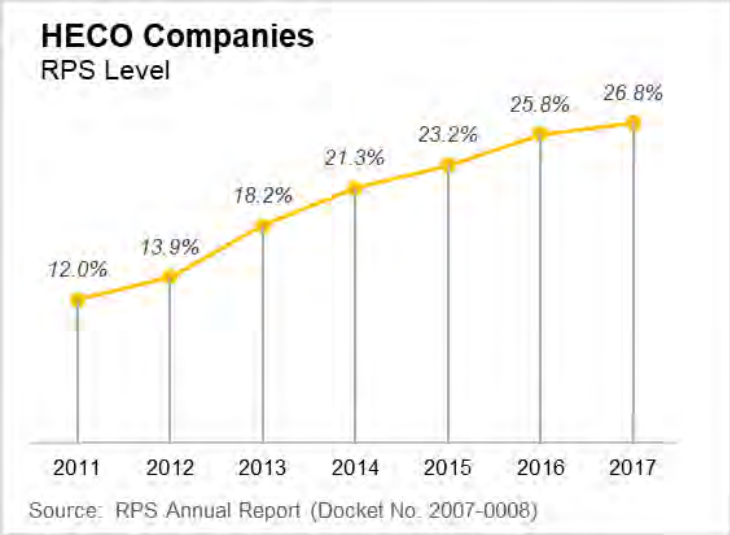
Where "renewable portfolio standard" means the percentage of electrical energy sales that is represented by renewable electrical energy (Sec 269-91 HRS). Beginning January 1, 2015, renewable electrical energy generated by the utility, independent power producers, and customer-sited, grid-connected sources are counted towards their RPS. While electrical savings from energy efficiency and solar water heating are not.

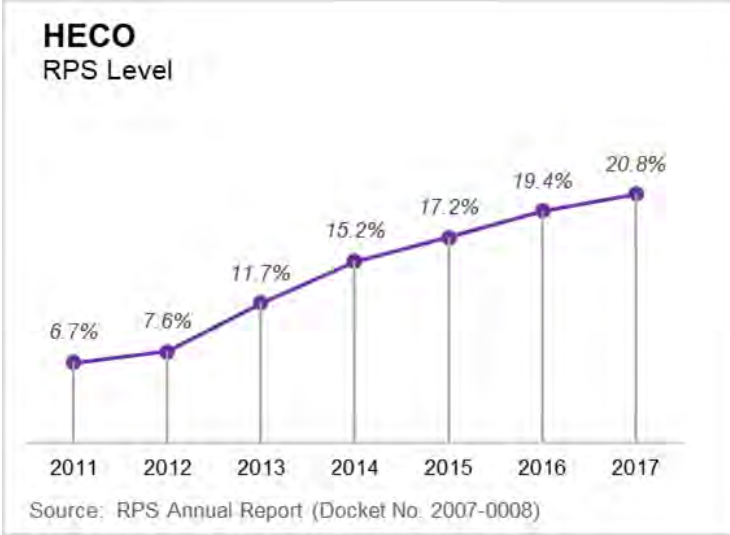
Each electric utility is also required to file an annual RPS status report to the PUC (Docket No. 2007-2008). Instead of filing individual RPS's for each company, the HECO Companies opt to consolidate their RPS's.

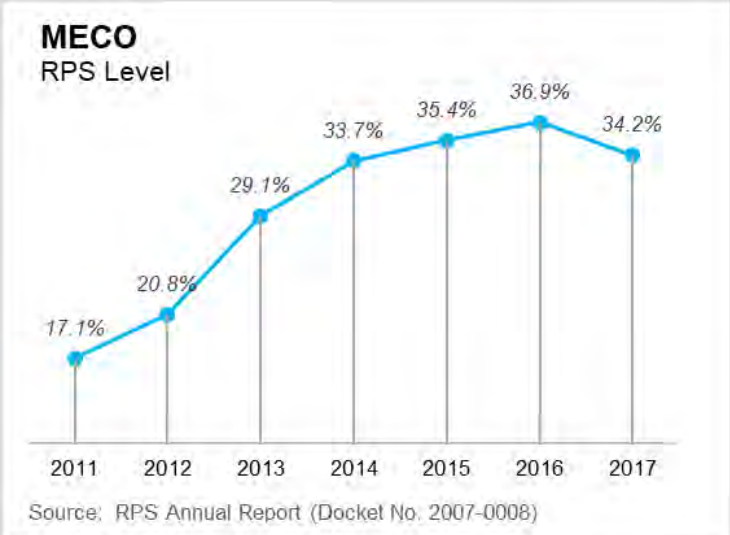
Renewable Energy

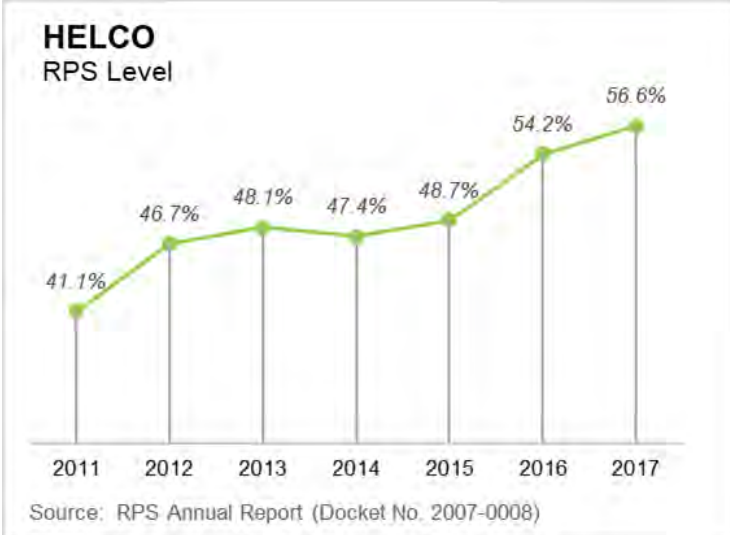












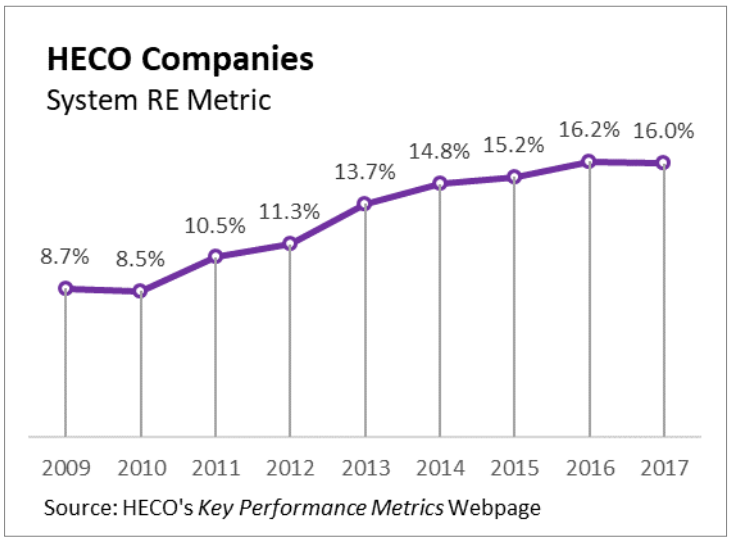
Renewable Energy

HAWAIIAN ELECTRIC COMPANIES KEY METRICS

The Hawaiian Electric Companies provide various key performance metrics on their website, two of these metrics are System Renewable Energy and Total Renewable Energy.

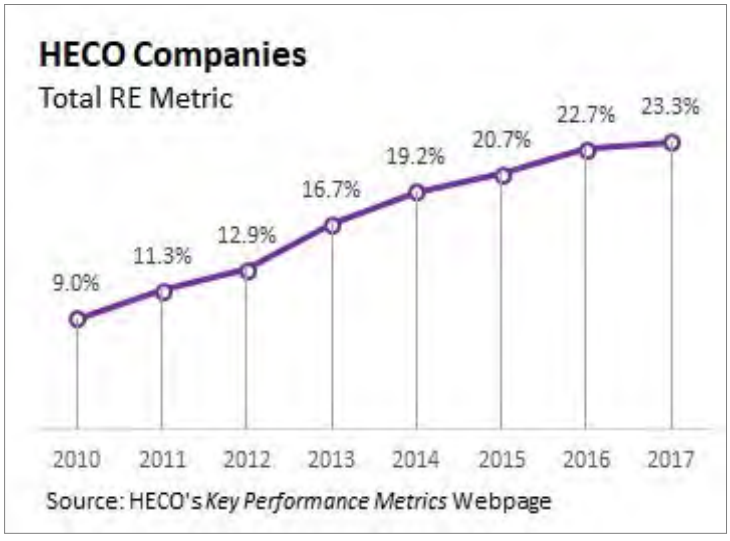
System Renewable Energy (System RE)

The System Renewable Energy metric differs from the Renewable Portfolio Standard because it estimates the percent of total net generation that is represented by renewable energy rather than being based on sales and does not include customer-sited renewable generation. Net generation is the amount of electricity generated and transmitted to the utility grid from the source (i.e., power plant). Generation from independent power producers ("IPPs") and utility power plants is recorded at the net generation level. Sales are lower than the net generation due to losses in transmitting the electricity from the source to the customers. Therefore, the System Renewable Energy will result in values lower than the RPS since customer-sited renewable generation is not included and net generation is used instead of sales. The charts below show the results for the Companies on a consolidated and individual basis.



Total Renewable Energy (Total RE)

The Total RE metric differs from the RPS because it is based on total energy and not sales. The Total RE metric is the total renewable generation provided by independent power producers, the utility, and estimates for customer-sited, grid-connected renewable energy, divided by the total generation provided by independent power producers, the utility, and estimates for customer-sited, grid-connected renewable energy.



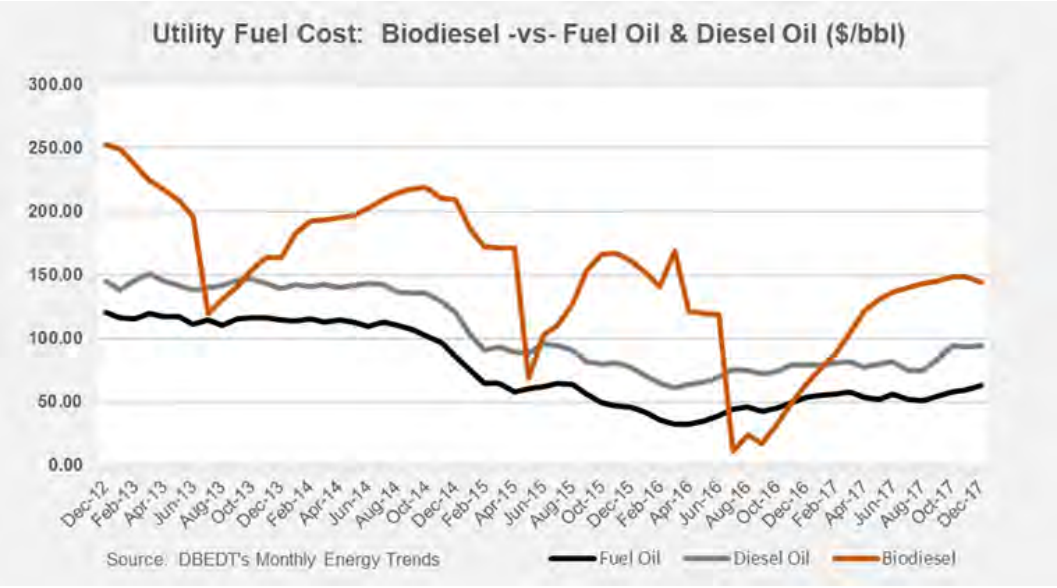
Bioenergy

"Bioenergy" includes both electricity generation and fuel production from biomass.

Biomass is plant and animal matter, including energy crops, wood, grasses, algae, vegetable oils, and agricultural and municipal wastes. Bioenergy production potential in Hawaii depends on the availability of land and feedstock; CO_2 sources (for algae); markets and values for primary products (electricity, fuels) and by-products (animal feed); and overall revenues compared to costs.

"Biofuel" sometimes is used interchangeably with bioenergy, however biofuels is more commonly used specifically to describe liquid bioenergy fuels. Biofuels are a renewable energy source that can be stored and transported in a manner similar to fossil fuels, can often be used in existing equipment and be blended with petroleum fuels. One ton of biomass replaces approximately one barrel of oil.

Since biodiesel fuel imports for electricity production began in 2010, the relative cost of the imported biodiesel fuel has been significantly higher than for the fossil-based fuels used for electricity generation in Hawaii.



DBEDT 2012 BIOFUEL REPORT

In December 2012, and in accordance with Act 203, Session Laws of Hawaii, 2011, the Hawaii State Department of Business, Economic Development and Tourism (DBEDT) provided a final report to the state Legislature, Biofuels Study. The following were taken from this report.

Hawaii's energy systems are highly dependent on liquid fuels. Petroleum is used for electricity production; ground, air, and marine transportation; military activities; and other needs. Each year, Hawaii uses between 1.7 and 2.2 billion gallons of liquid petroleum fuels (fuel oil, gasoline, diesel, jet fuel, bunker fuels, and others). These needs could be met by a combination of petroleum-based and renewable fuels (i.e. biofuels).

The materials (feedstocks) that could be used for biofuel production include sugars (from plants such as sugarcane or sweet sorghum); starch (such as from corn or cassava); fiber (from grasses, trees, husks, stalks, fibers from oilseeds, and from waste materials such as paper, sawdust, or other organic materials); and oil (such as jatropha, kukui, microalgae, soybean, peanut, sunflower, oil palm, or waste cooking oil).

Bioenergy

Active Bioenergy Facilities

Technology	Project Name	Capacity	Island	Location
Biofuel	Kauai Algae Farm	Demonstration	Kauai	Lihue
Biofuel	Honolulu International Airport Dispatchable Standby Generation Project	10 MW	Oahu	Honolulu
Biofuel	Pacific Biodiesel Honolulu Plant	1 MGY	Oahu	Honolulu
Biofuel	HECO Campbell Industrial Park Generating Station	110 MW	Oahu	Kapolei
Biofuel	Pacific Biodiesel Biofuel Crop Demonstration Project	Feedstock Demonstration	Maui	Central Valley
Biofuel	Cellana Algae Kona Demonstration Facility	Demonstration	Hawaii	Kailua-Kona
Biofuel	Big Island Biodiesel	5 MGY	Hawaii	Keaau
Biofuel	Hawaii Pure Plant Oil	Demonstration	Hawaii	Keaau
Biomass	Green Energy Biomass-to-Energy Facility	6.7 MW	Kauai	Koloa
Biomass	HC&S Co-Generation Facility	16 MW	Maui	Puunene
Waste-to-Energy	Hawaii Air National Guard Waste-to-Energy Microgrid System Demonstration	Demonstration	Oahu	Joint Base Pearl Harbor-Hickam
Waste-to-Energy	HPOWER	88 MW	Oahu	Kapolei (Campbell Industrial Park)
Waste-to-Energy	PVT Bioconversion Feedstock Processing Facility	Feedstock Production	Oahu	Nanakuli

Source: Hawaii State Energy Office, Renewable Energy Projects Directory

Geothermal

CURRENT PRODUCTION

The State of Hawaii has one operating geothermal power plant: the 38 megawatt (MW) Puna Geothermal Venture (PGV) facility owned and operated by Ormat Technologies and located in Pahoa on the eastside of Hawaii island. PGV began operating in 1993 at 25 MW and was expanded in 2011 to its current capacity of 38 MW. With its latest expansion, PGV became the world's first integrated combined cycle power plant capable of providing both baseload power to the grid and dispatchable power that supports the integration of other intermittent (fluctuating) renewable energy sources on Hawaii island (wind, solar, hydropower). PGV extracts steam and hot fluids from production wells deep beneath the earth's surface – a mile or more – and converts the steam into energy through heat exchangers and steam turbine generators. Reuse of the steam in a closed loop system maximizes the energy output of the extracted steam and fluids, and minimizes plant emissions under normal operating conditions. After use, the exhaust steam and fluids are re-injected into the ground via injection wells at similar depths as the production wells. PGV uses air to cool its turbines, which eliminates the need to use and dispose of water for cooling purposes. In 2017, PGV produced 322.6 gigawatt-hours (GWh), which is enough to power 55,545 average Hawaii homes a year and constitutes 30.8% of all energy used on Hawaii island and 3.7% of all energy used throughout the state (Hawaiian Electric Companies' 2017 Renewable Portfolio Standard Status Report). PGV was shut down in May 2018 due to the volcanic eruption of Kilauea. At time of this print, PGV's future status remains unknown due to the active lava flows in the project area.

Geothermal

Prior to PGV, the first geothermal production well in Hawaii was drilled in 1976 by the University of Hawaii in the lower Kilauea East Rift Zone on the southeast side of Hawaii island: the Hawaii Geothermal Project – Well A (HGP-A). In 1982, the U.S. Department of Energy developed a 3 MW experimental power plant at the site, which was shut down in the late 1980s.

Puna Geothermal Venture Power Plant, Pahoa, Hawaii Island

STATUS OF COMPETITIVE SOLICITATION

In October 2017, Maui County's electric utility, Maui Electric Company (MECO), submitted to the Hawaii Public Utilities Commission (PUC) a Draft Request for Proposals for Renewable Firm Capacity and Dispatchable Energy Resources on the island of Maui (Maui Firm RFP), which includes geothermal. In January 2018, the PUC instructed MECO to be prepared to initiate the Maui Firm RFP following further guidance from the PUC. The status of the Maui Firm RFP is still pending.

In May 2012, the Hawaii Electric Light Company (HELCO) initiated a competitive bidding procedure (request for proposals) seeking 50 MW of dispatchable geothermal firm capacity generation; however, in February 2016, HELCO notified the PUC and all other parties that power purchase agreement negotiations for this procurement had concluded unsuccessfully (PUC Docket No. 2012-0092).

RESOURCE PLANNING AND POTENTIAL

Hawaiian Electric's Power Supply Improvement Plan (PSIP) Update Report: December 2016 (PUC Docket No. 2014-0183) forecasts 40 MW of new geothermal development on Maui by 2040 and an additional 40 MW of geothermal on Hawaii island by 2030. Studies indicate the islands of Maui and Hawaii combined have a minimum potential geothermal capacity of 525 MW, with a more likely combined capacity of 1,535 MW (GeothermEx, Inc., 2005). Other Hawaiian islands, particularly Kauai and Oahu, do not show as much potential for geothermal development, but are still under consideration for additional study and possible use, as are Molokai and Lanai.

Geothermal

RESOURCE EXPLORATON

Geothermal's promise as a firm, cost-competitive source of baseload renewable energy continues to encourage exploratory efforts to better understand Hawaii's geothermal resource potential. Geothermal resources in Hawaii are difficult to fully characterize without exploration and drilling because Hawaii's high-temperature resources – some of the world's hottest – are generally found deep beneath the ground surface. Typical 'non-invasive' exploratory data gathering techniques used in Hawaii include: literary and oral research; magnetotellurics (MT), which uses electromagnetic signals to detect subsurface electrical conductivity; water sampling to detect chemical composition; and, computer modeling. The Hawaii Groundwater and Geothermal Resources Center (HGGRC) catalogs much of the completed and ongoing geothermal-related explorations in Hawaii (https://www.higp.hawaii.edu/hggrc/). Recently completed surficial geophysical studies in the Saddle Road area of Hawaii island indicate the potential presence of geothermal and groundwater activity in this region (Final Report: Magnetotelluric and AudioMagnetotelluric Surveys on DHHL Lands Mauna Kea East Flank, 2016).

The ongoing Hawaii Play Fairway Project, managed by HGGRC and supported by the U.S. Department of Energy, will provide the first statewide geothermal resource assessment conducted since the late 1970s. Phase I, completed in 2015, involved the identification, compilation, and ranking of existing geologic, groundwater, and geophysical datasets relevant to subsurface heat, fluid, and permeability in Hawaii. Phase II, completed in 2017, involved the collection new groundwater data in 10 locations across the State and new geophysical data on Lanai, Maui, and central Hawaii island, modeling the typography of the areas of interest to better characterize subsurface permeability, and the development of an updated geothermal resource probability map. Phase III, which is ongoing, involves the collection and analysis of scientific data from existing well sites and may include drilling of a geothermal test well ("slim hole") at one of the high probability locations determined through Phases I and II. Results from the Hawaii Play Fairway Project will also indicate areas warranting additional geothermal resource exploration.

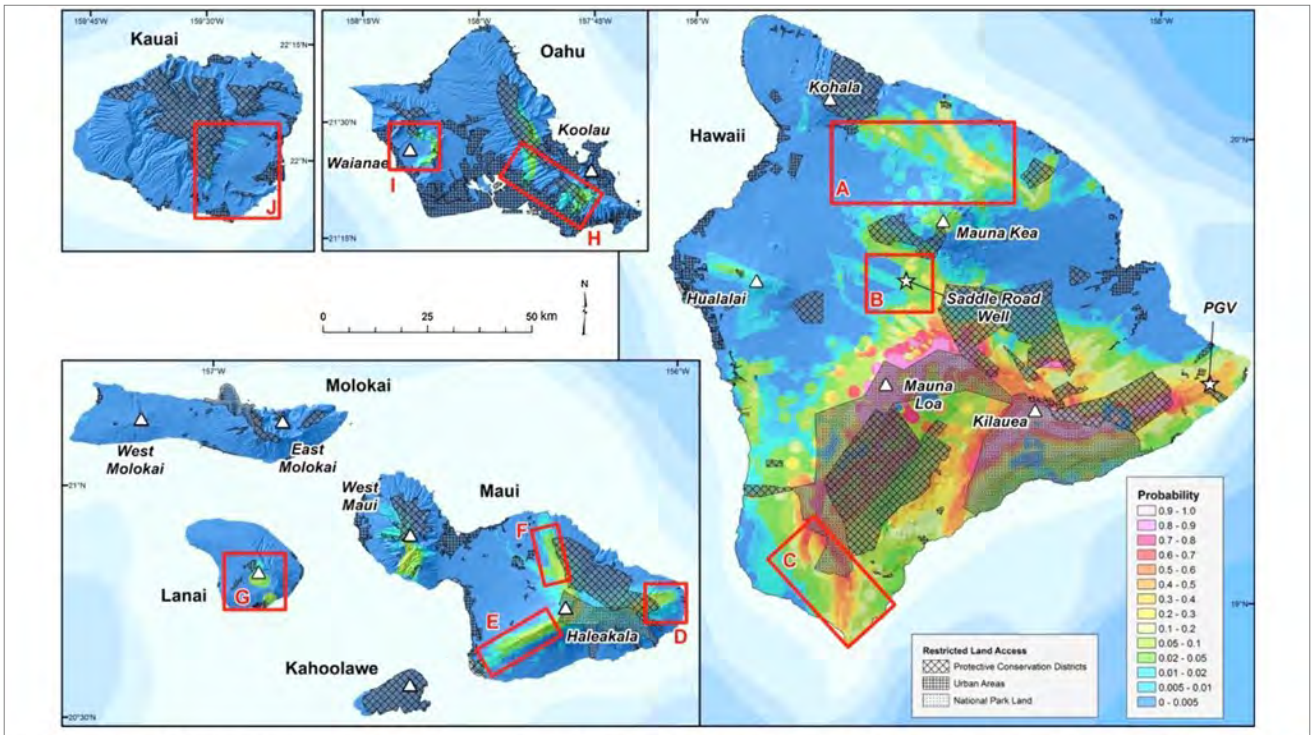


Fig. 1. Results of the DOE Phase 1 geothermal play fairway probability analysis for the State of Hawaii. Probabilities of a geothermal resource are colored. Areas with restricted land access are shown in stippled and crosshatch patterns (e.g., National Park lands, protective conservation districts, and urban areas). Red boxes outline areas proposed for Phase 2 study. White triangles indicate the calderas of the main shield volcanoes. White stars mark the locations of the Saddle Road well and Puna Geothermal Ventures (PGV). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

Hawaii Play Fairway Project (Lautze, N., Geothermics 2017)

Finally, Ormat had expressed interest in exploring on Maui around 2012, focusing on the southwest rift zone of Haleakala, with partial funding from the U.S. Department of Energy (USDOE), but nothing indicates Ormat is proceeding (Ulupalakua Geothermal Mining Lease and Geothermal Resource Subzone Modification Application, 2012).

Geothermal

PRICING

Geothermal electricity is generally cheaper than energy produced from petroleum fuels and other forms of renewable electricity in Hawaii. GeothermEx, Inc. estimates the levelized power cost of geothermal for a hypothetical 30 MW plant on Hawaii would be between 7¢ to 8.7¢ per kilowatt-hour (kWh), with operation and maintenance costs between 4¢ to 6¢ per kWh and capital costs between $2,500 to $5,000 per installed kilowatt (Assessment of Energy Reserves and Costs of Geothermal Resources in Hawaii, GeothermEx, Inc., 2005). PGV sells power to HELCO at the following cost (per kWh):

- First 25 MW: 18.8¢ on-peak, 15.9¢ off-peak
- Next 5 MW: 11.8¢
- Last 8 MW: 9¢

DIRECT USE GEOTHERMAL

While currently not used in Hawaii, direct use geothermal offers promise in areas with industrial or agricultural processing and hot groundwater at or near the surface. Direct use geothermal systems do not generate electricity, but extract heated groundwater for direct uses, including: large-scale pool heating; space heating, cooling, and on-demand hot water for buildings of most sizes; district heating (i.e., heat for multiple buildings in a city); heating roads and sidewalks to melt snow; and, some industrial and agricultural processes. Because hot water for direct use is typically close to the surface, drilling and development capital costs are relatively small compared to deeper geothermal systems.

ENVIRONMENTAL AND HEALTH CONSIDERATONS

Geothermal energy offers some environmental benefits because it can be produced with burning a fossil fuel, produces minimal emissions and manufactured wastes if designed and regulated properly, and provides a constant (24 hours a day) source of reliable power at around 90% output capacity. PGV's dispatchability also enables it to support the grid's integration of other sources of the renewable energy. Numerous federal, state, and county regulations are in place to govern geothermal developments. However, if not regulated, designed, and operated properly, geothermal exploration and production technologies have the potential to negatively impact the surrounding environment and human populations.

In Hawaii, concerns about geothermal's impacts to human health and the environment are well documented and have led to more stringent local regulations in some cases (i.e., night-time drilling ban on Hawaii island within one mile of nearest residence). One of the primary concerns in Hawaii is the release of hydrogen sulfide, a poisonous gas that can cause acute and chronic respiratory conditions in humans and acidic environmental conditions. Air monitoring, materials handling, and other controls are required to regulate planned and unplanned emission releases. The noise and lighting caused by drilling and plant operations can also impact nearby communities and often requires mitigation or avoidance measures. Also of concern is the potential risk to groundwater from the injection or inadvertent release of used geothermal fluids being extracted or injected back into the earth. Stringent well operations and drilling regulations, treatment of these fluids to match their extraction composition, and injection far below groundwater tables can mitigate this risk.

Any new geothermal developments in Hawaii would require thoughtful planning, comprehensive environmental impact analysis, and considerable community engagement prior to deciding on the viability of a given project.

CULTURAL CONSIDERATONS

The extraction and use of Hawaii's geothermal resources, including water and volcanic materials, requires careful consideration of the cultural values placed on those resources and their contemporary cultural uses. The native religion of the Hawaiian people has many deities connected to Hawaii's natural resources, including Pele, widely known as the goddess of fire and volcanoes. Some Native Hawaiian religion practitioners have opposed geothermal in Hawaii for religious reasons, which is documented by a lengthy history of litigation and administrative procedures. Conversely, some Native Hawaiian religion practitioners view geothermal as a gift to the people of Hawaii. Any new geothermal developments in Hawaii ought to include extensive consultation with Native Hawaiians and others to identify and discuss cultural impact considerations.

Hydropower

Wailuku River Hydroelectric Power Plant, 11 MW, Hilo, Hawaii

Hydroelectricity was the first renewable energy technology used to generate electricity in Hawaii – plants date back to 1888. Early hydroelectric facilities were located in Honolulu, Hilo, and on the island of Kauai. The Puueo Hydropower facility on Wailuku River on Hawaii Island was originally built in 1910 and remains operational today. During the sugarcane era, additional hydroelectric plants were installed to help power sugar operations and likely contributed to a significant percentage of the area population's overall energy needs. The technology is fully commercial and reliable but is limited by fluctuating water levels in Hawaii's streams and irrigation ditches. Due to Hawaii's geology, run-of-the-river and run-of-the-ditch systems, which have no dams, are the prevalent hydropower technology.

CURRENT PRODUCTION

Hawaii County Dept. of Water Supply's 45 kW in-line hydro plant in Kona, Hawaii

Small home-scale plants, commercial and municipal installations, and utility-scale hydropower facilities are currently in operation in Hawaii. Hawaii currently has about 37 megawatts (MW) of installed hydroelectricity capacity statewide – the largest being the 11 MW Wailuku River plant on Hawaii Island – and about 50 MW of hydroelectric projects proposed or under development (Hawaii Renewable Energy Projects Directory). In 2017, hydropower accounted for 0.67% of the total energy distributed by Hawaii's electric utilities statewide (2017 Renewable Portfolio Standard Status Reports). In 2017, hydro represented 6.9% of the electricity used on Kauai in 2017 and 2.8% of the electricity used on the island of Hawaii, the two islands with the most hydropower in operation. Another related technology is in-line hydro, which harvests energy within water pipelines. For example, the Hawaii County Department of Water Supply (DWS) has three small in-line hydro power plants which each have capacities of under 100 kilowatts (kW). These facilities capture the energy in pipes carrying water to DWS customers in West Hawaii.

PROPOSED PRODUCTION

In October 2017, the PUC approved Hawaii Electric Light Company's (HELCO) 2016 request to spend approximately $6,200,000 for its proposed Waiau Hydro Repowering Project to renovate and refurbish this nearly 100 year-old facility, which could more than double its current output. HELCO is currently seeking a 65-year water lease from the State Board of Land and Natural Resources for the project to replace its Revocable Permit renewed through 2019, which triggers the State environmental review process and has a watershed management plan requirement. HELCO is also seeking an easement form the Department of Hawaiian Home Lands (DHHL) for part of its diversion infrastructure located on DHHL lands. HELCO intends to begin work to solicit proposals for work on the Waiau Hydro Repowering Project planned to be completed by late-2020 or early-2021, but does not intend to proceed with construction until water rights are approved.

Kauai Island Utility Cooperative (KIUC) is seeking a long-term lease from the State (Department of Land and Natural Resources) for its existing Waiahi hydropower units. Gay & Robinson (G&R) is currently constructing a new 6 MW hydropower expansion facility below its existing 1.3 MW hydropower plant on the Olokele River/Makaweli Stream watershed at the former Kaumakani Sugar Mill site. The new facility would be the first new large-scale hydropower plant on Kauai in 80 years. The Hawaii Public Utilities Commission (PUC) approved the power purchase agreement (PPA) between G&R and KIUC in March 2016. The plant could be operational by late 2018 or early 2019 and is estimated to increase KIUC's renewable energy generation by about 5%.

Hydropower

PUMPED STORAGE HYDROPOWER

KIUC continues to investigate a new 25 MW pumped storage hydropower project on the westside of Kauai, utilizing the Puu Lua Reservoir, Puu Opae Reservoir, and Kokee Ditch. If successful, this project could provide more than 20% of the island's annual electricity requirements. KIUC is currently seeking a long-term water lease from the State (Department of Land and Natural Resources and Department of Hawaiian Home Lands) for this project, in addition to conducting other due diligence and complying with other regulatory processes.

Grand River Dam Authority (GRDA) Salina Pumped-Storage Project, Oklahoma

Pumped storage hydro uses a non-hydro source of electricity (e.g., wind, solar, conventional generation) to pump water from one reservoir to a second, higher reservoir. The water stored in the upper reservoir can be released as needed, running through a turbine on the way back down and generating power like a normal hydropower unit. Other reservoirs on Hawaii, Maui, and Oahu (Lake Wilson, Nuuanu) have also garnered attention for their pumped storage use potential.

HAWAII HYDROPOWER ASSESSMENTS

The U.S. Army Corps of Engineers (USACOE) conducted a Hydroelectric Power Assessment for the State of Hawaii in 2011, which is a feasibility study that identifies, evaluates, and recommends solutions to address the potential hydroelectric power needs in the State of Hawaii. USACOE studied more than 160 hydro sites and ocean energy areas across Hawaii as part of this assessment, including the site of KIUC's proposed pumped storage project.

ENVIRONMENTAL AND CULTURAL CONSIDERATIONS

Hydropower projects have the potential for significant agricultural, cultural, ecological, and other impacts. Any proposed projects with potential to impact Hawaii's surface waterways will undergo intense regulatory and community scrutiny to ensure protection of the impacted species and ecologies, and adequate water for downstream users (taro and other farmers, recreational users). If done properly, hydropower can support and benefit the resources, water uses, and other activities that depend upon Hawaii's surface waters.

Ocean and Marine Energy

Surrounded by the Pacific Ocean, Hawaii is rich in ocean renewable energy resources. Ocean or marine energy includes both hydrokinetic and thermal resources. Hydrokinetic technologies tap the movement in the ocean—waves, currents and tides—to generate electricity. Ocean Thermal Energy Conversion (OTEC) makes use of the temperature differences between warm surface waters and cold, deep ocean waters. Hawaii has superior potential for wave energy and OTEC, however, does not currently depend on wave or OTEC for any substantive energy production. Ocean current and tidal resources are not as promising in Hawaii due to its relatively mild tidal shifts compared to other parts of the world. Ocean energy technology continues to evolve as numerous ocean energy research, development, and demonstration projects are taking place in Hawaii and elsewhere in the world.

CURRENT PRODUCTION

The first ocean wave-generated electricity ever transmitted to the grid in the United States was generated by an Ocean Power Technologies (OPT) PowerBuoy at Kaneohe Bay in 2010. In a cooperative program with the U.S. Navy, three OPT buoys were deployed from 2004 to 2011.

Lifesaver Wave Energy Device connected to WETS, Kaneohe Bay, Oahu

Currently, the U.S. Navy has partnered with the Hawaii National Marine Renewable Energy Center (HINMREC) at the University of Hawaii-Manoa, one of three federally-funded centers for marine energy research and development in the nation, to establish a multiple-berth deep water wave energy test site (WETS) in Kaneohe Bay, Oahu. Located on the seafloor approximately 200-260 feet deep, approximately 6,500-8,200 feet offshore, the purpose of the WETS is to collect and analyze wave buoy equipment performance (grid-connected), cost, and durability (which will help guide industry design improvements), as well as monitor environmental impacts from wave energy technologies (EMF, sediment, ecology). With the WETS infrastructure secured in place, various wave energy conversion units will be connected and tested for one year or more. According to reports, the WETS is the first grid-connected wave test facility in the U.S. for commercial-scale WECs. Data from the wave buoys connected to the WETS will be collected and analyzed by the US Navy, US DOE, and UH. The first new tenant, Northwest Energy Innovations (NWEI), deployed its first Azura prototype wave buoy at the WETS 30-meter-deep berth. Other companies with wave energy devices connected to the WETS include Fred Olsen Ltd. and Columbia Power Technologies, and Ocean Energy announced it would be connecting its 1.25 megawatt capacity OE Buoy built by Vigor to WETS in 2018.

Ocean and Marine Energy

OCEAN THERMAL ENERGY CONVERSION (OTEC)

The Natural Energy Laboratory of Hawaii Authority (NELHA) at Keahole Point, Kona, is among the world's premier OTEC research centers. NELHA's Hawaii Ocean Science and Technology Park (HOST) houses enterprises that test renewable energy technologies on the cusp of commercialization. Major milestones in OTEC were achieved at NELHA in the 1980s and '90s, including a 1-MW floating OTEC pilot plant, Mini-OTEC (the world's first demonstration of net power output from a closed-cycle plant) and other demonstrations in both open- and closed-cycle OTEC.

OTEC Pilot Project, Keahole Point, Kona

NELHA's cold seawater supply pipes are the deepest large-diameter pipelines in the world's oceans, extending to 2,000-foot depths; providing a temperature variance between 6°C (43°F) at lower depths to 24° – 28.5°C (75° – 83°F) near the surface. The laboratory's location, with access to both warm surface water and cold deep ocean water, makes it a prime site for OTEC R&D. Presently, Makai Ocean Engineering is operating a heat exchanger test facility at NELHA, testing components and materials. A 100-kilowatt (kW) OTEC generator has been added to the test facility and became operational in August 2015. A 1-megawatt (MW) OTEC demonstration facility at NELHA is in the planning stages and power plants up to 100 MW in capacity have been proposed for locations off Oahu.

TIDAL POWER

Hawaii's lack of extreme tidal shifts has thus far discouraged the deployment of demonstration projects to convert tidal shifts to electrical energy.

ENVIRONMENTAL CONSIDERATONS

Ocean and marine energy generation projects have the potential for significant ecological, recreational, commercial, and other impacts. Any proposed projects with potential to impact Hawaii's ocean waters and uses will undergo intense regulatory and community scrutiny to ensure conservation of the impacted species and ecologies, protection of commercial and recreational ocean uses, and safeguards in case of unintended releases (water or equipment detached from seafloor).

Solar

Due to Hawaii's high-electricity prices, abundant solar resource, and progressive energy policies, the state has experienced unprecedented growth in solar generation. In recent years solar has become the primary renewable energy resource in Hawaii. Most of solar generation is provided by distributed PV systems. Largely incentivized by tax credits and the utilities' distributed energy resource programs , distributed PV has grown significantly.

HAWAIIAN ELECTRIC COMPANIES DISTRIBUTED ENERGY RESOURCES PROGRAMS

As of 5/15/18

	NEM	CGS	CSS	GSP	ISE	SIA	FIT
OAHU/HECO							
Total # Applications Executed (Cumulative - from inception to date)	48,061	2,761	324	-	-	318	110
Total Rated Capacity (MW)	324.30	20.17	2.00	-	-	84.87	29.85
MAUI/MECO							
Total # Applications Executed (Cumulative - from inception to date)	11,034	475	87	-	-	42	36
Total Rated Capacity (MW)	83.38	3.94	0.58	-	-	16.77	4.93
MOLOKAI/MECO							
Total # Applications Executed (Cumulative - from inception to date)	406	-	-	-	-	-	1
Total Rated Capacity (MW)	2.21	-	-	-	-	-	0.03
LANAI/MECO							
Total # Applications Executed (Cumulative - from inception to date)	119	-	-	-	-	1	-
Total Rated Capacity (MW)	1	-	-	-	-	1	-
HAWAII ISLAND/HELCO							
Total # Applications Executed (Cumulative - from inception to date)	11,136	781	139	-	-	48	16
Total Rated Capacity (MW)	73.29	5.59	1.01	-	-	15.43	2.51

Procurement Codes

Code	Definition
NEM	Net Energy Metering
CGS	Customer Grid Supply
CSS	Customer Self Supply
GSP	Customer Grid Supply Plus
ISE	Interim Smart Export
SIA	Standard Interconnection Agreement
FIT	Feed-In Tariff

Solar

KIUC DISTRIBUTED ENERGY RESOURCES PROGRAMS

As of 12/31/2017

KIUC	NEM	NEM Pilot	Schedule Q
Total Systems (executed)	171	154	3,951
Rated Capacity (MW)	0.72	3.44	20.63

Source: KIUC Annual NEM/Schedule Q Report

SCHEDULE Q MODIFIED

Currently only Schedule Q Modified is available to KIUC customers who own (or lease from a third party) a Qualifying Facility as described in PUC's Administrative Rules, Chapter 74 of Title 6, Subchapter 2; which requires the primary energy source of the facility to be biomass, waste, renewable resources, solar, wind, geothermal, or a combination thereof, and more than seventy-five per cent of the total energy input shall be from these sources. Under KIUC's Schedule Q Modified Tariff:

- Customers have the choice (1) to not sell electricity to KIUC, or (2) to sell excess energy to KIUC.
- If a customer chooses to sell electricity to KIUC they are charged a monthly metering charge (i.e. single-phase customers - $24.75/month).
- The rate that KIUC pays participants for electricity changes monthly and reflects the amount KIUC would have had to pay to generate the power if they didn't buy it from the customer ("avoided cost"). As more renewables come on line, the amount paid under Schedule Q is expected to drop.

Beyond distributed PV the state has pursued utility-scale PV projects, some of these projects include:

- In January 2017, HECO brought the EE Waianae Solar (27 MWac PV) project into service. Eurus will sell power to HECO at about 14.5 cents per kWh.
- KIUC partnered with SolarCity to develop a 13 MWac PV system with a 13 MW / 52 MWh Tesla Powerpack lithium-ion battery energy storage system. SolarCity will sell power to KIUC at 13.9 cents per KWh. Operations began in 2017.
- KIUC partnered with the AES Corporation to develop a 28 MWac PV system with a 28 MW / 100 MWh battery energy storage system. This system will sell power to KIUC at about 11 cents per kWh. Construction is expected to start in October 2017 and the facility is expected to be operational by October 2018.
- The Navy is proposing to lease land to a developer for the development of a utility-scale PV and battery energy storage system at the Pacific Missile Range Facility at Barking Sands on Kauai. The PV system would generate up to 44 MWdc.

Solar

Some of Hawaii's active utility-scale PV systems

Project Name	Capacity	Island	Location
Cyanotech Solar Array	500 kW	Hawaii	Kailua-Kona
Kapaa Solar Project	1 MW	Kauai	Kapaa
KRS1 Anahola Solar Farm	12 MWac	Kauai	Anahola
KRS2 Koloa Solar Farm	12 MWac	Kauai	Koloa
MP2 Kaneshiro Solar Project	300 kW	Kauai	Lawai
Port Allen Solar Facility	6 MW	Kauai	Eleele
SolarCity + Tesla Solar Project	13 MWac / 17 MWdc	Kauai	Lihue
Waimea Research Center PV Facility	250 kW	Kauai	Waimea Research Center
Wilcox Memorial Hospital Solar Photovoltaic Farm	500 kW	Kauai	Lihue
La Ola Solar Farm	1.2 MWac	Lanai	Lanai City
Aloha Solar Energy Fund I Solar Project	5 MWac / 6.2 MWdc	Oahu	Nanakuli
Dole Plantation Solar Array	500 kW	Oahu	Wahiawa
EE Waianae Solar	27.6 MWac	Oahu	Waianae
Hawaii FIT Forty, LLC	570 kWdc	Oahu	Waianae
Hawaii FIT Two	596.7 kWdc	Oahu	Waianae
Kahumana PV	245 Kw	Oahu	Waianae
Kalaeloa Renewable Energy Park	5 MW	Oahu	Kalaeloa
Kalaeloa Solar Power II	5 MW	Oahu	Kalaeloa
Kapolei Sustainable Energy Park	1 MW	Oahu	Kapolei
Pearl City Peninsula PV	1.23 MW	Oahu	Pearl Harbor
UH West Oahu Solar PV System	500 kW	Oahu	Kapolei
Waianae PV-2 Solar Farm	500 kW	Oahu	Waianae
Waihonu North Solar Farm	5 MW	Oahu	Mililani
Waihonu South Solar Farm	1.5 MW	Oahu	Mililani
Waipio Solar Facility	11 MWac / 14.3 MWdc	Oahu	Joint Base Pearl Harbor-Hickam

Source: Hawaii State Energy Office, Renewable Energy Projects Directory

Wind

Humans have been harnessing wind energy for centuries. In Hawaii, the first wind farm was built in the 1980's by Hawaiian Electric Company (HECO) in Kahuku, Oahu: a 9 megawatt (MW) wind farm that was later supplemented by a 3.2 MW wind turbine at the same location, the 360-ft. MOD-5-B, which was then the world's largest horizontal axis wind turbine. The Kahuku wind farm experienced winds that were more turbulent than expected and mechanical problems with the first-generation turbines resulted in low energy production. In the mid-1980s, Maui Electric Company (MECO) hosted a 340 kilowatt (kW) wind turbine demonstration unit for several years at its Maalaea facility and operated it until the end of its useful life .

Wind energy is Hawaii's second most utilized renewable energy resource behind distributed solar, accounting for the following in 2017 (2017 Renewable Portfolio Standard Status Reports):

- 21% of Hawaii's total renewable energy portfolio
- 5.8% of the State's overall energy use
- 2.9% of Oahu's energy use
- 21.1% of Maui's energy use
- 10.5% of Hawaii island's energy use

Kaheawa Wind Power I, 30 MW, Maui

CURRENT PRODUCTION

There are currently eight existing utility-scale wind energy projects in Hawaii located on the islands of Oahu, Maui, and Hawaii. No wind farms exist on Kauai, largely due to Kauai's protected seabird populations. In addition, other large-scale utility wind projects have been proposed or are now under development, including the 24 MW Na Pua Makani Wind Farm in Kahuku, Oahu, which could consist of up to eight to 10 new turbines. There are also numerous smaller, distributed wind turbines (up to 100 kW) currently in operation throughout Hawaii.

Project Name	Year Installed	Island	Developer	Capacity (MW)	Site Acres	Acres per MW
Hawi Renewable Development	2006	Hawaii	Hawi Renewables	10.5	250	23.8
Kaheawa I Wind Farm	2006	Maui	First Wind, SunEdison (now TerraForm Power)	30	200	6.7
Pakini Nui Wind Farm	2007	Hawaii	Tawhiri Power, Apollo Energy Corp.	20.5	67	3.3
Kahuku Wind Farm	2011	Oahu	First Wind, SunEdison (now TerraForm Power)	30	578	19.3
Kawailoa Wind Farm	2012	Oahu	First Wind, SunEdison (now D.E. Shaw)	69	650	9.4
Kaheawa II Wind Farm	2012	Maui	First Wind, SunEdison (now TerraForm Power)	21	143	6.8
Auwahi Wind	2012	Maui	Sempra Generation	21	68	3.2
Lalamilo Wind Farm	2016	Hawaii	County of Hawaii	3.3	126	38.1
Na Pua Makani	Under review	Oahu	Champlin Hawaii Wind Holdings	24	46	1.9

Source: Hawaii State Energy Office, Renewable Energy Projects Directory

Wind

WIND POTENTIAL IN HAWAII

Hawaii has one of the most robust and consistent wind regimes in the world, with capacity factors exceeding those commonly found elsewhere. In 2011, the U.S. Energy Information Administration (EIA) estimated the capacity factor of the Pakini Nui Wind Farm on the Big Island at 65%, Kaheawa Wind Power I on Maui at 47%, and the Hawi Renewables Wind Farm on the Big Island at 45%. Hawaii's strong wind regime and aggressive renewable energy goals are reflected by the amount of wind power Hawaii's electrical utilities plan to integrate into their respective grids by the year 2045. The Hawaiian Electric Companies' Power Supply Improvement Plan (PSIP) Update Report: December 2016 plans for up to an additional 64 megawatts (MW) of onshore wind on Oahu by the year 2045, and up to 200 to 800 MW of offshore wind of Oahu by 2045. The Hawaiian Electric Companies plan for between 42 MW to 150 MW of new onshore wind on Maui by 2045, up to 5 MW of new wind on Molokai by 2020, and up to 102 MW of additional wind on Hawaii Island. The current plan estimates this amount of wind, in combination of many other types of renewable energy, could be needed to get Hawaii to 100% renewable energy by the year 2045. This plan is subject to stakeholder review and approval by the Hawaii Public Utilities Commission and does not guarantee any of the proposed MW will be installed, but they do provide options for planning consideration.

CHALLENGES FACING WIND ENERGY DEVELOPMENT IN HAWAII

- The presence of protected or endangered birds or bats, plant species, or critical habitats in or around the project site will significantly impact the siting, development, and operation of wind projects in Hawaii. Significant ecological monitoring is required early in the project siting phase. The appropriate regulation of certain species with less available data, such as the Hawaiian Hoary Bat, is evolving as regulators and wind developers continue to better understand the species and the measures available to limit their harm. Completed and upcoming research on the Hawaiian Hoary Bat by the Hawaii Department of Land and Natural Resources and the U.S. Geological Survey will help inform all stakeholders. The increased level of ecological monitoring required for proposed and existing wind farms in Hawaii has also expanded the amount of information available on the impacted species and habitats.

- Given the size of large-scale wind turbines and limited sites suitable for wind development in Hawaii, visual and cultural impacts must be thoroughly identified and assessed early in the project siting phase. Developers ought to work closely with local communities early in the process to identify important community resources and values, which are core to the appropriateness of project siting. View planes are valued by local residents and the tourism industry, and are valued by Native Hawaiian religion practitioners to communicate between sites of cultural significance. Developers must account for day and night visuals, including warning lights required for aviation safety.
- Hawaii topography and infrastructure can make on-land transport of large wind equipment difficult in certain areas. Roadwork may be required in some cases, as well as roadway shutdowns and other approvals. Temporary storage of large equipment can also be challenging.
- The intermittent nature of Hawaii's wind resource can make integration into the electrical grid a challenge. Mitigation measures, such as forecasting, controls, and improved communication technologies can help mitigate some of these concerns. Storage technologies are also being deployed with increased regulatory to help integrate wind power more smoothly into the electrical grid.

Wind

OFFSHORE WIND

In response to an invitation from then-Gov. Neil Abercrombie, the Bureau of Ocean Energy Management (BOEM), in 2011-2012, established the BOEM/Hawaii Intergovernmental Renewable Energy Task Force to promote planning and coordination, and to facilitate effective and efficient review of requests for commercial and research seafloor leases and right-of-way grants for power cables on the federal outer continental shelf (OCS), which begins three nautical miles offshore Hawaii. Members of the Task Force, whose meetings and matters are open to the public, include representatives of federal, state, and local government agencies.

Attention to offshore wind in Hawaii has increased following notice of multiple unsolicited applications received by BOEM for seafloor lease applications for wind farms off-shore of Oahu; currently, still undergoing BOEM review. Multiple public meetings were conducted in 2016, with community members and other stakeholders voicing concerns, recommendations, and other opinions about the prospect of wind turbines off of Oahu's South and Northwest shores. In its last update, BOEM notified its Hawaii Task Members it is still working to determine whether an area offshore Oahu is suitable for commercial wind leasing. BOEM's determination is still pending.

Renewable Energy Resources

RENEWABLE ENERGY PROJECTS DIRECTORY

The Renewable Energy Projects Directory is an interactive map of existing and proposed renewable energy projects statewide, showcasing the variety of renewable energy resources that are moving the state closer to reaching energy independence. The Directory also serves to inform all stakeholders of planned and existing renewable energy projects of interest.
>> http://energy.ehawaii.gov/epd/public/energy-projects-map.html

PERMITTING

Permitting any large project in Hawaii, including a utility-scale renewable energy project, requires a thorough understanding of local processes, issues, and stakeholders. The development of numerous large-scale renewable energy projects over the last ten years has provided community members, regulators, and developers a more informed opinion of future projects in terms of potential benefits and impacts. With some of the more desirable locations now developed or otherwise not available, appropriate project siting and regulation will remain a challenge moving forward.

Some strategies to support the siting and permitting of renewable energy projects in Hawaii:

- Know the requirements and processes - retain professionals with experience in Hawaii.
- Review past studies/permits (EIS) for the site - where available, lessons learned from earlier efforts can provide a wealth of information.
- Meaningful community participation - engage public early in the project siting and design process.
- Identify the appropriate community contacts - seek out community members with knowledge of the area.
- Engage all stakeholders - identify and address all stakeholders and issues early in the process.
- Site projects appropriately - seek compatible areas to minimize environmental impacts.
- Be diligent - go slow in the beginning to go fast in the end.
- One submittal/one review - present agencies with well-planned projects, complete applications.
- Electronic permit processing - saves time, reduces back and forth, transparency, tracking.

The tools described below provide information on these topics, as well as guidance to assist appropriate project siting and due diligence. These tools also seek to lower project "soft" costs by reducing the resources needed to undergo the permitting processes without removing any of the environmental or community safeguard processes in place. Many local federal, state, and county agencies contributed to the development to these tools.

DEVELOPER & INVESTOR CENTER, SELF-HELP SUITE (HAWAII STATE ENERGY OFFICE)

The Hawaii State Energy Office's interactive *Developer & Investor Center* and *Self-Help Suite* provide comprehensive information on the siting, permitting, and development of renewable energy facilities in Hawaii. The Energy Office aims to regularly update these resources as requirements, policies, and procedures change. The Center focuses on permitting assistance through its *Project Permitting Assistance and Resources* website, which also provides a permit Guidebook and individual briefs on numerous county, state, and federal permit processes.
>> http://energy.hawaii.gov/developer-investor

In addition to these resources, the Center provides lists of environmental consultants familiar with planning and permitting in Hawaii. While not exhaustive, this list identifies numerous firms with experience permitting and siting renewable energy projects in Hawaii.
>> http://energy.hawaii.gov/developer-investor/project-permitting-assistance-and-resources

RENEWABLE ENERGY PERMITTING WIZARD (HAWAII STATE ENERGY OFFICE)

The *Permitting Wizard* was developed to help those proposing renewable energy projects understand the county, state, and federal permits that may be required for their individual projects. After answering a series of questions about their proposed project, a Permit Plan for the project is produced, identifying the permits required, prerequisites approvals and recommended sequencing, and estimated time of issuance. Software upgrades and content updates to the Wizard were last completed by the Hawaii State Energy Office in 2015, however, the Energy Office seeks to update the Wizard content periodically.
>> http://wizard.hawaiicleanenergyinitiative.org/

Renewable Energy Resources

RENEWABLE ENERGIS MAPPING TOOL (HAWAII STATE ENERGY OFFICE, OFFICE OF PLANNING)

Renewable EnerGIS provides renewable energy resource and site information for specific Hawaii locations selected by the user. *EnerGIS* helps users understand the renewable energy potential and permitting requirements for specific selected sites.
>> http://energy.hawaii.gov/resources/renewable-energis-map

HAWAII CLEAN ENERGY PROGRAMMATIC ENVIRONMENTAL IMPACT STATEMENT (U.S. DEPARTMENT OF ENERGY)

In September 2015, the U.S. Department of Energy (USDOE) published the *Hawaii Clean Energy Final Programmatic Environmental Impact Statement* which assesses common impacts and best management practices associated with 31 clean energy technologies.
>> http://energy.hawaii.gov/testbeds-initiatives/hawaii-clean-energy-peis/peis-overview

ELECTRONIC PERMITTING

Electronic permitting is another effective method of streamlining the permit review process without removing any of the environmental or community safeguards in place. Some examples of state and county agencies in Hawaii utilizing electronic permitting include:

E-PERMITTING PORTAL (HAWAII DEPARTMENT OF HEALTH - DOH)

The DOH Environmental Health Administration (EHA) e-Permitting Portal provides access to environmental permit applications. e-Permitting allows for efficient and accurate electronic application compilation and submission, tracking, processing, management, and fee payment.
>> https://eha-cloud.doh.hawaii.gov/epermit/

ONLINE BUILDING PERMITS (CITY AND COUNTY OF HONOLULU - CCH)

Oahu's Department of Planning and Permitting website provides for the electronic submission and processing of building permits required for residential solar heating, photovoltaic, and electric vehicle charger installations in the City and County of Honolulu. Building Permit status can also be monitored online.
>> http://www.honoluludpp.org

ELECTRONIC PLAN REVIEW (EPLAN) AND BUILDING PERMIT STATUS (COUNTY OF KAUAI)

Kauai's Department of Public Works, Building Division, offers online tools to submit building permits electronically (Electronic Plan Review or "ePlan") and get information on Building Permit status, details, and other relevant information.
>> http://www.kauai.gov/EPR

ONLINE PERMITTING (DEPARTMENT OF LAND AND NATURAL RESOURCES - DLNR)

In late 2016, DLNR launched new electronic permit and asset management tools for DLNR's Engineering Division and Division of Forestry and Wildlife, Native Invertebrates Program. These resources are designed to support the electronic submission, processing, and issuance of select DLNR permits.
>> https://inforps-dp.hawaii.gov/DLNRInvPermitting/#/login
>> https://inforps-dp.hawaii.gov/IPSDynamicPortal-DLNRENG/Views/Login.aspx

Energy Systems and Planning

Planning for a 100 percent clean energy future in the electricity sector involves studying and analyzing the needs and technological developments that will be necessary to fully complete the transition. Balancing electricity demand and available generation becomes increasingly challenging as intermittent renewable energy in the energy resource mix grows. At higher levels of renewable energy penetration, solutions will need to be found to ensure reliability and resilience at a reasonable cost. Smart grids, electric vehicles, demand response, energy storage, and rapidly evolving technologies all represent possible contributions to tackling the challenges ahead that should be thoroughly examined and planned for on the path to independence from imported fossil fuels.

Renewable Portfolio Standards (RPS) milestones[10]

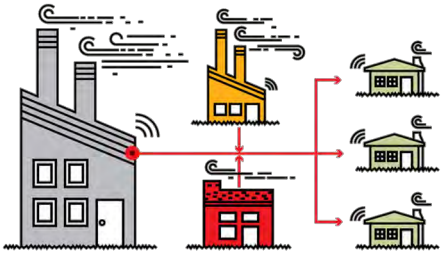
12/31/2020	**30%**	12/31/2030	**40%**
12/31/2040	**70%**	12/31/2045	**100%**

Smart Grid

WHAT IS SMART GRID[11]

The electric "grid" is a network of transmission and distribution lines, substations, transformers and more that deliver electricity from power plants to homes and businesses. It's what electric lights and appliances are plugged into. A "smart grid" is one that has more automatic sensors, controls, energy storage, and intelligent systems to better manage the complexity of constantly fluctuating demand and production of electricity efficiently and cost-effectively. Some common "smart grid" components are:

- Smart ("Advanced") Metering Infrastructure
  - Provide timely and detailed energy use information for customers
  - Allow for time variant rates
- DERMS (Distributed Energy Resource Management Systems)
  - Monitor conditions in real time
  - Improved forecasting of intermittent resources
  - Increased control and integration of Distributed Energy Resources
- Energy Storage (batteries, capacitors, flywheels, pumped hydro, hydrogen)
  - Supports increased renewable energy penetration
  - Stabilize the grid by conditioning power and smoothing fluctuations
- Demand Response (managing electricity use in response to available supply)
- U.S. Department of Energy gave $3.4 billion in grants for smart grid projects and grid upgrades in recent years[12]



POTENTIAL MARKET IN HAWAII

- Residential and commercial building energy management systems may become even more effective when connected to a utility-wide smart grid.
- Over 500,000 housing units and condos,[13] and tens of thousands of commercial and government buildings statewide, can take advantage of smart grid technologies.

On March 31, 2016, the Hawaiian Electric Companies filed an application with the Public Utilities Commission (Docket No. 2016-0087) requesting approval to commit funds and recover costs for a Smart Grid Foundation (SGF) Project. The purpose of the SGF Project is to implement the initial Smart Grid capabilities that will serve as the platform to support not only immediate customer benefits, but also as the cornerstone for additional projects that can expand customer options, such as optimizing the integration of distributed energy resources ("DER"), implementing demand response ("DR"), time-of-use ("TOU") rates and real-time-pricing ("RTP"), and increasing reliability through distribution automation ("DA").[14] The SGF project concluded with PUC order 34281, which dismissed the application and directed the HECO companies to submit a detailed, scenario-based grid modernization strategy for each utility.

As updated in PUC order 34436, a draft was submitted for stakeholder review and comment by June 30, 2017 and on August 29, 2017, a final grid modernization strategy was submitted. Through order 35268 the PUC directed the Companies to implement the strategy, subject to the directives, conditions, and guidance contained in the order and closed the docket.

Clean Transportation

Hawaii's transformation to a clean energy economy requires the integration of transportation. In tackling transportation HSEO has a near-term focus in ground transportation and maintains a long-term perspective that includes alternatives fuels and efficiency in aviation and marine transportation. To reduce Hawaii's consumption of petroleum within the ground transportation sector, HSEO is looking at plug-in electric vehicles (EV) as well as other alternative transportation solutions to address the challenges of modernizing our energy system and building a clean transportation future.

Performance metrics are an important means of quantitatively evaluating progress and specifically, the advancement of clean transportation strategies and policies. As HSEO continues to expand its assessment of clean transportation in Hawaii, it will incorporate additional clean transportation facts and figures.

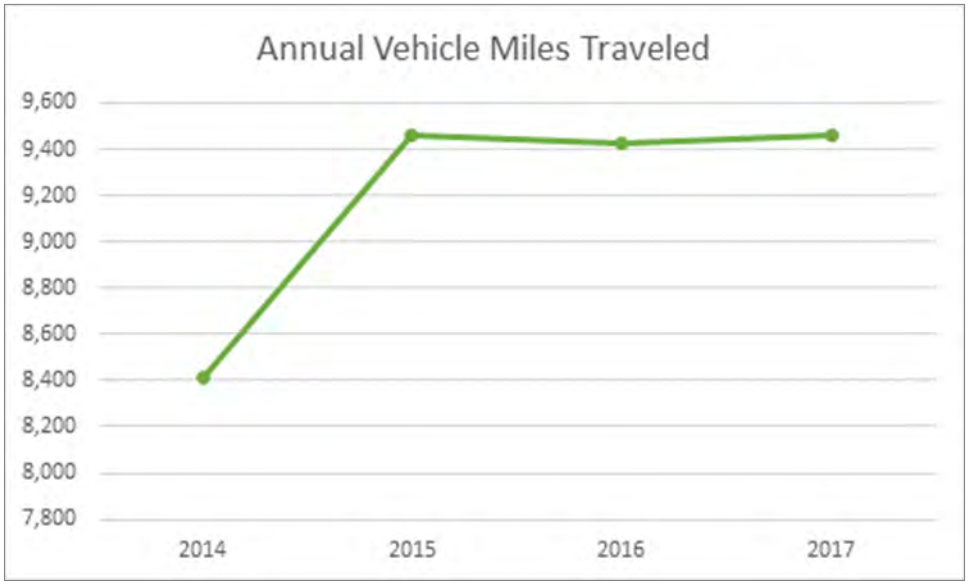
HAWAII'S CLEAN TRANSPORTATION LAWS AND PROCLAMATIONS

Hawaii's clean transportation policies are now at the forefront of the legislative agenda in Hawaii.

- HRS §226-18(a)(2) - Hawaii State Planning Act; Objectives and policies for facility systems – energy. Increased energy security and self-sufficiency through the reduction and ultimate elimination of Hawaii's dependence on imported fuels for electrical generation and ground transportation;
- HRS §103D-412 - Hawaii's vehicle procurement guidelines require State and County agencies to follow a hierarchy when leasing or purchasing light-duty motor vehicles that are not covered by federal procurement rules: (1) EV or PHEV; (2) Hydrogen FCEV; (3) Alternative fuel vehicle; (4) Hybrid; (5) Fuel economy leader
- HRS §225P-3 - Hawaii climate change mitigation and adaptation commission; general functions, duties, and powers aligning Hawaii with the goals of the Paris Agreement.
- City and County of Honolulu, Maui County, Hawaii County, and Kauai County committed to eliminate fossil fuels use within ground transportation by 2045 – mirroring the 100% RPS time frame for the electric sector. Notably the City and County of Honolulu, Maui County and Kauai County pledged to lead the way by transitioning all of their fleet vehicles to 100% clean energy by 2035.

VEHICLE MILES TRAVELED

The graph below reflects Hawaii's average annual vehicle miles traveled per registered vehicle[15]:



Clean Transportation

Hawaii 2016 Travel to Work US Census Bureau's American Community Survey[16]		
Title	**Percentage**	**Hawaii National Rank**
Mean travel time to work of workers 16 years and over who did not work at home (minutes)	27.7	11
Percent of workers 16 years and over who traveled to work by car, truck, or van – drove alone	66.9	49
Percent of workers 16 years and over who traveled to work by car, truck, or van – carpooled	13.6	1
Percent of workers 16 years and over who traveled to work by public transportation	6.7	7

County Transit Ridership

County	2017 County Transit Passenger Ridership
City & County Honolulu	66,857,810
Maui	1,879,072
Kauai	710,129
Hawaii	766,472

BICYCLING

Bicycling significantly reduces transportation emissions while also reducing traffic. Alternative forms of transportation such as bicycling is a means by which to decarbonize the transportation sector by reducing demand for energy as opposed to shifting transportation energy demand to a renewable fuel source such as biofuels or renewable electricity.

Bicycle Transit System

Biki is Honolulu's bicycle transit system launched by Bikeshare Hawaii in June 2017. Bikeshare Hawaii benefits Hawaii residents and visitors by providing a low-cost, convenient, zero emissions transportation option that is healthy for users, the community, and the environment.[17] Biki currently has 1,000 bikes, 100 self-service "Biki Stops" from Chinatown to Diamond Head, roughly 6,000 Biki members, and averaging 66,000 rides per month.

Clean Transportation

Bicycle Lanes and Laws

County	Miles of Bike Lanes[18] (including protected bike lanes, bike paths, bike routes, and shared roads)	Bike Laws
Oahu	147 Miles	A comprehensive list of City & County of Honolulu bicycle regulations can be found here: https://www.hbl.org/bikelaws/
Maui	60.4 miles	A comprehensive list of Maui county bicycle regulations can be found here: https://www.mauibike.org/hawaii-bicycle-laws/
Hawaii	27.4 miles	A comprehensive list of County of Hawaii bicycle regulations can be found here: https://hilo.hawaii.edu/campusinfo/BikeGuidelines.php
Kauai	31.7 miles	

Electric Vehicles

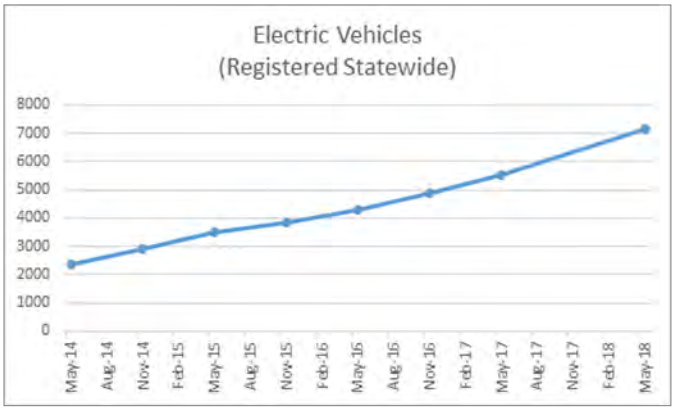
An EV uses electricity in place of gasoline, reducing the need for petroleum-based fuel as the electric sector continues on the path towards 100% RPS. Since EVs can use electricity produced from renewable resources available in Hawaii (i.e. sun, wind, hydropower, ocean energy, geothermal energy), the transition from gasoline fueled vehicles to EVs supports Hawaii's energy independence goals.

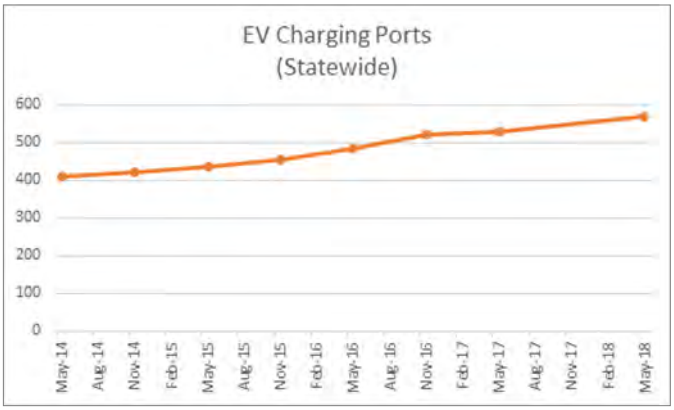
Based on statewide averages, the amount of fossil fuel used to power an electric vehicle in Hawaii is 34%-40% less than the fossil fuel required to power a similar gasoline-fueled vehicle.[19] This is expected to improve as renewable energy increases in Hawaii.

Registered EVs[20] and Public Charging Stations[21] in Hawaii

County	Electric Vehicles	Level 2[22] Charging Station Ports	Level 3[23] Charging Station Ports	Total Ports
Oahu	5,582	334	12	346
Maui	875	80	45	125
Molokai	26	0	0	0
Lanai	39	2	0	2
Hawaii	366	53	5	58
Kauai	246	38	1	39
Total statewide	**7,134**	**507**	**63**	**570**

EV Trends in Hawaii 2014-2018





EVs have seen a 200% increase since May 2014 and EV charging infrastructure has increased by 38.7%.

Fuel Cost Comparison

Vehicle	2018 Nissan Versa	2018 Honda Civic	2018 Nissan LEAF[24]	
Fuel Type	**Gasoline**	**Gasoline**	**Electricity**	
Miles Per Gallon (MPG)	35 mpg combined 378 miles total range	37 mpg combined 458.8 miles total range	112 combined MPG 151 miles total range	
Fuel Costs	$3.56/gallon	$3.56/gallon	Residential Electricity Rate: $0.31/kWh [25]	Schedule TOU-RI for mid-day EV Charging: $ 0.128/kWh[26]
Fuel Cost per Year[27]	$962.73	$910.69	$776.23	$320.51

Fuel cost comparisons show approximate savings between internal combustion engine and electric vehicles. The example above shows that fuel costs are lower for the Nissan LEAF than for a comparable gasoline fueled vehicle.

Electric Vehicles

HAWAII'S ELECTRIC VEHICLE LAWS AND INCENTIVES

· Free parking is provided in state and county government lots, facilities, and at parking meters.
· Vehicles with EV license plates are exempt from High Occupancy Vehicle lane restrictions.
· Parking lots with at least 100 public parking spaces are required to have at least one parking space, equipped with an EV charging system, reserved exclusively for EVs.
· Non-EVs parked in a space designated and marked as reserved for EVs shall be fined not less than $50 nor more than $100.
· Hawaiian Electric Co. offer EV Time of Use Rates designed to incentivize customers, through lower rates, to charge their EVs during off-peak times of day.
· Multi-family residential dwellings or townhomes cannot prohibit the placement or use of EV charging systems altogether.

For more information about state and federal laws and incentives, visit energy.hawaii.gov/testbeds-initiatives/ev-ready-program/laws-incentives.

EV QUICK FACTS

Hawaii ranks fourth in the nation behind California, Washington and Oregon of total EV sales.	One percentage of total state sales[28]
In 2016, Hawaii had the second highest concentration of EVs in the nation.	Hawaii had nearly four EVs per 1,000 people followed by Washington and Oregon with about three EVs per 1,000 people. California had the highest concentration of EVs with 6.65 PEVs per 1,000 people.[29]
Cost for a government or commercial property owner to install a Level 2 charging station.	Approximately $4,000-$8,000 per station. A relatively simple project in Hawaii can range from $4,000 to $25,000 to $100,000; however, prices vary considerably.[30]

EV STATIONS HAWAII

The Hawaii State Energy Office developed a mobile app designed to help drivers locate publicly available EV charging stations statewide. EV Stations Hawaii helps drivers pinpoint charging stations as well as provide detailed information of the station giving them the confidence that they can recharge while on the road. The free app is available for Apple and Android smartphones and mobile devices.

energy.hawaii.gov/testbeds-initiatives/ev-ready-program/ev-stations-hawaii-mobile-app

Endnotes

[1] U.S. Energy Information Administration, "1990-2015 Net Generation by State by Type of Producer by Energy Source (EIA-906, EIA-920, EIA-923)", http://www.eia.gov/electricity/data/state/
[2] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends/
[3] Volumes. Source: Energy Information Administration, State Energy Data System
[4] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/
[5]DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2
[6] 1 barrel = 42 U.S. gallons
[7] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/
[8] Electricity: http://www.eia.gov/state/rankings/#/series/31 (last accessed 5/17/17); natural gas: http://www.eia.gov/state/rankings/#/series/28 (last accessed 5/17/17)
[9] DBEDT's Monthly Energy Trends, http://dbedt.hawaii.gov/economic/data_reports/energy-trends-2/
[10] Chapter 269-91 et. seq., Hawaii Revised Statutes. http://www.capitol.hawaii.gov/hrscurrent/Vol05_Ch0261-0319/HRS0269/HRS_0269-0092.htm
[11] SmartGrid.gov: http://www.smartgrid.gov/the_smart_grid
[12] RECOVERY ACT: SMART GRID DEMONSTRATION PROGRAM (SGDP):https://energy.gov/oe/information-center/recovery-act-smart-grid-demonstration-program-sgdp
[13] Hawaii Data Book: http://files.hawaii.gov/dbedt/economic/databook/db2015/section01.pdf
[14] Hawaiian Electric Companies. Docket No. 2016-0087, Approval for Smart Grid Foundation Project. March 31, 2016
[15] http://dbedt.hawaii.gov/economic/databook/2016-individual/_18/
[16] http://census.hawaii.gov/acs/acs-2016/; http://files.hawaii.gov/dbedt/census/acs/ACS2016/ACS2016_1_Year/state_rank/2016_acs_1yr_sumranktab_final.pdf
[17] https://gobiki.org/about-us/
[18] https://www.honolulu.gov/bicycle
http://hidot.hawaii.gov/highways/files/2013/02/Bike-Plan-appendixc.pdf
https://www.kauai.gov/Portals/0/PW_Bldg/BikePathProject/Articles/Bike_path_overview.pdf?ver=2015-04-20-160259-343
[19] Level 3, also known as "fast charging," can provide an 80% charge for some vehicles in less than 30 minutes, depending on vehicle and charger specifications. Not all vehicles can use fast charging
[20] EV figures updated DBEDT monthly energy trends (May 2018) http://dbedt.hawaii.gov/economic/energy-trends-2/
[21] EV Stations Hawaii app (http://energy.hawaii.gov/testbeds-initiatives/ev-ready-program/ev-stations-hawaii-mobile-app)
[22] Level 2 charging is at 240 volts. All electric vehicles are equipped for this type of charging. A "charger" can have one or more ports. The number of "ports" determines how many vehicles each charger can service at a time. One "port" can service one vehicle
[23] Level 3, also known as "fast charging," can provide an 80% charge for some vehicles in less than 30 minutes, depending on vehicle and charger specifications. Not all vehicles can use fast charging
[24] Fuel cost comparisons show approximate savings between internal combustion engine and electric vehicles. The example shows that fuel costs are lower for the Nissan Leaf than for a comparable gasoline fueled vehicle. 2018 Nissan Leaf: 40 kWh battery; 3.78 kWh per mile
[25] Electricity rate based on Schedule R - Residential Service rate for Dec. 2017 was 31.03 cents. Source: Monthly Energy Trend, READ, DBEDT http://files.hawaii.gov/dbedt/economic/data_reports/energy-trends/Energy_Trend.pdf
[26] Electricity rate based on Schedule TOU-RI Mid-Peak or Midday Rate (Residential Rate - $0.12). Source: HECO Website: https://www.hawaiianelectric.com/Documents/my_account/rates/hawaiian_electric_rates/heco_rates_tou_ri.pdf
[27] Based on fuel prices and 9,465 annual miles per year from Hawaii State Data Book. http://dbedt.hawaii.gov/economic/databook/. Figure does not include operations and maintenance costs, which are generally shown to be lower for electric vehicle ownership
[28] https://autoalliance.org/economy/consumer-choice/electric-vehicles/HI/
Additional information is also available at: https://autoalliance.org/energy-environment/advanced-technology-vehicle-sales-dashboard/
[29] https://www.energy.gov/eere/vehicles/articles/fotw-1004-november-20-2017-california-had-highest-concentration-plug-vehicles
[30] Hawaii State Energy Office, Report to the Maui Electric Vehicle Alliance Driving EVs Forward: A Case Study of the Market Introduction and Deployment of the EV in Hawaii (PDF) http://energy.hawaii.gov/wp-content/uploads/2011/10/ReportMauiElectricVehicleAlliance_12_20_12.pdf