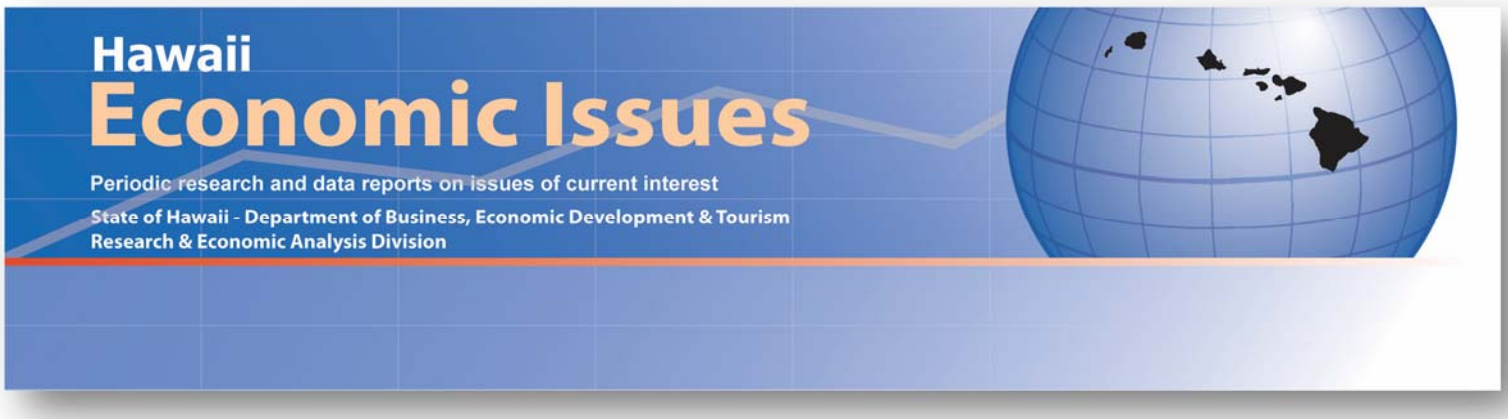

Hawaii's Electricity Industry: 2016 Analysis and Recent Trends

December 2017

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Executive Summary

This report analyzes the generation, consumption, and cost of Hawaii's electricity using data from the U.S. Energy Information Administration (EIA) and the monthly financial reports (MFR) of Hawaii's electric utilities. The following is a summary of the results and trends identified in this report:

- The importance of Hawaii's non-utility electricity producers has increased over time. The utility companies (HECO, MECO, HELCO, and KIUC) generated 50.7 percent of the total electricity generated by the electric power industry (excluding customer generated electricity) in 2016 and purchased the remainder from IPPs and CHPs. This was a 31.7 percentage point decrease from 1990, when utilities generated 82.4 percent of the total electricity sold in Hawaii. This has also contributed to the increase in the share of electricity generation from renewable sources, because non-utility producers in Hawaii use more renewable energy and less petroleum.
- The gross generation of electricity (including customer generated electricity) in Hawaii was estimated to be about 11,138 GWH in 2016. Of this, 49.8 percent was generated by the utilities, 42.8 percent by the non-utility producers, and 7.4 percent by the customers. Station use accounted for about 5.0 percent of gross generation. Utility loss accounted for about 4.2 percent of gross generation. The 10,111 GWH net consumption includes 827 GWH generated by customers and 9,284 GWH utility electricity sales.
- In 2016, gross generation in Hawaii was almost unchanged. Decreased utility generation was offset by increased generation of customers and non-utility producers. Net electricity consumption increased 41 GWH, mainly due to reduced utility loss. The increase in net consumption was mainly the 145 GWH increase in customer generated electricity; the electricity sold by utilities decreased 104 GWH.
- From 2005 to 2016, gross generation in Hawaii increased 620 GWH; utility gross generation decreased 1,765 GWH; gross generation of non-utility producers increased 320 GWH, and electricity generated by customers increased 824 GWH. Since the decrease of utility net generation was more than the increase in purchased electricity and customer generated electricity, gross consumption decreased 551 GWH. Reduced utility loss led to a smaller reduction of net consumption. However, since customer generated electricity increased 824 GWH over this period, electricity sold by utilities decreased 1,254 GWH.

- Hawaii's dependence on petroleum for electricity generation has decreased over time. According to the data from EIA, about 66.6 percent of the electricity generated by the electric power industry was generated from petroleum fuel in 2016, and this represented a 23.4 percentage point decrease from the 1990 figure of 90.0 percent. In 2016, electricity generated from renewable sources accounted for 17.3 percent of the total electricity sold by the utilities.
- Most of the non-petroleum generated electricity was produced by non-utility producers. From 1990 to 2016, the petroleum generated electricity share of total utility generated electricity decreased only slightly from 99.6 percent to 97.8 percent; the petroleum generated electricity share of non-utility generated electricity decreased from 45.0 percent to 34.5 percent; the share of coal generated electricity increased from 0.1 percent to 32.1 percent; the share of wind generated electricity increased from 1.7 percent to 13.6 percent; the share of geothermal electricity increased from 0.0 to 5.5 percent; and the share of biomass decreased from 48.9 percent to 6.0 percent.
- In 2016, total operating expense of the utilities in Hawaii decreased by $245 million, about 88.2 percent or $216 million of the decrease was due to the reduced fuel cost, about 7.1 percent or $17 million was due to the reduced purchased power cost, and about 6.1 percent or $15 million was due to reduced taxes. The utility O&M, transmission and distribution, customer cost, and administration and general cost change was very small.
- Due to petroleum price increases from 2005 to 2012, utilities fuel cost reached a peak of $1,391 million and purchased electricity also increased to $732 million in 2012. From 2012 to 2016, fuel cost decreased substantially, and purchased electricity cost also decreased. Over this period, total operating expense of the utilities in Hawaii decreased $1,072 million, about 84.2 percent or $902 million of the decrease was due to the reduced fuel cost, about 13.2 percent or $141 million was due to the reduced purchased power cost, and about 7.3 percent or $78 million was due to reduced taxes.
- In spite of a significant price decrease in 2016, the quantity of electricity sold in Hawaii decreased only slightly. Decreased utility electricity sales was less than the increased generation of customer-sited electricity, suggesting that Hawaii's electricity demand is inelastic with respect to price. Total electricity sold by Hawaii's utilities decreased 1.1 percent or 104 GWH from 9,389 GWH in 2015 to 9,284 GWH in 2016. Total generation of the customer-sited electricity increased 145 GWH in 2016.

- The average price of electricity in 2016 was 24.0 cents/KWH statewide. Kauai consumers paid the highest electricity rate at 32.6 cents/KWH, followed by Big Island consumers at 29.0 cents/KWH, Maui consumers at 27.4 cents/KWH, and Oahu consumers at 22.0 cents/KWH.
- Before 2015, the average purchased power cost was below the average utility fuel cost in most of the years. Since 2015, average purchased power cost was above the average utility fuel cost. In 2016, the ratio of average purchased power cost to average utility fuel cost increased to 140 percent. The purchased electricity was cheapest at HECO (12.4 cents/kWh), followed by HELCO (14.0 cents/kWh), MECO (17.3 cents/kWh), and KIUC (17.7 cents/kWh).
- Hawaii's residential electricity consumption decreased more than the other sectors. From 2005 to 2016, electricity sold to the residential sector decreased 667 GWH or 2.1 percent per year. Over the same period, electricity sold to the commercial sector decreased 392 GWH or 1.1 percent per year, and electricity sold to the industrial sector decreased only 195 GWH or 0.5 percent per year. In 2016, 40.0 percent of the electricity was consumed by the industrial sector, 33.1 percent by the commercial sector, and 26.9 percent by the residential sector.
- Total electricity demand in Hawaii was an estimated 12,951 GWH in 2016. Of this amount, 2,640 GWH or 20.4 percent was from customer rooftop photovoltaic systems, solar water heating (SWH), and demand-side-management (DSM) such as using energy star appliances. Total electricity generated by utilities, independent power producers (IPP), and combined heat and power (CHP) firms totaled 10,311 GWH.
- From 2005 to 2016, total electricity demand in Hawaii increased an average 0.5 percent per year, from 12,280 GWH to 12,951 GWH. Electricity generation by the electric power industry decreased 1.2 percent per year from 11,755 GWH to 10,311 GWH, electricity generated by user owned PV systems increased 69.9 percent per year from 2 GWH to 827 GWH; electricity replaced by SWH increased 7.4 percent per year from 84 GWH to 184 GWH; and electricity replaced by DSM programs increased 15.8 percent per year from 439 GWH to 1,629 GWH.

1. Introduction

Electricity plays an important role in Hawaii's economy. Hawaii's total expenditures on utility sold electricity reached a peak of about $3.3 billion in 2012 due to the state's heavy reliance on imported petroleum and the rapid increase in petroleum prices until 2012. From 2005 to 2012, total expenditures on utility sold electricity in Hawaii increased from $1.9 billion to $3.3 billion, an average annual increase of 7.9 percent. It is important to note that this increase was much higher than the 3.4 percent Honolulu CPI-U increase during the same period, which indicates that energy expenditure growth outpaced inflation during this period. Since 2012, total expenditures on utility sold electricity decreased due to decreased petroleum prices and increase generation of customer-sited solar electricity. In 2016, total expenditures on utility sold electricity decreased $244.0 million or 10.7 percent. The total fuel and purchased power cost of Hawaii's utilities decreased $233.7 million or 17.8 percent, and the average revenue per kWh of electricity sold decreased 8.8 percent in 2016.

In 2013, the Research and Economic Analysis Division of DBEDT conducted a study to examine Hawaii's electric power industry based on data up to 2012. As a fourth follow up to the 2013 study, this study intends to answer the following research questions:

- Who produces electricity in Hawaii?
- What type of fuels are used to generate electricity in Hawaii?
- What are the main factors that affect electricity prices in Hawaii?
- How have the factors affecting electricity prices changed over time?
- What role does renewable energy play in electricity generation?
- What factors impact the production cost of electricity?
- Who consumes electricity in Hawaii?
- What are the recent trends in electricity consumption by types of consumers?
- What is the performance of the electricity industry in 2016?

The data provided in this report were primarily from two major sources. The first source was publicly available state level energy data from the U.S. Energy Information Administration (EIA); the second source of data was each respective Hawaii electric utility's Monthly Financial Reports (MFR). The MFR data provided both annual and monthly data by county utility.

2. Electricity Generation by Producers

Electricity consumed in Hawaii is mainly sold by the four electric utility companies: Hawaiian Electric Company (HECO), serving the island of Oahu; Maui Electric Company (MECO), serving the islands of Maui, Lanai, and Molokai; Hawaii Electric Light Company (HELCO), serving the island of Hawaii; and Kauai Island Utility Cooperative (KIUC), serving the island of Kauai. MECO and HELCO are whole owned subsidiaries of HECO, which is in turn a wholly owned subsidiary of Hawaii Electric Industries, Inc.

Electricity consumed in Hawaii is generated mainly by the electric utilities and non-utility electricity producers. Non-utility producers include independent power producers (IPP), combined heat and power (CHP)-Electric Power, CHP-Industrial Power, and CHP-Commercial Power. Over time, the share of electricity generated by the utilities decreased. As shown in Table 1, from 1990 to 2016, the electric utilities' share of total electricity generation (excluding customer-sited systems) decreased from 82.4 percent to 50.7 percent. Electricity generated by utilities and the four types of non-utility producers are defined as the electricity generated by the electric power industry in the EIA data.

In addition to the electricity generated by the electric power industry, some consumers also generated electricity, such as electricity generated from the photovoltaic (PV) systems owned by residential or commercial users. Electricity generated by consumers and directly used without being sold to the utility systems is not included in the total generation and consumption data.

Electricity generation data provided by the EIA and the utility MFR are not exactly comparable. According to the MFR, electricity sold by the four utilities includes net generation of the utilities and purchased electricity minus electricity lost in the utility systems (including a small portion of electricity used but not paid for by electricity users). The net electricity generation of the utilities is the total electricity generated minus the total usage by the utility owned power stations. The purchased electricity is the total generation of non-utility producers minus their station use. Since the usage data of non-utility producers is not available, total generation by the non-utility producers is also not available. In 2015, total utility generation (including station use) and purchased electricity in Hawaii was 10,201 GWH based on the utility MFR, slightly higher than the total electricity generation from the EIA data (10,120 GWH). It appears that the station use of non-utility producers is not included in the total electricity generation data provided by EIA.

Table 1. Total Electricity Generation by Producer

Year	State Total Generation 1/ GWh	% of Total Generation Units: %				
				CHP		
		Utility	IPP	Electric	Industry	Commercial
1990	9,703	82.4	4.0	5.6	8.0	-
1991	8,703	84.3	4.3	1.7	9.7	-
1992	9,844	69.7	4.1	17.9	8.3	-
1993	9,944	61.2	5.2	26.0	7.7	-
1994	10,109	59.9	6.2	26.8	7.1	-
1995	10,304	60.1	6.2	27.3	6.4	-
1996	10,628	60.4	5.7	27.6	6.3	-
1997	10,312	60.2	6.4	27.8	5.6	-
1998	10,228	61.6	6.3	27.3	4.8	-
1999	10,404	62.0	5.8	26.7	5.4	-
2000	10,593	61.7	6.2	27.0	5.1	-
2001	10,633	60.0	4.9	30.3	4.7	-
2002	11,663	64.4	3.4	28.2	4.0	-
2003	10,976	59.2	5.0	33.2	2.7	-
2004	11,410	61.2	2.3	31.3	2.3	2.9
2005	11,523	60.0	2.4	32.7	2.3	2.5
2006	11,559	60.9	3.0	30.9	2.3	2.9
2007	11,533	60.1	4.4	30.6	2.3	2.6
2008	11,376	58.9	7.9	28.0	2.2	2.9
2009	11,011	59.1	7.3	28.4	2.3	2.9
2010	10,836	59.2	7.0	27.2	3.7	2.9
2011	10,723	59.5	7.5	26.4	3.7	3.0
2012	10,469	57.4	8.6	27.0	4.1	2.9
2013	10,267	56.0	9.6	27.2	3.8	3.5
2014	10,204	54.1	10.4	27.4	4.4	3.7
2015	10,120	54.3	11.2	26.6	4.2	3.7
2016*	9,607	50.7	11.4	29.2	4.4	4.2

* Preliminary

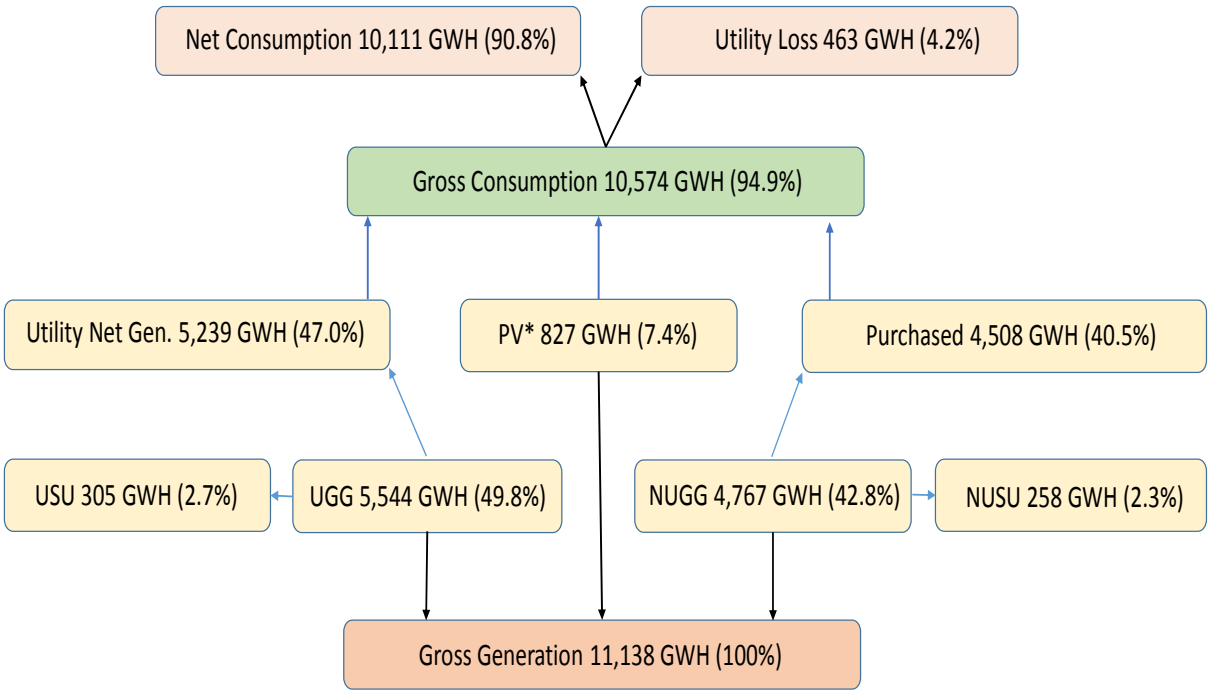
1/ Total generation from EIA is based on survey of electricity producers' net generation (excluding station use).

Source: Energy Information Administration, State Energy Data System

As shown in Figure 1, total gross electricity generation includes gross generation by the utilities, non-utility electricity producers, and customer generated electricity. Gross generation of the utilities includes utility net generation and utility station use (USU). Non-utility gross generation includes utility purchased electricity and non-utility station use (NUSU). Gross consumption of electricity is gross generation minus station use. Gross consumption minus utility loss is the net consumption of electricity.

In 2016, based on the utility MFR, gross generation in Hawaii was about 11,138 GWH, about 49.8 percent was generated by the utilities, 42.8 percent by the non-utility producers, and 7.4 percent by customers. Station use accounted for about 5.0 percent of gross generation. Utility loss accounted for about 4.2 percent of gross generation. The 10,111 GWH net consumption includes 827 GWH generated by customers and 9,284 GWH utility electricity sales.

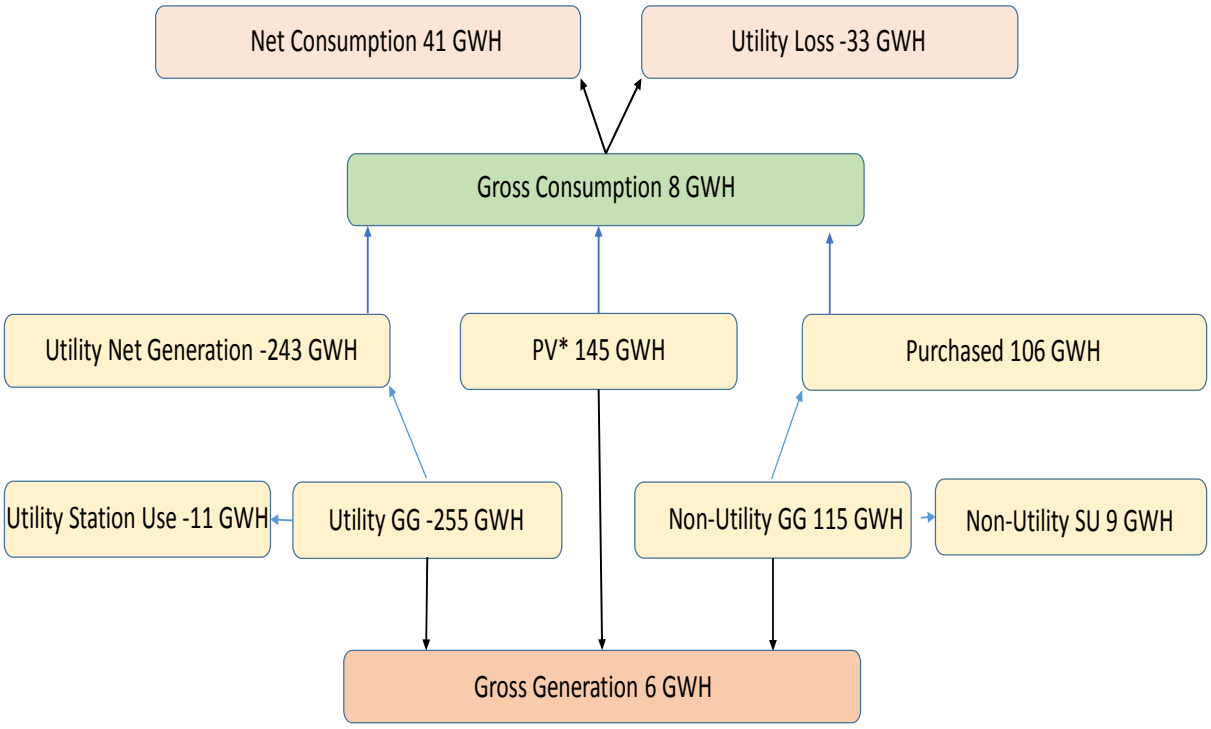
Figure 1. Electricity Production and Consumption in Hawaii: 2016



* Customer-sited grid-connected PV.

As shown in Figure 2, from 2015 to 2016, gross generation in Hawaii remained almost unchanged. Decreased utility generation was offset by increased generation from customers and non-utility producers. Net electricity consumption increased by 41 GWH, mainly due to reduced utility loss. The increase in net consumption was mainly due to the 145 GWH increase in customer generated electricity; the electricity sold by utilities decreased by 104 GWH.

Figure 2. Changes in Electricity Production and Consumption in Hawaii: 2015-2016

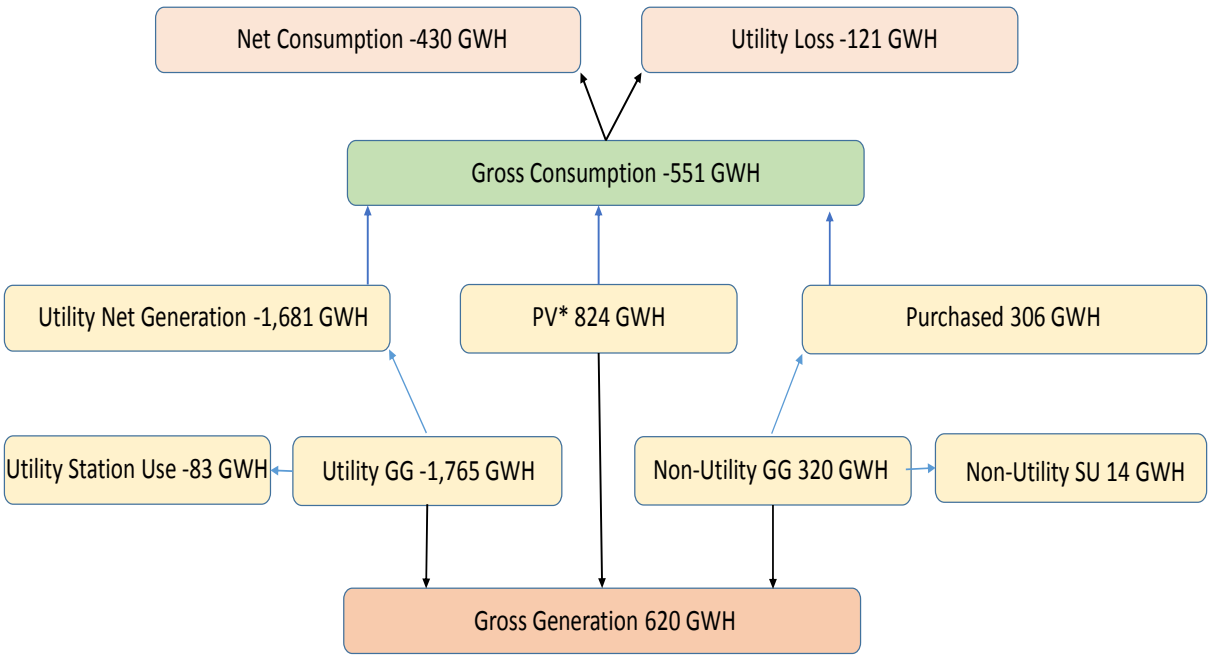


* Customer-sited grid-connected PV.

Figure 3 shows the changes in electricity production and consumption from 2005 to 2016. Over the past 11 years, gross generation in Hawaii increased by 620 GWH, accounting for about 5.6 percent of gross generation in 2016. Utility gross generation decreased 1,765 GWH, gross generation of non-utility producers increased 320 GWH, and electricity generated by customers increased 824 GWH.

Since the decrease of utility net generation was more than the increase in purchased electricity and customer generated electricity, gross consumption decreased 551 GWH. Reduced utility loss led to a smaller reduction of net consumption. However, since customer generated electricity increased 824 GWH over this period, electricity sold by utilities decreased 1,254 GWH or 13.5 percent of utility sales in 2016.

Figure 3. Changes in Electricity Production and Consumption in Hawaii: 2005-2016



* Customer-sited grid-connected PV.

As shown in Table 2, the four electric utilities in Hawaii generated (including station use) about 5,544 GWH of electricity in 2016, a decrease of 4.4 percent or 255 GWH from the previous year. From 2005 to 2016, total utility generation decreased about 2.5 percent per year on average.

Both total generation and station use decreased over time, but station use decreased less than that of the total generation on average. In 2016, station use for the state accounted for about 5.5 percent or 305 GWH of utility total generation. From 2005 to 2016, utility station use decreased 2.2 percent per year, which was less than the 2.5 percent decrease of total generation. As a result, the share of station use in the state increased from 5.3 percent in 2005 to 5.5 percent in 2016. The share of station use was the highest at HECO, followed by HELCO, MECO, and KIUC. From 2005 to 2016, utility net generation decreased 2.5 percent per year on average, from 6,920 GWH in 2005 to 5,239 GWH in 2016. About 66.5 percent of Hawaii's utility net generation in 2016 was produced by HECO, 17.0 percent by MECO, 10.8 percent by HELCO, and 5.7 percent by KIUC.

Table 2. Hawaii Net Electricity Generation by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total utility generation											
State Total	GWh	7,309	6,861	6,818	6,377	6,100	5,840	5,799	5,544	-4.4%	-2.5%
HECO	GWh	5,021	4,720	4,699	4,399	4,170	3,970	3,977	3,714	-6.6%	-2.7%
HELCO	GWh	561	584	586	518	571	573	536	595	11.0%	0.5%
MECO	GWh	1,279	1,119	1,104	1,034	945	903	917	927	1.2%	-2.9%
KIUC	GWh	448	438	429	426	415	394	369	308	-16.6%	-3.3%
Utility station use											
State Total	GWh	389	382	379	362	345	327	317	305	-3.6%	-2.2%
HECO	GWh	300	293	293	278	263	247	243	229	-5.6%	-2.4%
HELCO	GWh	31	31	31	29	30	28	24	27	16.0%	-1.0%
MECO	GWh	45	45	43	43	40	40	38	39	2.3%	-1.2%
KIUC	GWh	13	13	13	12	12	12	12	9	-20.9%	-2.9%
Utility net generation											
State Total	GWh	6,920	6,479	6,439	6,016	5,755	5,513	5,482	5,239	-4.4%	-2.5%
HECO	GWh	4,721	4,426	4,406	4,121	3,907	3,723	3,734	3,485	-6.7%	-2.7%
HELCO	GWh	530	553	555	489	540	546	512	567	10.8%	0.6%
MECO	GWh	1,234	1,074	1,060	992	905	863	878	888	1.1%	-2.9%
KIUC	GWh	435	425	417	414	403	381	358	299	-16.5%	-3.4%
Utility share of net generation											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	68.2%	68.3%	68.4%	68.5%	67.9%	67.5%	68.1%	66.5%		
HELCO	%	7.7%	8.5%	8.6%	8.1%	9.4%	9.9%	9.3%	10.8%		
MECO	%	17.8%	16.6%	16.5%	16.5%	15.7%	15.7%	16.0%	17.0%		
KIUC	%	6.3%	6.6%	6.5%	6.9%	7.0%	6.9%	6.5%	5.7%		
% of station use of utility generation											
State Total	%	5.3%	5.6%	5.6%	5.7%	5.7%	5.6%	5.5%	5.5%		
HECO	%	6.0%	6.2%	6.2%	6.3%	6.3%	6.2%	6.1%	6.2%		
HELCO	%	5.5%	5.3%	5.2%	5.5%	5.3%	4.8%	4.4%	4.6%		
MECO	%	3.5%	4.0%	3.9%	4.1%	4.3%	4.4%	4.2%	4.2%		
KIUC	%	2.9%	2.9%	2.9%	2.8%	2.8%	3.1%	3.2%	3.1%		

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 3 shows that electricity purchased by the utilities increased from 4,202 GWH in 2005 to 4,508 GWH in 2016, an increase of 306 GWH. This increase is in contrast to the 1,681 GWH decrease in net utility generation during the same period. Electricity purchased decreased from 2005 to 2011 and then increased from 2011 to 2016. In 2016, electricity purchased increased 2.4 percent or 106 GWH, over the previous year. Electricity purchased plus utility net generation is the electricity net to system. The share of purchased electricity, as a percentage of the total net to system, increased from 37.8 percent in 2005 to 46.3 percent in 2016.

Table 3. Hawaii Electricity Sales by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Electricity purchased											
State Total	GWh	4,202	4,090	4,046	4,131	4,244	4,371	4,402	4,508	2.4%	0.6%
HECO	GWh	3,383	3,231	3,187	3,190	3,281	3,379	3,352	3,478	3.8%	0.3%
HELCO	GWh	688	641	631	681	619	595	631	578	-8.4%	-1.6%
MECO	GWh	97	191	191	222	296	333	325	292	-10.1%	10.5%
KIUC	GWh	35	27	37	38	49	65	94	159	69.4%	14.8%
Electricity net to system											
State Total	GWh	11,122	10,569	10,485	10,147	9,999	9,884	9,884	9,747	-1.4%	-1.2%
HECO	GWh	8,104	7,657	7,594	7,311	7,187	7,102	7,086	6,963	-1.7%	-1.4%
HELCO	GWh	1,217	1,194	1,187	1,170	1,159	1,140	1,143	1,146	0.2%	-0.6%
MECO	GWh	1,331	1,265	1,252	1,214	1,201	1,196	1,203	1,181	-1.9%	-1.1%
KIUC	GWh	470	453	453	452	452	446	452	458	1.4%	-0.2%
Utility loss											
State Total	GWh	584	556	524	508	498	478	496	463	-6.6%	-2.1%
HECO	GWh	383	380	352	335	329	320	332	303	-8.8%	-2.1%
HELCO	GWh	101	84	83	85	83	78	79	78	-0.3%	-2.3%
MECO	GWh	79	74	70	69	66	64	66	63	-4.2%	-2.0%
KIUC	GWh	21	18	19	19	20	16	19	19	-3.8%	-1.0%
Total electricity sold											
State Total	GWh	10,539	10,013	9,962	9,639	9,501	9,406	9,389	9,284	-1.1%	-1.1%
HECO	GWh	7,721	7,277	7,242	6,976	6,859	6,782	6,754	6,660	-1.4%	-1.3%
HELCO	GWh	1,116	1,110	1,104	1,085	1,076	1,063	1,065	1,067	0.2%	-0.4%
MECO	GWh	1,252	1,192	1,181	1,145	1,135	1,132	1,138	1,118	-1.7%	-1.0%
KIUC	GWh	449	435	435	433	431	430	432	439	1.6%	-0.2%
Share of purchased of net to system											
State Total	%	37.8%	38.7%	38.6%	40.7%	42.4%	44.2%	44.5%	46.3%		
HECO	%	41.7%	42.2%	42.0%	43.6%	45.6%	47.6%	47.3%	50.0%		
HELCO	%	56.5%	53.7%	53.2%	58.2%	53.4%	52.1%	55.2%	50.5%		
MECO	%	7.3%	15.1%	15.3%	18.3%	24.7%	27.8%	27.0%	24.8%		
KIUC	%	7.4%	6.1%	8.1%	8.4%	10.8%	14.5%	20.8%	34.8%		
Share of loss of net to system											
State Total	%	5.2%	5.3%	5.0%	5.0%	5.0%	4.8%	5.0%	4.7%		
HECO	%	4.7%	5.0%	4.6%	4.6%	4.6%	4.5%	4.7%	4.3%		
HELCO	%	8.3%	7.1%	7.0%	7.3%	7.2%	6.8%	6.9%	6.8%		
MECO	%	5.9%	5.8%	5.6%	5.7%	5.5%	5.4%	5.5%	5.3%		
KIUC	%	4.5%	4.0%	4.1%	4.1%	4.5%	3.6%	4.3%	4.1%		

Source: Hawaii Electric Utility Monthly Financial Reports.

It is important to note that not all the electricity sent to the utility systems was sold to consumers; some electricity was lost during the process of transmission and distribution. In Hawaii, about 4.7 percent of the electricity sent to the system was lost in 2016. The percent of utility loss was highest in the HELCO system (6.8 percent), followed by MECO (5.3 percent), HECO (4.3 percent), and KIUC (4.1 percent). Total electricity sold is electricity net to system minus utility lost. From 2005 to 2016, total electricity sold decreased 1.1 percent per year on average from 10,539 GWH to 9,284 GWH. The utility loss share of electricity net to system decreased from 5.2 percent to 4.7 percent for the state over this period.

Table 4 shows that utility station use and loss decreased from 972 GWH in 2005 to 768 GWH in 2016, a decrease of 2.1 percent per year on average. The share of utility station usage and loss as a percentage of total utility generation and purchased electricity decreased from 8.4 percent in 2005 to 7.6 percent in 2016.

Table 4. Share of Utility Station Usage and Loss of Total Electricity Production

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total utility generation and purchased 1/											
State Total	GWh	11,511	10,951	10,864	10,508	10,344	10,211	10,201	10,052	-1.5%	-1.2%
HECO	GWh	8,404	7,950	7,886	7,589	7,450	7,349	7,329	7,192	-1.9%	-1.4%
HELCO	GWh	1,248	1,225	1,217	1,199	1,189	1,168	1,167	1,173	0.5%	-0.6%
MECO	GWh	1,376	1,310	1,295	1,256	1,241	1,236	1,242	1,220	-1.8%	-1.1%
KIUC	GWh	482	465	466	464	463	458	463	467	0.8%	-0.3%
Station use and loss											
State Total	GWh	972	938	903	869	843	805	812	768	-5.5%	-2.1%
HECO	GWh	683	673	644	613	592	568	575	532	-7.4%	-2.2%
HELCO	GWh	132	115	114	114	113	105	102	106	3.5%	-2.0%
MECO	GWh	124	119	114	111	106	104	104	102	-1.8%	-1.7%
KIUC	GWh	34	31	31	31	32	28	31	28	-10.3%	-1.7%
% of station use and loss											
State Total	%	8.4%	8.6%	8.3%	8.3%	8.1%	7.9%	8.0%	7.6%	-4.1%	-0.9%
HECO	%	8.1%	8.5%	8.2%	8.1%	7.9%	7.7%	7.8%	7.4%	-5.7%	-0.9%
HELCO	%	10.5%	9.4%	9.3%	9.5%	9.5%	9.0%	8.8%	9.0%	2.9%	-1.4%
MECO	%	9.0%	9.1%	8.8%	8.9%	8.6%	8.4%	8.4%	8.4%	-0.1%	-0.7%
KIUC	%	7.0%	6.6%	6.7%	6.6%	6.9%	6.2%	6.8%	6.0%	-11.0%	-1.4%

1/ Excluding station use of non-utility producers.

Source: Hawaii Electric Utility Monthly Financial Reports.

Data for the station use of non-utility producers is not available. If we assume that the station use share of the non-utility producers as a percentage of purchased electricity is similar to that of the utility station use share of net generation, the share of total station use and loss in gross generation would be about 10.0 percent for 2016.

Hawaii's gross electricity generation of utility and non-utility electricity producers in 2016 was estimated to be about 10,311 GWH. In 2016, about 71.8 percent of the gross generation of electricity producers was produced by the HECO system (including both utility and non-utility producers). HELCO accounted for about 11.6 percent of gross generation, MECO about 12.0 percent, and KIUC about 4.6 percent. From 2005 to 2016, each respective county utility's share of gross generation remained fairly stable.

Table 5. Share of Total Station Usage and Loss of Total Electricity Production

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Station use of non-utility											
State Total	GWh	244	243	240	250	254	256	249	258	3.8%	0.5%
HECO	GWh	202	201	198	202	207	211	205	215	4.9%	0.6%
HELCO	GWh	38	34	33	38	33	29	28	27	-4.2%	-3.1%
MECO	GWh	3	8	8	9	13	15	14	12	-9.1%	12.4%
KIUC	GWh	1	1	1	1	1	2	3	5	60.6%	15.4%
Total gross generation 1/											
State Total	GWh	11,755	11,194	11,104	10,758	10,598	10,467	10,450	10,311	-1.3%	-1.2%
HECO	GWh	8,606	8,151	8,085	7,791	7,657	7,560	7,534	7,407	-1.7%	-1.4%
HELCO	GWh	1,286	1,259	1,250	1,237	1,222	1,197	1,195	1,200	0.4%	-0.6%
MECO	GWh	1,379	1,318	1,302	1,265	1,254	1,251	1,255	1,232	-1.8%	-1.0%
KIUC	GWh	484	466	467	465	465	460	466	472	1.2%	-0.2%
Share of gross generation											
State Total	%	100%	100%	100%	100%	100%	100%	100%	100.0%	0.0%	0.0%
HECO	%	73%	73%	73%	72%	72%	72%	72%	71.8%	-0.4%	-0.2%
HELCO	%	11%	11%	11%	11%	12%	11%	11%	11.6%	1.8%	0.6%
MECO	%	12%	12%	12%	12%	12%	12%	12%	12.0%	-0.5%	0.2%
KIUC	%	4%	4%	4%	4%	4%	4%	4%	5%	2.6%	1.0%
Total station use and loss											
State Total	GWh	1,217	1,181	1,143	1,119	1,097	1,061	1,061	1,027	-3.3%	-1.5%
HECO	GWh	885	874	842	815	799	778	780	747	-4.2%	-1.5%
HELCO	GWh	169	149	147	152	146	134	130	132	1.8%	-2.2%
MECO	GWh	127	126	121	120	119	119	118	114	-2.7%	-1.0%
KIUC	GWh	35	32	32	32	33	30	34	33	-4.1%	-0.5%
% of station use and loss											
State Total	%	10.3%	10.5%	10.3%	10.4%	10.3%	10.1%	10.2%	10.0%	-2.0%	-0.4%
HECO	%	10.3%	10.7%	10.4%	10.5%	10.4%	10.3%	10.3%	10.1%	-2.6%	-0.2%
HELCO	%	13.2%	11.8%	11.7%	12.3%	12.0%	11.2%	10.9%	11.0%	1.4%	-1.6%
MECO	%	9.2%	9.6%	9.3%	9.5%	9.5%	9.5%	9.4%	9.3%	-0.8%	0.1%
KIUC	%	7.2%	6.8%	6.9%	6.8%	7.2%	6.6%	7.4%	7.0%	-5.2%	-0.3%

1/ Including station use of non-utility producers. Estimated by DBEDT

Source: Hawaii Electric Utility Monthly Financial Reports.

3. Electricity Generation by Sources

Hawaii's electricity generation depends heavily on imported petroleum as the major fuel source. Before 1990, Hawaii's electricity was almost all generated from petroleum products. However, since 1990, electricity generated from waste, coal, wind, and geothermal energy became more significant. Nevertheless, petroleum remains the dominant fuel in Hawaii's electricity generation and is the primary driver for the changes of electricity prices in Hawaii.

Table 6. Electricity Generation by Source: Total Electric Power Industry

	Total Electricity Generation	% of Total Electricity Generation									
Year	GWH	Petroleum	Coal	Other Gases 1/	Biomass	Wood	Geothermal	Hydro	Wind	Solar 2/	Other
1990	9,703	90.0	0.0	0.2	8.7	-	-	0.8	0.3	-	-
1991	8,703	88.6	0.1	0.6	9.5	-	-	0.8	0.4	-	-
1992	9,844	84.7	5.7	0.6	8.2	-	0.0	0.6	0.2	-	-
1993	9,944	74.4	14.9	0.6	7.8	0.0	1.5	0.6	0.2	-	-
1994	10,109	75.6	13.1	0.7	7.2	0.0	1.8	1.4	0.2	-	-
1995	10,304	74.5	15.2	0.7	6.2	0.0	2.3	0.9	0.2	-	0.0
1996	10,628	74.9	15.5	0.6	5.6	0.0	2.3	1.0	0.2	-	-
1997	10,312	74.6	15.3	0.6	5.9	0.0	2.4	1.1	0.2	-	-
1998	10,228	76.8	14.0	0.6	4.9	-	2.3	1.2	0.2	-	-
1999	10,404	76.8	13.8	0.5	5.5	-	2.0	1.1	0.2	-	-
2000	10,593	76.0	14.9	0.4	5.1	-	2.5	1.0	0.2	-	-
2001	10,633	77.3	15.1	0.4	2.7	-	1.9	0.9	0.0	-	1.6
2002	11,663	81.2	13.3	0.3	2.5	-	0.6	0.8	0.0	-	1.2
2003	10,976	77.5	15.0	0.4	3.2	-	1.6	0.8	0.0	-	1.6
2004	11,410	78.4	14.1	0.4	2.9	-	1.9	0.8	0.1	-	1.5
2005	11,523	78.7	14.2	0.4	2.7	-	1.9	0.8	0.1	-	1.3
2006	11,559	78.3	13.4	0.4	2.8	-	1.8	1.0	0.7	-	1.5
2007	11,533	77.3	13.7	0.4	2.5	-	2.0	0.8	2.1	-	1.3
2008	11,376	76.2	14.5	0.3	2.7	-	2.1	0.7	2.1	0.0	1.4
2009	11,011	75.3	13.6	0.2	2.6	-	1.5	1.0	2.3	0.0	3.5
2010	10,836	74.6	14.3	0.2	2.6	0.0	1.9	0.6	2.4	0.0	3.4
2011	10,723	73.9	13.3	0.3	2.9	-	2.1	0.9	3.2	0.0	3.4
2012	10,469	71.5	14.7	0.4	2.7	-	2.5	1.1	3.6	0.0	3.5
2013	10,267	70.3	13.7	0.4	3.2	-	2.7	0.8	4.9	0.2	3.8
2014	10,204	67.9	14.8	0.6	3.3	-	2.5	0.9	5.7	0.4	4.0
2015	10,120	69.4	13.2	0.5	3.2	-	2.3	1.2	6.1	0.5	3.6
2016*	9,607	66.6	15.8	0.4	3.4	-	2.7	1.2	6.7	1.0	2.2

* Preliminary

1/ Other gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.

2/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

From 1990 to 2016, the share of petroleum generated electricity in Hawaii (including both utility and non-utility producers) decreased from 90.0 percent to 66.6 percent; the share of coal generated electricity increased from 0.0 percent to 15.8 percent; the share of wind generated electricity increased from 0.3 percent to 6.7 percent; the share of geothermal electricity increased from 0.0 to 2.7 percent; and the share of biomass decreased from 8.7 percent to 3.4 percent (Table 6). In 2016, total renewable electricity (excluding customer-sited solar) accounted for about 14.9 percent of total electricity generation.

Most of the non-petroleum generated electricity was produced by non-utility producers. As shown in Table 7, almost all electricity generated from the utilities was from petroleum fuel. From 1990 to 2016, the petroleum generated electricity share of total utility generated electricity decreased only slightly from 99.6 percent to 97.8 percent. In 2016, only about 2.2 percent of electricity generated by the utilities was from renewable sources. Due to increased generation of non-utility producers and decreased generation of utilities, over the same period, the utility petroleum generated electricity share of total petroleum generated electricity decreased from 91.2 percent to 74.5 percent.

Non-utility producers depends more on non-petroleum sources of energy to generate electricity, especially coal and wind. As shown in Table 8, from 1990 to 2016, the petroleum generated electricity share of non-utility generated electricity decreased from 45.0 percent to 34.5 percent; the share of coal generated electricity increased from 0.1 percent to 32.1 percent; the share of wind generated electricity increased from 1.7 percent to 13.6 percent; the share of geothermal electricity increased from 0.0 to 5.5 percent; and the share of biomass decreased from 48.9 percent to 6.0 percent.

The increased share of non-petroleum generated electricity, especially coal-fired electricity, kept the growth rate of purchased electricity costs low. For example, the average cost of coal-fired electricity purchased by HECO was only about 10 cents per kWh and this was substantially below the average price of HECO electricity.

Table 7. Electricity Generation by Source: Electric Utilities

Year	Total Electricity Generation GWH	% of Total Electricity Generation									
		Petroleum	Coal	Other Gases 1/	Biomass	Wood	Geothermal	Hydro	Wind	Solar 2/	Other
1990	7,996	99.6	-	-	0.1	-	-	0.3	-	-	-
1991	7,333	99.7	-	-	-	-	-	0.3	-	-	-
1992	6,861	99.9	-	-	-	-	-	0.1	-	-	-
1993	6,084	99.8	-	-	-	-	-	0.2	-	-	-
1994	6,055	99.7	-	-	-	-	-	0.3	-	-	-
1995	6,191	99.7	-	-	-	-	-	0.3	-	-	-
1996	6,420	99.7	-	-	-	-	-	0.3	-	-	-
1997	6,213	99.7	-	-	-	-	-	0.3	-	-	-
1998	6,301	99.8	-	-	-	-	-	0.2	0.00	-	-
1999	6,452	99.6	-	-	-	-	-	0.3	0.06	-	-
2000	6,535	99.7	-	-	-	-	-	0.2	0.04	-	-
2001	6,383	99.7	-	-	-	-	-	0.3	0.03	-	-
2002	7,513	99.9	-	-	-	-	-	0.1	0.02	-	-
2003	6,493	99.9	-	-	-	-	-	0.0	0.02	-	-
2004	6,982	99.8	-	-	-	-	-	0.1	0.02	-	-
2005	6,915	99.8	-	-	-	-	-	0.1	0.02	-	-
2006	7,040	99.7	-	-	-	-	-	0.3	0.01	-	-
2007	6,928	99.8	-	-	-	-	-	0.2	0.01	-	-
2008	6,701	99.7	-	-	-	-	-	0.3	0.00	-	-
2009	6,510	96.2	-	-	0.1	-	-	0.4	0.00	-	3.3
2010	6,416	96.3	-	-	0.0	-	-	0.3	-	-	3.4
2011	6,376	95.8	-	-	0.6	-	-	0.3	-	-	3.3
2012	6,013	95.6	-	-	0.4	-	-	0.5	-	-	3.6
2013	5,748	95.6	-	-	0.5	-	-	0.3	-	-	3.6
2014	5,517	94.9	-	-	0.7	-	-	0.4	-	0.2	3.8
2015	5,492	94.9	-	-	1.0	-	-	0.4	-	0.5	3.3
2016*	4,874	97.8	-	-	0.8	-	-	0.5	-	1.0	-

* Preliminary

1/ Other gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.

2/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

Table 8. Electricity Generation by Source: IPP & CHP

Year	Total Electricity Generation GWH	% of Total Electricity Generation									
		Petroleum	Coal	Other Gases 1/	Biomass	Wood	Geothermal	Hydro	Wind	Solar 2/	Other
1990	1,707	45.0	0.1	0.9	48.9	-	-	3.3	1.7	-	-
1991	1,370	29.3	0.6	3.8	60.1	-	-	3.7	2.6	-	-
1992	2,983	49.7	18.7	2.1	27.0	-	0.1	1.7	0.8	-	-
1993	3,860	34.3	38.3	1.6	20.1	0.0	3.9	1.1	0.6	-	-
1994	4,054	39.6	32.7	1.6	18.0	0.0	4.6	3.0	0.5	-	-
1995	4,113	36.6	38.0	1.7	15.5	0.0	5.7	2.0	0.5	-	0.1
1996	4,208	37.1	39.0	1.4	14.1	0.0	5.8	2.0	0.5	-	-
1997	4,100	36.5	38.4	1.6	14.8	0.0	6.0	2.4	0.4	-	-
1998	3,927	39.8	36.5	1.5	12.8	-	6.0	2.7	0.5	-	-
1999	3,952	39.6	36.4	1.3	14.6	-	5.3	2.4	0.3	-	-
2000	4,059	37.8	38.9	1.0	13.3	-	6.5	2.2	0.4	-	-
2001	4,250	43.8	37.8	0.9	6.8	-	4.9	1.9	0.0	-	4.0
2002	4,150	47.3	37.2	1.0	7.1	-	1.8	2.1	0.0	-	3.5
2003	4,483	44.9	36.7	0.9	7.7	-	4.0	2.0	0.0	-	3.8
2004	4,428	44.6	36.2	1.1	7.4	-	4.8	1.9	0.1	-	3.9
2005	4,608	47.0	35.4	0.9	6.7	-	4.8	1.9	0.1	-	3.2
2006	4,519	45.1	34.3	0.9	7.2	-	4.7	2.1	1.7	-	3.9
2007	4,605	43.5	34.3	1.0	6.2	-	5.0	1.7	5.2	-	3.2
2008	4,676	42.5	35.2	0.8	6.5	-	5.0	1.4	5.1	0.00	3.4
2009	4,501	45.0	33.3	0.5	6.2	-	3.7	1.9	5.6	0.03	3.7
2010	4,420	43.2	35.0	0.5	6.4	0.0	4.5	1.2	5.9	0.04	3.3
2011	4,347	41.8	32.8	0.8	6.3	-	5.2	1.7	7.8	0.08	3.6
2012	4,457	39.0	34.5	1.1	5.8	-	5.9	1.9	8.5	0.10	3.3
2013	4,519	38.2	31.1	0.9	6.7	-	6.1	1.3	11.1	0.43	4.2
2014	4,687	36.1	32.2	1.3	6.3	-	5.4	1.5	12.3	0.62	4.1
2015	4,627	39.1	28.9	1.1	5.8	-	5.0	2.1	13.2	0.64	4.1
2016*	4,733	34.5	32.1	0.9	6.0	-	5.5	2.0	13.6	0.91	4.4

* Preliminary

1/ Other gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.

2/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

Based on the most recent data available from EIA, the generating capacity for Hawaii's total electric power industry increased from 1,976 MW in 1990 to 2,921 MW in 2015, an increase of 1.6 percent per year on average. Coal-fired capacity increased from 24 MW to 203 MW or 9.0 percent per year over the period, wind capacity increased from 23 MW to 206 MW or 9.1 percent per year on average, petroleum generation capacity increased from 1,692 MW to 2,060 MW or an average of 0.8 percent over the period, and biomass capacity increased from 211 MW to 256 MW or a 0.8 percent average per year (Table 9).

Table 9. Power Generating Capacity by Source: Total Electric Power Industry

	Power Generating Capacity Units: MW									
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar 1/	Other	Total
1990	1,692	24	9	211	-	18	23	-	-	1,976
1991	1,910	24	9	204	-	18	23	-	-	2,187
1992	1,947	228	9	230	30	18	23	-	-	2,484
1993	1,976	228	9	222	30	18	23	-	-	2,505
1994	1,976	228	9	206	30	28	23	-	-	2,498
1995	1,976	228	9	193	35	29	22	-	-	2,491
1996	1,984	228	9	193	35	29	22	-	-	2,500
1997	1,972	228	9	178	35	29	20	-	-	2,471
1998	1,997	228	9	164	35	29	20	-	-	2,482
1999	2,007	228	9	156	35	28	9	-	-	2,473
2000	2,091	228	9	155	35	27	12	-	-	2,557
2001	2,093	227	9	151	35	26	11	-	-	2,552
2002	2,093	227	9	110	35	25	11	-	-	2,510
2003	2,089	227	9	114	35	23	11	-	-	2,508
2004	2,178	203	9	114	35	23	11	-	-	2,573
2005	2,192	203	9	114	35	25	11	-	-	2,589
2006	2,220	203	9	114	35	25	43	-	-	2,649
2007	2,224	203	9	114	35	25	64	-	-	2,674
2008	2,224	203	9	114	35	25	64	1	-	2,675
2009	2,242	203	9	227	35	25	64	1	-	2,805
2010	2,214	203	9	227	35	25	62	2	-	2,776
2011	2,214	203	12	227	35	25	92	2	-	2,810
2012	2,181	203	6	227	51	26	206	7	75	2,982
2013	2,181	203	6	260	51	26	206	15	60	3,008
2014	2,077	203	6	256	51	26	206	32	60	2,917
2015	2,060	203	9	256	51	26	206	44	66	2,921

1/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

Table 10 shows that the generating capacity of the utilities increased from 1,542 MW in 1990 to 1,855 MW in 2015, an increase of 0.7 percent per year on average. The generating capacity added by the utilities from 1990 to 2015 was mainly petroleum and biomass-fired (utilizing biodiesel) capacity. In 2016, the average cost of biodiesel for HECO was about 24 cents per kWh, lower than the HECO average cost of diesel at about 37 cents per kWh.

Table 10. Power Generating Capacity by Source: Electric Utilities

	Power Generating Capacity Units: MW									
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar 1/	Other	Total
1990	1,538	-	-	-	-	3	-	-	-	1,542
1991	1,574	-	-	-	-	3	-	-	-	1,577
1992	1,617	-	-	-	-	3	-	-	-	1,621
1993	1,655	-	-	-	-	3	-	-	-	1,659
1994	1,655	-	-	-	-	3	-	-	-	1,659
1995	1,655	-	-	-	-	3	-	-	-	1,659
1996	1,664	-	-	-	-	3	-	-	-	1,667
1997	1,652	-	-	-	-	3	-	-	-	1,655
1998	1,677	-	-	-	-	3	-	-	-	1,680
1999	1,687	-	-	-	-	3	-	-	-	1,690
2000	1,705	-	-	-	-	3	2	-	-	1,710
2001	1,703	-	-	-	-	3	2	-	-	1,708
2002	1,702	-	-	-	-	2	2	-	-	1,706
2003	1,702	-	-	-	-	2	2	-	-	1,706
2004	1,791	-	-	-	-	2	2	-	-	1,795
2005	1,806	-	-	-	-	4	2	-	-	1,812
2006	1,833	-	-	-	-	4	2	-	-	1,839
2007	1,838	-	-	-	-	4	2	-	-	1,844
2008	1,838	-	-	-	-	4	2	-	-	1,844
2009	1,856	-	-	113	-	4	2	-	-	1,975
2010	1,827	-	-	113	-	4	-	-	-	1,944
2011	1,827	-	-	113	-	4	-	-	-	1,945
2012	1,788	-	-	113	-	4	-	-	39	1,945
2013	1,788	-	-	113	-	4	-	-	39	1,945
2014	1,684	-	-	113	-	4	-	12	39	1,852
2015	1,669	-	-	113	-	4	-	24	45	1,855

1/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

Table 11 shows that the generating capacity of the non-utility producers in Hawaii increased from 435 MW in 1990 to 1,066 MW in 2015, an increase of 3.7 percent per year on average. The growth rate of wind capacity was the highest during this period at 9.1 percent on average per year. Wind was followed by coal-fired capacity at 9.0 percent per year and petroleum capacity at 3.8 percent per year. Geothermal capacity increased from zero to 51 MW, but the biomass capacity decreased from 211 MW to 143 MW over the period. The figures do not include electricity generation from the customer-sited solar systems.

Table 11. Power Generating Capacity by Source: IPP and CHP

	Power Generating Capacity Units: MW									
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar 1/	Other	Total
1990	154	24	9	211	-	15	23	-	-	435
1991	337	24	9	204	-	15	23	-	-	610
1992	329	228	9	230	30	15	23	-	-	863
1993	320	228	9	222	30	15	23	-	-	846
1994	320	228	9	206	30	24	23	-	-	839
1995	320	228	9	193	35	26	22	-	-	832
1996	320	228	9	193	35	26	22	-	-	833
1997	320	228	9	178	35	26	20	-	-	816
1998	320	228	9	164	35	26	20	-	-	802
1999	320	228	9	156	35	25	9	-	-	782
2000	386	228	9	155	35	24	10	-	-	847
2001	390	227	9	151	35	23	9	-	-	844
2002	391	227	9	110	35	23	9	-	-	804
2003	387	227	9	114	35	21	9	-	-	802
2004	387	203	9	114	35	21	9	-	-	778
2005	386	203	9	114	35	21	9	-	-	777
2006	387	203	9	114	35	21	41	-	-	810
2007	386	203	9	114	35	21	62	-	-	830
2008	386	203	9	114	35	21	62	1	-	831
2009	386	203	9	114	35	21	62	1	-	830
2010	387	203	9	114	35	21	62	2	-	832
2011	386	203	12	114	35	21	92	2	-	865
2012	393	203	6	114	51	22	206	7	36	1,037
2013	393	203	6	147	51	22	206	15	21	1,064
2014	393	203	6	143	51	22	206	20	21	1,065
2015	391	203	9	143	51	22	206	20	21	1,066

1/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

The detailed power generating capacity by county in 2017 is provided in Table 12. Currently, the state of Hawaii has about 2,407.3 MW firm capacity (guaranteed available at a given time); 1,726.5 MW in Honolulu, 281.4 MW in Hawaii County, 274.1 MW in Maui County, and 125.3 MW in Kauai County. About 83.2 percent of the firm capacity use petroleum, 7.5 percent use coal, and 7.8 percent use biofuel or waste.

The state also installed about 354.2 MW non-firm capacity, mostly by non-utility producers; 177.2 MW in Honolulu, 47.5 MW in Hawaii County, 73.7 MW in Maui County, and 55.8 MW in Kauai County. Wind accounted for about 57.0 percent of the non-firm capacity; followed by solar at 23.4 percent, hydro at 9.5 percent, and petroleum at 5.2 percent. In addition, about 607.2 MW customer-sited solar was installed in Hawaii; 411.0 MW in Honolulu, 81.5 MW in Hawaii County, 93.7 MW in Maui County, and 21.0 MW in Kauai County. Most of the electricity generated by these systems were directly consumed by the consumers and not included in the utility electricity sales.

Table 12. Power Generating Capacity by Source in 2017

	Petroleum	Coal	Other Gases	Biofuel Waste	Geothermal	Hydro	Wind	Solar	Total
State Total MW W/O Customer-Sited Solar	2,021.4	180.0	9.6	195.9	34.6	35.1	202.1	82.9	2,761.5
State Total Firm MW	2,002.9	180.0	-	188.5	34.6	1.3	-	-	2,407.3
State Total Non-Firm MW	18.5	-	9.6	7.4	-	33.8	202.1	82.9	354.2
State Total Customer-Sited Solar								607.2	607.2
State Total MW W/O Customer-Sited Solar	2,021.4	180.0	9.6	195.9	34.6	35.1	202.1	82.9	2,761.5
Honolulu	1,376.5	180.0	9.6	188.5	-	-	99.0	50.1	1,903.7
Hawaii	246.8	-	-	-	34.6	16.5	31.1	-	328.9
Maui	274.1	-	-	-	-	0.5	72.0	1.2	347.8
Kauai	124.0	-	-	7.4	-	18.1	-	31.6	181.1
State Total Firm MW	2,002.9	180.0	-	188.5	34.6	1.3	-	-	2,407.3
Honolulu	1,358.0	180.0	-	188.5	-	-	-	-	1,726.5
Hawaii	246.8	-	-	-	34.6	-	-	-	281.4
Maui	274.1	-	-	-	-	-	-	-	274.1
Kauai	124.0	-	-	-	-	1.3	-	-	125.3
State Total Non-Firm MW	18.5	-	9.6	7.4	-	33.8	202.1	82.9	354.2
Honolulu	18.5	-	9.6	-	-	-	99.0	50.1	177.2
Hawaii	-	-	-	-	-	16.5	31.1	-	47.5
Maui	-	-	-	-	-	0.5	72.0	1.2	73.7
Kauai	-	-	-	7.4	-	16.8	-	31.6	55.8
State Total Customer-Sited Solar	-	-	-	-	-	-	-	607.2	607.2
Honolulu	-	-	-	-	-	-	-	411.0	411.0
Hawaii	-	-	-	-	-	-	-	81.5	81.5
Maui	-	-	-	-	-	-	-	93.7	93.7
Kauai	-	-	-	-	-	-	-	21.0	21.0

Source: Power Facts provided by HECO and KIUC.

The generating units in the electric power industry have multiple functions. Some generating units are used to serve base load needs, while others are used to serve peak loads. Units serving the base load needs have more average operating hours per year, and the average cost per kWh is normally lower than the average cost of the units serving peak loads. Based on the EIA data of electricity generation and capacity, the average annual operating hours can be calculated.

Table 13. Average Operating Hours: Total Electric Power Industry

	Average Operating Hours Units: Hours/Year								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar 1/	Total
1990	5,163	100	1,796	3,990	-	4,418	1,245	-	4,909
1991	4,038	320	5,720	4,044	-	3,944	1,580	-	3,979
1992	4,281	2,443	6,933	3,508	71	3,396	1,006	-	3,964
1993	3,743	6,493	7,008	3,500	5,075	3,125	973	-	3,970
1994	3,868	5,824	7,302	3,553	6,177	5,052	902	-	4,047
1995	3,887	6,853	7,701	3,308	6,701	3,384	932	-	4,136
1996	4,014	7,213	6,707	3,066	6,914	3,600	1,023	-	4,252
1997	3,899	6,913	7,265	3,403	7,011	3,950	792	-	4,173
1998	3,931	6,299	6,716	3,073	6,774	4,196	952	-	4,121
1999	3,983	6,322	5,501	3,696	6,024	4,046	1,783	-	4,208
2000	3,851	6,924	4,686	3,473	7,487	3,832	1,417	-	4,143
2001	3,929	7,069	4,206	1,905	5,903	3,875	193	-	4,167
2002	4,523	6,810	4,535	2,696	2,079	3,803	147	-	4,647
2003	4,070	7,243	4,472	3,045	5,094	3,935	143	-	4,377
2004	4,107	7,900	5,323	2,884	6,094	4,083	681	-	4,435
2005	4,137	8,034	4,570	2,717	6,331	3,848	603	-	4,451
2006	4,079	7,629	4,751	2,857	6,065	4,803	1,853	-	4,364
2007	4,008	7,778	5,025	2,502	6,568	3,694	3,722	-	4,313
2008	3,898	8,116	4,286	2,653	6,695	3,374	3,750	18	4,253
2009	3,697	7,390	2,483	1,253	4,788	4,506	3,929	1,390	3,925
2010	3,653	7,613	2,435	1,249	5,731	2,817	4,212	885	3,903
2011	3,579	7,015	2,889	1,378	6,397	3,741	3,721	1,633	3,817
2012	3,431	7,573	7,839	1,239	5,118	4,373	1,840	640	3,511
2013	3,312	6,915	6,888	1,265	5,389	2,988	2,448	1,281	3,413
2014	3,335	7,444	10,367	1,303	4,977	3,591	2,814	1,219	3,498
2015	3,410	6,588	5,573	1,252	4,516	4,625	2,980	1,231	3,464

1/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

As shown in Table 13, for the total electric power industry, coal-fired units had the highest average annual operating hours at 6,588 hours, followed by other gases-fueled units at 5,573 hours, hydro units at 4,625 hours, and geothermal units at 4,516 hours. The coal-fired units were used to serve base load needs. Petroleum units have average annual operating hours of 3,328 hours, similar to the average annual operating hours of all units at 3,464 hours. Biomass units have relatively low average operating hours because the biodiesel units at HECO are used to serve peak loads. The low average operating hours of solar units is due to the lower daily solar generating window.

Table 14. Average Operating Hours: Electric Utilities

	Average Operating Hours Units: Hours/Year								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar 1/	Total
1990	5,180	-	-	-	-	6,789	-	-	5,187
1991	4,647	-	-	-	-	6,090	-	-	4,650
1992	4,236	-	-	-	-	2,932	-	-	4,233
1993	3,667	-	-	-	-	4,105	-	-	3,668
1994	3,646	-	-	-	-	5,613	-	-	3,650
1995	3,730	-	-	-	-	4,763	-	-	3,732
1996	3,848	-	-	-	-	5,333	-	-	3,851
1997	3,749	-	-	-	-	5,609	-	-	3,753
1998	3,749	-	-	-	-	4,104	-	-	3,750
1999	3,811	-	-	-	-	5,625	-	-	3,817
2000	3,822	-	-	-	-	5,038	1,325	-	3,821
2001	3,736	-	-	-	-	6,044	1,055	-	3,737
2002	4,408	-	-	-	-	4,267	803	-	4,404
2003	3,813	-	-	-	-	1,039	781	-	3,806
2004	3,892	-	-	-	-	4,862	743	-	3,890
2005	3,823	-	-	-	-	2,292	849	-	3,816
2006	3,828	-	-	-	-	5,914	420	-	3,828
2007	3,761	-	-	-	-	3,682	219	-	3,757
2008	3,636	-	-	-	-	4,468	86	-	3,634
2009	3,374	-	-	29	-	7,152	43	-	3,296
2010	3,382	-	-	14	-	4,180	-	-	3,300
2011	3,342	-	-	343	-	4,878	-	-	3,279
2012	3,213	-	-	191	-	7,059	-	-	3,092
2013	3,073	-	-	252	1	4,625	-	-	2,956
2014	3,110	-	-	324	2	5,742	-	-	2,979
2015	3,124	-	-	464	3	5,301	-	-	2,961

1/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

Table 14 and Table 15 compare the average operating hours of utility generating units and non-utility generating units. For all generating units, the average operating hours of utility-based units decreased from 5,187 hours per year in 1990 to 2,961 hours per year in 2015, a decrease of 2.2 percent per year on average. In contrast, the average operating hours of non-utility units increased from 3,925 hours per year in 1990 to 4,341 hours per year in 2015, an increase of 0.4 percent per year on average.

Table 15. Average Operating Hours: IPP and CHP

	Average Operating Hours Units: Hours/Year								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar 1/	Total
1990	5,000	100	1,796	3,962	-	3,875	1,245	-	3,925
1991	1,193	320	5,720	4,044	-	3,453	1,580	-	2,245
1992	4,503	2,443	6,933	3,508	71	3,502	1,006	-	3,457
1993	4,134	6,493	7,008	3,500	5,075	2,900	973	-	4,561
1994	5,011	5,824	7,302	3,553	6,177	4,974	902	-	4,830
1995	4,697	6,853	7,701	3,308	6,701	3,204	932	-	4,941
1996	4,874	7,213	6,707	3,066	6,914	3,372	1,023	-	5,054
1997	4,669	6,913	7,265	3,403	7,011	3,735	792	-	5,023
1998	4,884	6,299	6,716	3,073	6,774	4,208	937	-	4,897
1999	4,890	6,322	5,501	3,696	6,024	3,835	1,373	-	5,051
2000	3,976	6,924	4,686	3,473	7,487	3,681	1,435	-	4,792
2001	4,772	7,069	4,206	1,905	5,903	3,592	1	-	5,036
2002	5,023	6,810	4,535	2,696	2,079	3,762	1	-	5,162
2003	5,202	7,243	4,472	3,045	5,094	4,211	1	-	5,590
2004	5,099	7,900	5,323	2,884	6,094	4,008	668	-	5,691
2005	5,604	8,034	4,570	2,717	6,331	4,144	548	-	5,930
2006	5,267	7,629	4,751	2,857	6,065	4,592	1,923	-	5,579
2007	5,184	7,778	5,025	2,502	6,568	3,696	3,835	-	5,548
2008	5,149	8,116	4,286	2,653	6,695	3,165	3,869	18	5,627
2009	5,251	7,390	2,483	2,466	4,788	4,002	4,054	1,390	5,423
2010	4,932	7,613	2,435	2,472	5,731	2,557	4,212	885	5,312
2011	4,703	7,015	2,889	2,407	6,397	3,516	3,721	1,633	5,025
2012	4,423	7,573	7,839	2,279	5,118	3,875	1,840	640	4,296
2013	4,400	6,915	6,888	2,041	5,389	2,685	2,448	1,281	4,247
2014	4,304	7,444	10,367	2,074	4,977	3,192	2,814	1,428	4,401
2015	4,633	6,588	5,573	1,873	4,516	4,499	2,980	1,458	4,341

1/ Does not include customer-sited solar.

Source: Energy Information Administration, State Energy Data System

For petroleum generating capacity, the average operating hours of utility-based units decreased from 5,180 hours per year in 1990 to 3,124 hours per year in 2015, an average decrease of 2.0 percent per year. The average operating hours of non-utility units decreased from 5,000 hours per year in 1990 to 4,633 hours per year in 2015, an average decrease of 0.3 percent per year.

Table 16. Fossil Fuel Consumption: Total Electric Power Industry

	Consumption			Consumption Per MWH		
Year	Petroleum BBL	Coal ST	Other Gases Billion BTU	Petroleum BBL	Coal ST	Other Gases Billion BTU
1990	16,033,262	2,013	211	1.84	0.85	0.01
1993	12,605,395	603,669	1,044	1.70	0.41	0.02
1994	12,933,103	596,431	913	1.69	0.45	0.01
1995	13,034,983	688,499	663	1.70	0.44	0.01
1996	13,451,479	742,026	1,027	1.69	0.45	0.02
1997	13,226,872	754,453	622	1.72	0.48	0.01
1998	13,262,910	638,057	811	1.69	0.44	0.01
1999	13,544,370	646,215	447	1.69	0.45	0.01
2000	13,754,387	691,513	388	1.71	0.44	0.01
2001	13,661,310	717,290	315	1.66	0.45	0.01
2002	15,661,770	706,734	325	1.65	0.46	0.01
2003	13,133,452	751,987	361	1.54	0.46	0.01
2004	13,995,473	702,545	269	1.56	0.44	0.01
2005	14,131,327	703,865	231	1.56	0.43	0.01
2006	14,211,287	674,909	240	1.57	0.44	0.01
2007	13,943,232	689,627	254	1.56	0.44	0.01
2008	13,407,277	746,642	213	1.55	0.45	0.01
2009	12,739,777	663,171	126	1.54	0.44	0.01
2010	12,334,599	733,480	123	1.53	0.47	0.01
2011	12,089,799	709,440	198	1.53	0.50	0.01
2012	11,199,945	756,726	265	1.50	0.49	0.01
2013	10,765,251	701,013	228	1.49	0.50	0.01
2014	10,388,099	743,893	350	1.50	0.49	0.01
2015	10,510,012	653,257	276	1.50	0.49	0.01
2016*	9,598,139	741,472	234	1.50	0.49	0.01

* Preliminary

Source: Energy Information Administration, State Energy Data System

Fossil fuels used to generate electricity in Hawaii consist mainly of petroleum and coal. As shown in Table 16, for the whole electric power industry, total petroleum used for electricity generation decreased from about 16.0 million barrels (BBLs) in 1990 to 9.6 million BBLs in 2016, an average decrease of 2.0 percent per year. Decreased petroleum consumption for electricity generation was due to both a reduction in electricity generated by petroleum and a reduction in petroleum consumption per kWh of electricity generated. From 1990 to 2016, total electricity generated by petroleum decreased an average of 1.2 percent per year and petroleum consumption per MWH of electricity decreased 0.8 percent per year, from 1.84 BBL per MWH in 1990 to 1.50 BBL per MWH in 2016.

Coal used for electricity generation in Hawaii was very limited before 1993. From 1993 to 2016, total coal used for electricity generation increased from 603,669 short tons (STs) to 741,472 STs, an average increase of 0.9 percent per year. During this period, total coal generated electricity increased 0.1 percent per year, and coal consumption per MWH generated increased 0.8 percent per year on average, from 0.41 ST per MWH to 0.49 ST per MWH.

The utilities accounted for about 85 percent of the petroleum used to generate electricity in Hawaii. As shown in Table 17, petroleum consumption per MWH was fairly stable over the period analyzed for utility units. From 1990 to 2016, petroleum consumption per MWH decreased only slightly from 1.73 BBL per MWH to 1.72 BBL per MWH.

The non-utility petroleum units are more energy efficient than the utility units. In addition, the energy efficiency of non-utility units improved over time. From 1990 to 2016, petroleum consumption per MWH for non-utility petroleum units decreased an average of 4.4 percent per year from 2.95 BBL to 0.87 BBL. In 2016, the petroleum consumption per MWH for non-utility producers was only about 51 percent of the per MWH petroleum consumption by utility producers.

Table 17. Fossil Fuel Consumption: Electric Utility

	Consumption			Consumption Per MWH		
Year	Petroleum BBL	Coal ST	Other Gases Billion BTU	Petroleum BBL	Coal ST	Other Gases Billion BTU
1990	13,769,448	-	-	1.73	-	-
1995	10,712,608	-	-	1.73	-	-
1996	10,980,227	-	-	1.72	-	-
1997	10,792,923	-	-	1.74	-	-
1998	10,864,385	-	-	1.73	-	-
1999	11,195,221	-	-	1.74	-	-
2000	11,439,206	-	-	1.76	-	-
2001	11,055,880	-	-	1.74	-	-
2002	12,825,449	-	-	1.71	-	-
2003	11,099,634	-	-	1.71	-	-
2004	12,046,236	-	-	1.73	-	-
2005	12,039,252	-	-	1.74	-	-
2006	12,238,861	-	-	1.74	-	-
2007	12,027,927	-	-	1.74	-	-
2008	11,516,852	-	-	1.72	-	-
2009	10,859,417	-	-	1.73	-	-
2010	10,601,260	-	-	1.72	-	-
2011	10,471,897	-	-	1.71	-	-
2012	9,646,276	-	-	1.68	-	-
2013	9,267,226	-	-	1.69	-	-
2014	8,892,659	-	-	1.70	-	-
2015	8,877,217	-	-	1.70	-	-
2016*	8,179,784	-	-	1.72	-	-

* Preliminary

Source: Energy Information Administration, State Energy Data System

Table 18. Fossil Fuel Consumption: IPP and CHP

	Consumption			Consumption Per MWH		
Year	Petroleum BBL	Coal ST	Other Gases Billion BTU	Petroleum BBL	Coal ST	Other Gases Billion BTU
1990	2,263,814	2,013	211	2.95	0.85	0.01
1993	1,949,294	603,669	1,044	1.47	0.41	0.02
1994	2,524,020	596,431	913	1.57	0.45	0.01
1995	2,322,375	688,499	663	1.54	0.44	0.01
1996	2,471,252	742,026	1,027	1.58	0.45	0.02
1997	2,433,949	754,453	622	1.63	0.48	0.01
1998	2,398,525	638,057	811	1.53	0.44	0.01
1999	2,349,149	646,215	447	1.50	0.45	0.01
2000	2,315,181	691,513	388	1.51	0.44	0.01
2001	2,605,430	717,290	315	1.40	0.45	0.01
2002	2,836,321	706,734	325	1.44	0.46	0.01
2003	2,033,818	751,987	361	1.01	0.46	0.01
2004	1,949,237	702,545	269	0.99	0.44	0.01
2005	2,092,075	703,865	231	0.97	0.43	0.01
2006	1,972,426	674,909	240	0.97	0.44	0.01
2007	1,915,305	689,627	254	0.96	0.44	0.01
2008	1,890,425	746,642	213	0.95	0.45	0.01
2009	1,880,360	663,171	126	0.93	0.44	0.01
2010	1,733,339	733,480	123	0.91	0.47	0.01
2011	1,617,902	709,440	198	0.89	0.50	0.01
2012	1,553,669	756,726	265	0.89	0.49	0.01
2013	1,498,025	701,013	228	0.87	0.50	0.01
2014	1,495,440	743,893	350	0.89	0.49	0.01
2015	1,632,795	653,257	276	0.90	0.49	0.01
2016*	1,418,355	741,472	234	0.87	0.49	0.01

* Preliminary

Source: Energy Information Administration, State Energy Data System

Fuel consumption data provided by the EIA is only available at the state level. Conversely, data available from the utility MFR includes fuel consumption by individual utility producers, and the average price of fuel data is also available. The fuel cost of non-utility producers, however, is not available in the utility MFR.

As shown in Table 19, from 2005 to 2016, total petroleum consumption by the four electric utilities in Hawaii decreased an average 2.6 percent per year from about 12.0 million BBLs to about 9.0 million BBLs; fuel oil consumption decreased an average 2.9 percent per year from 9.1 million BBLs to 6.6 million BBLs; diesel oil consumption decreased an average 1.6 percent per year, from 2.9 million BBLs to 2.4 million BBLs. In 2016, petroleum consumption by the utilities decreased 3.9 percent from the previous year; fuel oil decreased 2.9 percent, while diesel decreased 6.8 percent.

Table 19. Hawaii Utility Fuel Consumption

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Petroleum											
State Total	BBL	12,046,758	10,999,054	10,955,730	10,101,880	9,731,334	9,381,568	9,389,734	9,019,130	-3.9%	-2.6%
HECO	BBL	7,993,010	7,382,437	7,394,958	6,793,695	6,506,464	6,283,047	6,374,751	5,952,009	-6.6%	-2.6%
HELCO	BBL	1,136,268	1,046,406	1,031,711	904,034	997,659	965,542	909,157	1,034,292	13.8%	-0.9%
MECO	BBL	2,170,554	1,846,995	1,806,667	1,697,767	1,539,175	1,480,580	1,477,603	1,515,071	2.5%	-3.2%
KIUC	BBL	746,926	723,216	722,394	706,384	688,036	652,399	628,223	517,758	-17.6%	-3.3%
Fuel Oil											
State Total	BBL	9,120,687	8,357,750	8,263,907	7,612,236	7,207,891	6,867,426	6,766,206	6,573,322	-2.9%	-2.9%
HECO	BBL	7,874,530	7,307,478	7,285,178	6,703,981	6,391,243	6,112,576	6,139,949	5,768,973	-6.0%	-2.8%
HELCO	BBL	726,866	612,502	577,107	533,394	533,483	458,212	387,475	509,691	31.5%	-3.2%
MECO	BBL	519,291	437,770	401,622	374,861	283,165	296,638	238,782	294,658	23.4%	-5.0%
KIUC	BBL	-	-	-	-	-	-	-	-		
Diesel											
State Total	BBL	2,926,071	2,641,304	2,691,823	2,489,644	2,523,443	2,514,142	2,623,528	2,445,808	-6.8%	-1.6%
HECO	BBL	118,480	74,959	109,780	89,714	115,221	170,471	234,802	183,036	-22.0%	4.0%
HELCO	BBL	409,402	433,904	454,604	370,640	464,176	507,330	521,682	524,601	0.6%	2.3%
MECO	BBL	1,651,263	1,409,225	1,405,045	1,322,906	1,256,010	1,183,942	1,238,821	1,220,413	-1.5%	-2.7%
KIUC	BBL	746,926	723,216	722,394	706,384	688,036	652,399	628,223	517,758	-17.6%	-3.3%
% of Fuel Oil											
State Total	%	75.7%	76.0%	75.4%	75.4%	74.1%	73.2%	72.1%	72.9%		
HECO	%	98.5%	99.0%	98.5%	98.7%	98.2%	97.3%	96.3%	96.9%		
HELCO	%	64.0%	58.5%	55.9%	59.0%	53.5%	47.5%	42.6%	49.3%		
MECO	%	23.9%	23.7%	22.2%	22.1%	18.4%	20.0%	16.2%	19.4%		
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		
County % of Fuel Oil											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	86.3%	87.4%	88.2%	88.1%	88.7%	89.0%	90.7%	87.8%		
HELCO	%	8.0%	7.3%	7.0%	7.0%	7.4%	6.7%	5.7%	7.8%		
MECO	%	5.7%	5.2%	4.9%	4.9%	3.9%	4.3%	3.5%	4.5%		
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		
County % of Diesel											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	4.0%	2.8%	4.1%	3.6%	4.6%	6.8%	8.9%	7.5%		
HELCO	%	14.0%	16.4%	16.9%	14.9%	18.4%	20.2%	19.9%	21.4%		
MECO	%	56.4%	53.4%	52.2%	53.1%	49.8%	47.1%	47.2%	49.9%		
KIUC	%	25.5%	27.4%	26.8%	28.4%	27.3%	25.9%	23.9%	21.2%		

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 19 also shows that the fuel oil share of total petroleum consumption for electricity production decreased from 75.7 percent in 2005 to 72.9 percent in 2016. For HECO, almost all the petroleum consumed was fuel oil. In 2016, fuel oil accounted for about 49.3 percent of total petroleum consumption at HELCO, and about 19.4 percent of total petroleum consumption at MECO. All petroleum consumed at KIUC was diesel.

From 2005 to 2012, both total fuel oil cost and total diesel oil cost paid by the utilities in Hawaii increased significantly, although consumption of both fuels decreased. The growth rate of fuel oil costs was significantly higher than the growth rate of diesel costs.

Table 20. Hawaii Utility Fuel Cost

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Petroleum											
State Total	$M	694	969	1,356	1,391	1,277	1,216	706	489	-30.7%	-3.1%
HECO	$M	421	631	909	945	851	821	458	305	-33.3%	-2.9%
HELCO	$M	65	93	122	117	126	117	72	55	-23.3%	-1.5%
MECO	$M	154	176	234	235	209	193	125	94	-24.4%	-4.4%
KIUC	$M	54	69	91	94	92	84	51	35	-32.2%	-4.0%
Fuel Oil											
State Total	$M	467	708	993	1,033	922	868	465	323	-30.6%	-3.3%
HECO	$M	412	623	889	924	831	790	428	292	-31.6%	-3.1%
HELCO	$M	33	50	62	65	60	48	24	19	-19.4%	-5.0%
MECO	$M	22	35	42	44	31	30	13	11	-16.9%	-6.1%
KIUC	$M	-	-	-	-	-	-	-	-		
Diesel											
State Total	$M	226	261	363	358	356	348	241	167	-30.8%	-2.7%
HECO	$M	9	8	20	21	20	31	30	13	-57.4%	3.4%
HELCO	$M	32	43	60	52	66	69	48	36	-25.2%	1.1%
MECO	$M	132	141	192	191	178	164	111	83	-25.3%	-4.1%
KIUC	$M	54	69	91	94	92	84	51	35	-32.2%	-4.0%
% of Fuel Oil											
State Total	%	67.4%	73.0%	73.2%	74.2%	72.1%	71.4%	65.9%	65.9%		
HECO	%	97.9%	98.7%	97.8%	97.8%	97.6%	96.2%	93.4%	95.8%		
HELCO	%	51.2%	53.8%	50.6%	55.4%	47.5%	40.8%	32.8%	34.5%		
MECO	%	14.5%	19.7%	18.0%	18.7%	14.7%	15.3%	10.7%	11.8%		
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		

Source: Hawaii Electric Utility Monthly Financial Reports.

From 2005 to 2012, total petroleum costs for Hawaii's utilities increased an average 10.5 percent per year, from $694 million to $1,391 million; fuel oil costs increased an average 12.0 percent per year, from $467 million to $1,033 million; and diesel oil costs increased an average 6.8 percent per year, from $226 million to $358 million (Table 20). Due to the faster growth of fuel oil expenditures, the fuel oil share of total utility petroleum expenditures increased from 67.4 percent in 2005 to 74.2 percent in 2012, an increase of 6.9 percentage points.

Since 2012, however, the costs of fuel oil and diesel both decreased from each of the previous years. In 2016, the cost of utility petroleum decreased 30.7 percent or $216 million from the previous year; the cost of fuel oil decreased 30.6 percent or $142 million, and the cost of diesel decreased 30.8 percent or $74 million. The decrease in fuel costs in 2016 was mainly driven by the decrease in petroleum prices. Reduced electricity generation by petroleum also contributed to the decreases in fuel costs.

The average unit cost of petroleum used for utility electricity generation increased rapidly from 2005 to 2012, with the growth rate being significantly higher than the growth rate of crude oil prices. In this period, the average unit petroleum cost for the four electric utilities in Hawaii increased an average of 13.3 percent per year, from $57.57 per BBL to $137.74 per BBL (Table 21). Fuel oil costs increased an average 14.9 percent per year, from $51.22 per BBL to $135.72 per BBL, and diesel oil costs increased an average 9.3 percent per year, from $77.36 per BBL to $143.93 per BBL. In comparison, the average crude oil price increased an average 7.6 percent per year during the same period.

From 2012 to 2016, the unit fuel oil cost decreased 22.5 percent per year on average, and the unit diesel cost decreased 17.0 percent per year. In 2016, the unit fuel oil costs were highest at HECO, followed by MECO and HELCO. Unit diesel costs were highest at HECO, followed by HELCO, MECO, and KIUC.

Table 21. Hawaii Utility Average Fuel Cost

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Petroleum											
State Total	$/BBL	57.57	88.13	123.74	137.74	131.26	129.63	75.14	54.25	-27.8%	-0.5%
HECO	$/BBL	52.61	85.49	122.94	139.14	130.85	130.71	71.86	51.30	-28.6%	-0.2%
HELCO	$/BBL	57.44	89.33	118.09	129.27	125.81	121.40	79.03	53.27	-32.6%	-0.7%
MECO	$/BBL	70.88	95.17	129.58	138.60	135.57	130.51	84.38	62.21	-26.3%	-1.2%
KIUC	$/BBL	72.19	95.27	125.40	133.12	133.37	129.37	81.09	66.75	-17.7%	-0.7%
Fuel Oil											
State Total	$/BBL	51.22	84.71	120.15	135.72	127.85	126.38	68.67	49.06	-28.5%	-0.4%
HECO	$/BBL	52.26	85.27	122.03	137.88	130.04	129.30	69.65	50.69	-27.2%	-0.3%
HELCO	$/BBL	45.96	82.05	106.84	121.43	111.80	104.45	60.89	37.29	-38.8%	-1.9%
MECO	$/BBL	42.93	79.14	105.17	117.39	108.67	99.99	55.92	37.67	-32.6%	-1.2%
KIUC	$/BBL										
Diesel											
State Total	$/BBL	77.36	98.93	134.79	143.93	140.99	138.49	91.83	68.18	-25.8%	-1.1%
HECO	$/BBL	76.07	107.47	183.76	232.92	175.60	181.04	129.46	70.77	-45.3%	-0.7%
HELCO	$/BBL	77.84	99.61	132.38	140.56	141.92	136.71	92.51	68.79	-25.6%	-1.1%
MECO	$/BBL	79.67	100.14	136.56	144.61	141.64	138.15	89.87	68.13	-24.2%	-1.4%
KIUC	$/BBL	72.19	95.27	125.40	133.12	133.37	129.37	81.09	66.75	-17.7%	-0.7%

Source: Hawaii Electric Utility Monthly Financial Reports.

In recent years, electricity generated from renewable sources has increased significantly. Based on the most recent data provided by the utility Renewable Portfolio Standard Status Reports, from 2005 to 2016, total renewable electricity generated by the electric power industry (excluding customer generated electricity) increased 7.9 percent per year on average, from 714 GWH to 1,639 GWH (Table 22). The renewable electricity share of total electricity sales increased from 6.8 percent to 17.7 percent during this period.

Table 22. Renewable Electricity Generation in Hawaii

	Renewable Electricity Generation (GWH)						
Year	Total	Biomass	Biofuels	Geothermal	Hydro	Wind	PV&Solar 1/
2005	714	403	0	221	82	7	-
2006	861	470	0	212	97	82	-
2007	938	392	1	230	72	242	-
2008	963	413	2	234	78	237	-
2009	930	399	5	168	107	250	1
2010	897	359	3	202	70	261	2
2011	1,096	365	59	233	90	344	4
2012	1,134	342	23	266	104	388	12
2013	1,352	416	30	281	74	504	48
2014	1,457	433	37	255	85	578	68
2015	1,517	422	53	230	107	613	92
2016	1,639	473	38	260	89	657	122
Change 05-16	926	70	38	39	7	650	122
Growth 05-16	7.9%	1.5%	71.8%	1.5%	0.7%	51.1%	NA
Growth 13-16	6.6%	4.4%	8.9%	-2.6%	6.7%	9.3%	36.2%
	% in Renewable Electricity Generation						
Year	Total	Biomass	Biofuels	Geothermal	Hydro	Wind	PV&Solar 1/
2005	100.0	56.5	0.0	31.0	11.6	1.0	-
2006	100.0	54.6	0.0	24.6	11.3	9.5	-
2007	100.0	41.8	0.1	24.5	7.7	25.9	-
2008	100.0	42.8	0.2	24.3	8.1	24.6	-
2009	100.0	42.9	0.5	18.0	11.5	26.9	0.1
2010	100.0	40.0	0.4	22.5	7.8	29.1	0.2
2011	100.0	33.3	5.4	21.3	8.3	31.4	0.3
2012	100.0	30.1	2.0	23.5	9.2	34.2	1.0
2013	100.0	30.7	2.2	20.8	5.4	37.2	3.6
2014	100.0	29.7	2.5	17.5	5.9	39.7	4.7
2015	100.0	27.8	3.5	15.2	7.0	40.4	6.1
2016	100.0	28.8	2.3	15.9	5.5	40.1	7.4

1/ Does not include customer-sited solar.

Source: HECO and KIUC Renewable Portfolio Standard Status Report.

In 2016, 40.1 percent of Hawaii's renewable electricity was generated from wind, 28.8 percent from biomass, 15.9 percent from geothermal, 5.5 percent from hydro, 2.3 percent from biofuels, and 7.4 percent from PV and solar thermal (does not include customer-sited PV solar systems).

Table 23 shows renewable electricity generation by county. From 2005 to 2016, excluding customer generated electricity, Honolulu renewable electricity generation increased the most at 410 GWH or 7.6 percent per year. This was followed by Maui at 218 GWH or 13.2 percent per year, Hawaii County at 196 GWH or 5.1 percent per year, and Kauai at 101 GWH or 12.6 percent per year. In 2016, excluding customer generated electricity, renewable electricity accounted for about 43.5 percent of electricity sales in Hawaii County. Hawaii County was followed by Kauai at 31.6 percent, Maui at about 26.2 percent, and Honolulu at 11.2 percent.

In addition to the renewable electricity generated by the electricity producers, electricity customers also generate significant renewable electricity. From 2005 to 2016, customer generated electricity in Hawaii increased 69.9 percent per year from 2.4 GWH to 827 GWH. Customer generated electricity increased the most in Honolulu at about 548 GWH or 92.8 percent per year. Honolulu was followed by Maui at 119 GWH or 72.3 percent, Hawaii County at 113 GWH or 47.5 percent per year, and Kauai at 44 GWH or 70.9 percent per year. From 2005 to 2016, total renewable electricity, including customer generated electricity increased 1,750 GWH or 11.9 percent per year in Hawaii. In 2016, total renewable electricity generated in Hawaii was about 2,466 GWH, accounting for about 26.6 percent of total electricity sold by utilities.

Table 23. Hawaii Renewable Electricity Generation by County

		2005	2007	2009	2011	2013	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Renewable Generation State 1/	GWH	714	938	930	1,096	1,352	1,517	1,639	8.0%	7.9%
Honolulu	GWH	333	326	364	431	552	695	743	6.9%	7.6%
Hawaii	GWH	268	389	368	436	470	429	464	8.3%	5.1%
Maui	GWH	75	196	161	189	283	314	293	-6.7%	13.2%
Kauai	GWH	37	26	37	40	48	80	139	74.1%	12.6%
Customer-Sited, Grid-Connecte	GWH	2.4	7.7	33.3	90.1	355.6	681.3	826.8	21.4%	69.9%
Honolulu	GWH	0.4	1.7	15.7	54.2	248.9	464.4	548.6	18.1%	92.8%
Hawaii	GWH	1.6	4.4	9.6	17.7	47.5	89.7	114.8	28.0%	47.5%
Maui	GWH	0.3	1.3	4.8	13.0	47.5	89.0	119.4	34.3%	72.3%
Kauai	GWH	0.1	0.3	3.3	5.2	11.7	38.3	44.0	15.0%	70.9%
Total Renewable	GWH	716.0	945.2	963.1	1,186.0	1,707.8	2,198.8	2,466.0	12.2%	11.9%
Honolulu	GWH	333.4	327.7	379.3	484.8	801.0	1,159.6	1,292.0	11.4%	13.1%
Hawaii	GWH	269.6	393.1	377.7	453.3	517.4	518.3	578.8	11.7%	7.2%
Maui	GWH	75.4	197.7	165.8	202.3	330.1	402.8	412.3	2.4%	16.7%
Kauai	GWH	37.6	26.7	40.2	45.6	59.4	118.0	182.9	55.0%	15.5%

1/ Does not include customer-sited solar.

Source: HECO and KIUC Renewable Portfolio Standard Status Report.

Table 24 shows detailed renewable electricity (excluding customer generated electricity) by county and by energy sources.

Table 24. Hawaii Renewable Electricity Generation by County and by Source

		2005	2007	2009	2011	2013	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Renewable Generation State 1/	GWH	714	938	930	1,096	1,352	1,517	1,639	8.0%	7.9%
Honolulu	GWH	333	326	364	431	552	695	743	6.9%	7.6%
Hawaii	GWH	268	389	368	436	470	429	464	8.3%	5.1%
Maui	GWH	75	196	161	189	283	314	293	-6.7%	13.2%
Kauai	GWH	37	26	37	40	48	80	139	74.1%	12.6%
Biomass State	GWH	403	392	399	365	416	422	473	12.0%	1.5%
Honolulu	GWH	333	326	360	322	375	386	419	8.5%	2.1%
Hawaii	GWH	-	-	-	-	-	-	-		
Maui	GWH	70	66	38	44	41	31	4	-85.8%	-22.3%
Kauai	GWH	-	-	-	-	-	5	50	808.6%	
Biofuels State	GWH	0	1	5	59	30	53	38	-28.0%	71.8%
Honolulu	GWH	-	-	3	45	29	52	37	-28.5%	
Hawaii	GWH	-	-	-	-	-	-	-		
Maui	GWH	0	1	2	15	1	1	1	-0.4%	23.1%
Kauai	GWH	-	-	-	-	-	-	-		
Geothermal State	GWH	221	230	168	233	281	230	260	12.9%	1.5%
Honolulu	GWH	-	-	-	-	-	-	-		
Hawaii	GWH	221	230	168	233	281	230	260	12.9%	1.5%
Maui	GWH	-	-	-	-	-	-	-		
Kauai	GWH	-	-	-	-	-	-	-		
Hydroelectricity State	GWH	82	72	107	90	74	107	89	-16.3%	0.7%
Honolulu	GWH	-	-	-	-	-	-	-		
Hawaii	GWH	40	42	60	45	35	63	54	-14.5%	2.8%
Maui	GWH	5	3	10	6	5	10	1	-90.1%	-13.9%
Kauai	GWH	37	26	37	39	33	34	34	1.9%	-0.8%
Wind State	GWH	7	242	250	344	504	613	657	7.2%	51.1%
Honolulu	GWH	-	-	-	64	122	216	234	8.0%	
Hawaii	GWH	7	116	141	157	152	132	146	10.1%	31.8%
Maui	GWH	-	126	110	123	230	264	277	5.0%	
Kauai	GWH	-	-	-	-	-	-	-		
Photovoltaic and Solar State	GWH	-	-	1	4	48	92	122	32.6%	
Honolulu	GWH	-	-	-	0	27	41	54	31.8%	
Hawaii	GWH	-	-	-	0	2	3	4	59.2%	
Maui	GWH	-	-	1	2	5	8	9	14.9%	
Kauai	GWH	-	-	-	1	14	41	55	35.1%	
Electricity Sold State	GWH	10,539	10,585	10,126	9,962	9,501	9,389	9,284	-1.1%	-1.1%
Honolulu	GWH	7,721	7,675	7,378	7,242	6,859	6,754	6,660	-1.4%	-1.3%
Hawaii	GWH	1,116	1,163	1,120	1,104	1,076	1,065	1,067	0.2%	-0.4%
Maui	GWH	1,252	1,280	1,192	1,181	1,135	1,138	1,118	-1.7%	-1.0%
Kauai	GWH	449	467	437	435	431	432	439	1.6%	-0.2%
% of Renewable State	%	6.8	8.9	9.2	11.0	14.2	16.2	17.7		
Honolulu	%	4.3	4.2	4.9	5.9	8.0	10.3	11.2		
Hawaii	%	24.0	33.4	32.9	39.5	43.7	40.3	43.5		
Maui	%	6.0	15.3	13.5	16.0	24.9	27.6	26.2		
Kauai	%	8.4	5.7	8.5	9.3	11.0	18.5	31.6		

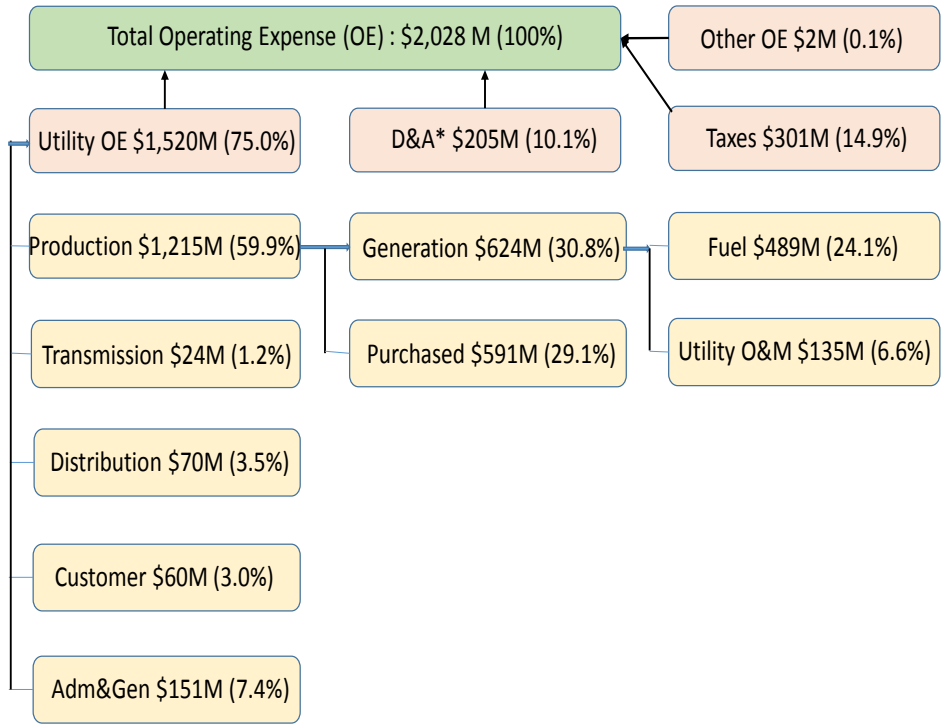
1/ Does not include customer-sited solar.

Source: HECO and KIUC Renewable Portfolio Standard Status Report.

4. Factors Affecting Electricity Expenditures in Hawaii

The electricity expenditures of customers in Hawaii, excluding the expenditures of the customer-generated electricity, are determined by the revenues of the utilities in Hawaii. The revenues of the utilities are mainly affected by the operating expense of the utilities. As shown in Figure 4, the total operating expense (OE) includes four components: (1) utility operating expense, (2) depreciation and amortization (D&A), (3) taxes, and (4) other operation expense. In 2016, utility operating expense accounted for about 75 percent of total OE, the other three components accounted for about 25 percent. Utility OE includes five major components: production cost, transmission cost, distribution cost, customer accounts and serves cost, and administration and general cost. The production cost accounted for 59.9 percent of total OE in 2016. The production cost includes mainly fuel cost, purchased power cost, and utility operation and maintenance cost (O&M). In 2016, fuel cost accounted for about 24.1 percent of total OE, purchased power accounted for about 29.1 percent.

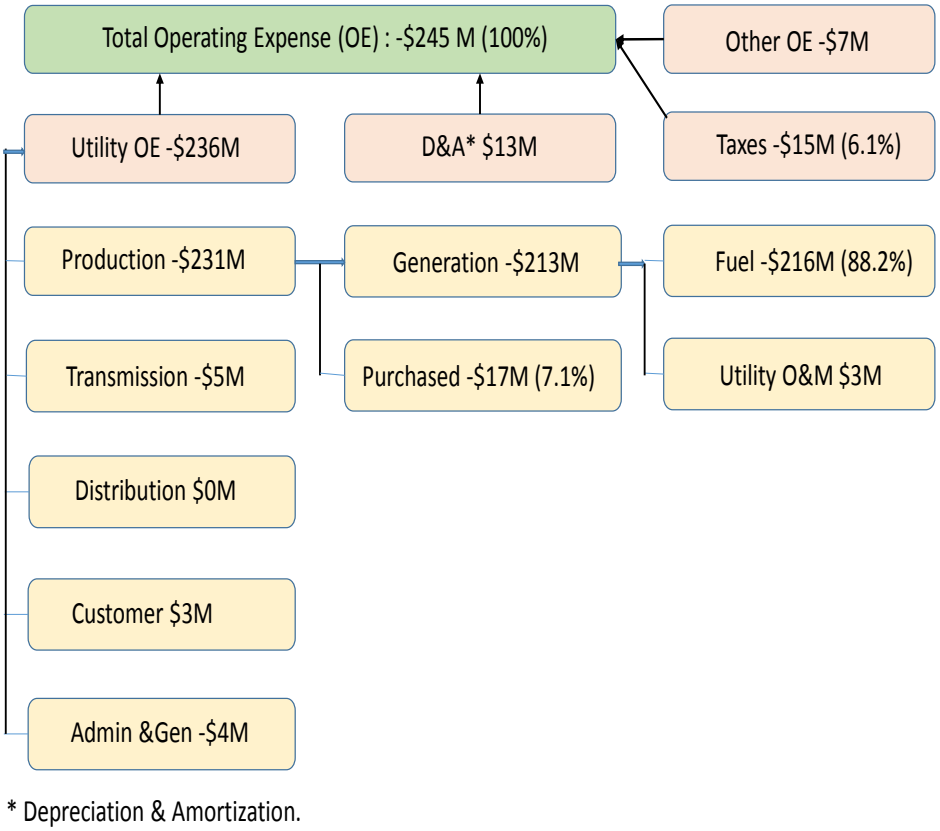
Figure 4. Components of Utility Operating Expense in Hawaii: 2016



* Depreciation & Amortization.

As shown in Figure 5, in 2016, the total operating expense of Hawaii's utilities decreased by $245 million. Of this decrease, about 88.2 percent or $216 million was due to the reduced fuel cost, about 7.1 percent or $17 million was due to the reduced purchased power cost, and about 6.1 percent or $15 million was due to reduced taxes. The utility O&M, transmission and distribution, customer cost, and administration and general cost changed very little.

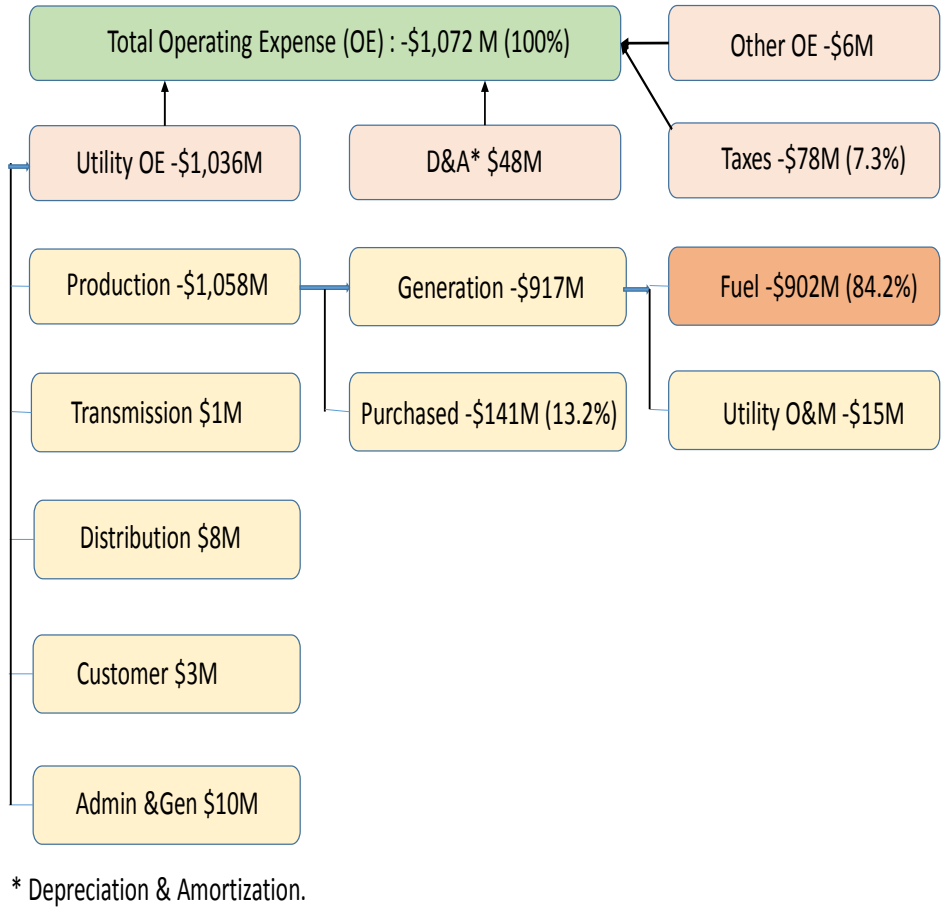
Figure 5. Changes of Utility Operating Expense in Hawaii: 2015-2016



* Depreciation & Amortization.

Due to petroleum price increases from 2005 to 2012, the utilities' fuel cost reached a peak of $1,391 million and purchased electricity increased to $732 million in 2012. From 2012 to 2016, due to reduced petroleum prices and reduced electricity generation from petroleum, the fuel cost decreased substantially. Along with this, purchased electricity costs also decreased to a lesser degree. As shown in Figure 6, from 2012 to 2016, the total operating expense of Hawaii utilities decreased $1,072 million. Of this decrease, $902 million (84.2 percent) was due to reduced fuel costs, $141 million (13.2 percent) was due to reduced purchased power costs, and about $78 million (7.3 percent) was due to reduced taxes.

Figure 6. Changes of Utility Operating Expense in Hawaii: 2012-2016

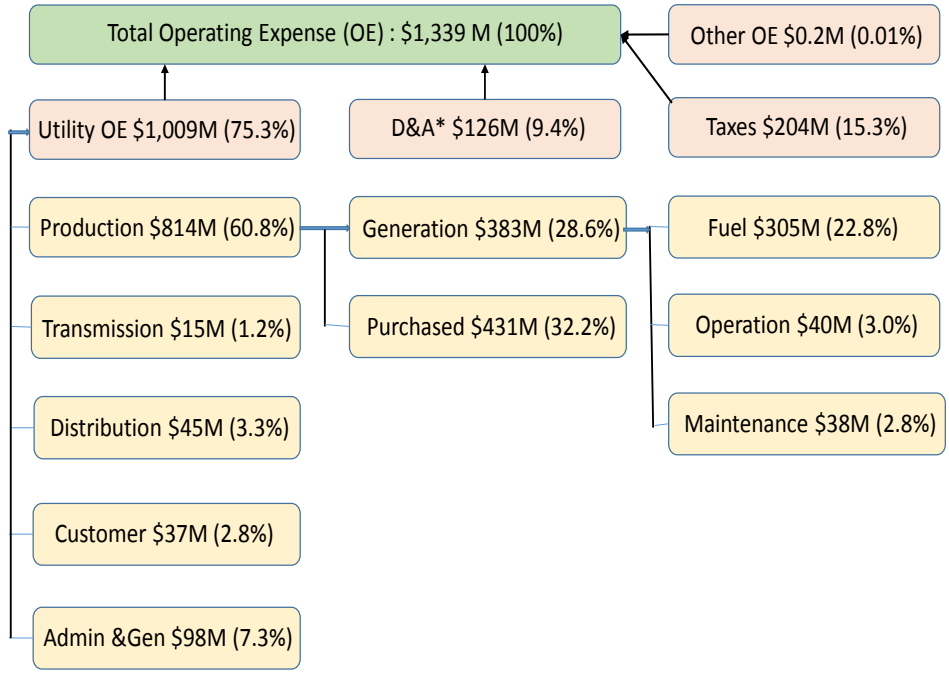


* Depreciation & Amortization.

The cost structures of the four utilities in Hawaii are not the same. Compared with the neighbor island utilities, the share of fuel cost in the HECO system was lower, and the share of purchased power was higher. As shown in Figure 7, in 2016, the total operating expense for HECO was $1,339 million; fuel cost accounted for $305 million or 22.8 percent; and purchased electricity accounted for $431 million or 32.2 percent. In comparison, the fuel cost and purchased electricity cost in the neighbor island utilities accounted for 26.7 percent and 23.2 percent of total operating expense, respectively.

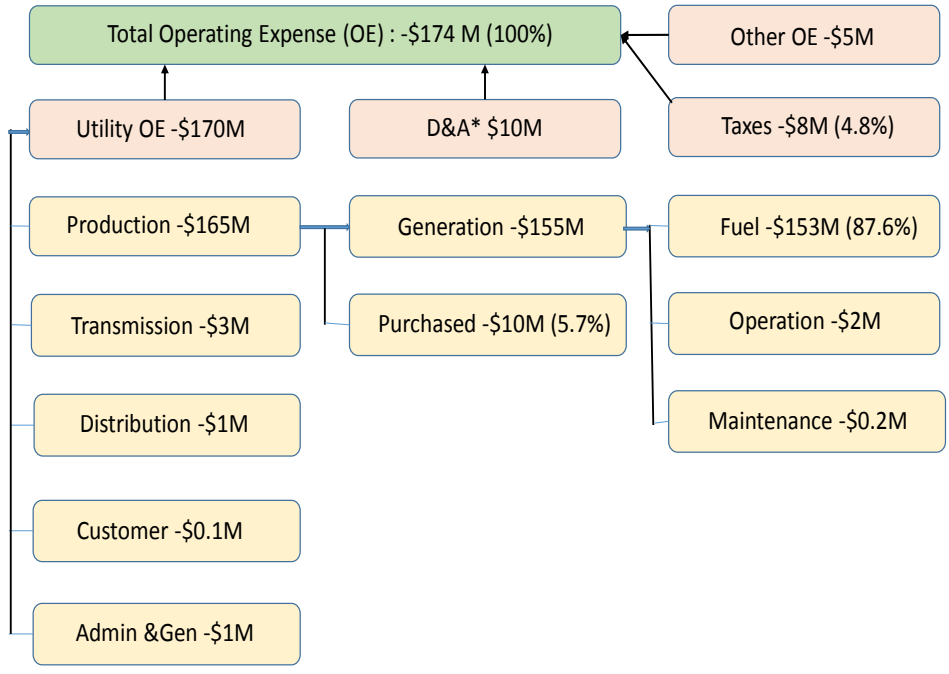
Figure 8 shows the changes of operating expense in the HECO system in 2016. Total operating expense of HECO decreased $174 million. Of this, about 87.6 percent or $153 million of the decrease was due to the reduced fuel cost, about 5.7 percent or $10 million was due to the reduced purchased power cost, and about 4.8 percent or $8 million was due to reduced taxes.

Figure 7. Components of HECO Operating Expense: 2016



* Depreciation & Amortization.

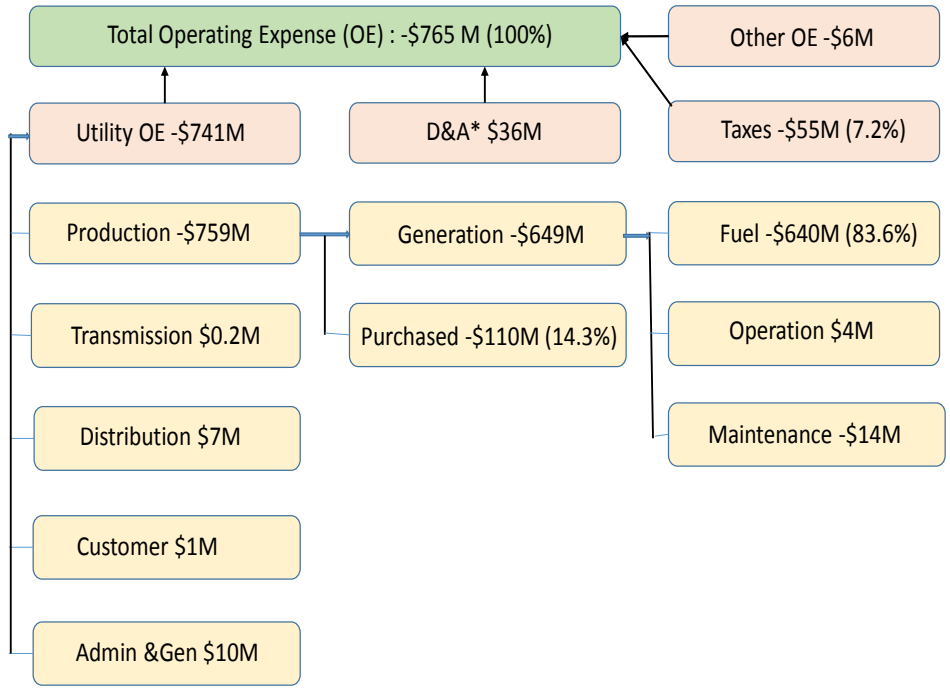
Figure 8. Changes of HECO Operating Expense: 2015-2016



* Depreciation & Amortization.

Figure 9 shows the changes of operating expenses for the HECO system from 2012 to 2016. The total operating expense of HECO decreased by $765 million from 2012 to 2016. A majority of the decrease, 83.6 percent or $640 million, was due to the reduced fuel cost, about 14.3 percent or $110 million was due to the reduced purchased power cost, and about 7.2 percent or $55 million was due to reduced taxes.

Figure 9. Changes of HECO Operating Expense: 2012-2016



The reduced fuel cost and purchased power cost was due to both reduced petroleum prices and reduced electricity generation from petroleum. In 2016, total electricity generated from petroleum decreased 8.9 percent, and the total fuel cost and purchased electricity cost decreased 17.8 percent.

The total revenue for the utilities, which reflects the total cost of electricity for customers, increased an average of 7.9 percent per year from $1.9 billion in 2005 to $3.3 billion in 2012. From 2012 to 2016, total revenue from electricity sales decreased an average of 9.2 percent per year. From 2005 to 2007, total GWH sold in Hawaii increased only slightly. However, since 2007, total GWH sold has decreased each year. From 2012 to 2016, total GWH sold decreased about 0.9 percent per year on average.

Since the consumption of electricity has been relatively stable over time, the fluctuation of the total electricity cost for customers was mainly due to fluctuations in the average price of electricity. As shown in Table 25, the average revenue per kWh sold in Hawaii increased almost every year from 18.3 cents in 2005 to 34.0 cents in 2012, an increase of 9.3 percent per year over this period. From 2012 to 2016, however, the average revenue from electricity sales decreased 8.4 percent per year, from 34.0 cents per kWh to 24.0 cents per kWh. The average electricity revenue in 2016 was the highest at KIUC at about 32.6 cents per kWh. This was followed by HELCO at 29.0 cents per kWh, MECO at 27.4 cents per kWh, and HECO at 22.0 cents per kWh. From 2005 to 2016, the average cost of electricity increased the most at HECO at 3.2 percent per year; this was followed by MECO at 1.2 percent per year, KIUC at 1.0 percent per year, and HELCO at 0.9 percent per year.

Table 25. Hawaii Average Revenue of Electricity by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Revenue from electricity sales											
State Total	$M	1,927	2,516	3,147	3,281	3,153	3,154	2,467	2,226	-9.8%	1.3%
HECO	$M	1,201	1,645	2,104	2,217	2,116	2,134	1,636	1,466	-10.4%	1.8%
HELCO	$M	294	372	443	439	430	421	344	310	-10.0%	0.5%
MECO	$M	302	344	417	437	422	421	344	307	-10.8%	0.1%
KIUC	$M	130	155	182	188	184	179	143	143	0.04%	0.8%
Total electricity sold											
State Total	GWh	10,539	10,013	9,962	9,639	9,501	9,406	9,389	9,284	-1.1%	-1.1%
HECO	GWh	7,721	7,277	7,242	6,976	6,859	6,782	6,754	6,660	-1.4%	-1.3%
HELCO	GWh	1,116	1,110	1,104	1,085	1,076	1,063	1,065	1,067	0.2%	-0.4%
MECO	GWh	1,252	1,192	1,181	1,145	1,135	1,132	1,138	1,118	-1.7%	-1.0%
KIUC	GWh	449	435	435	433	431	430	432	439	1.6%	-0.2%
Average revenue/kWh sold											
State Total	$/kWh	0.183	0.251	0.316	0.340	0.332	0.335	0.263	0.240	-8.8%	2.5%
HECO	$/kWh	0.156	0.226	0.290	0.318	0.309	0.315	0.242	0.220	-9.1%	3.2%
HELCO	$/kWh	0.263	0.335	0.402	0.405	0.400	0.396	0.323	0.290	-10.2%	0.9%
MECO	$/kWh	0.241	0.288	0.353	0.382	0.372	0.372	0.302	0.274	-9.2%	1.2%
KIUC	$/kWh	0.291	0.357	0.420	0.435	0.428	0.416	0.331	0.326	-1.6%	1.0%

Source: Hawaii Electric Utility Monthly Financial Reports.

The total cost of electricity in Hawaii was mainly affected by two factors, the fuel cost and purchased power cost. The cost of utility fuel and the cost of purchased power were both impacted by fluctuations in petroleum prices. Before 2015, the fuel and purchased power costs accounted for more than 60 percent of the total electricity costs for almost every year. In 2015 and 2016, the fuel and purchased power share of the total electricity cost decreased to 53.3 percent and 48.5 percent, respectively, as a result of lower petroleum prices.

In 2016, the fuel and purchased power cost decreased the most at HELCO and MECO at 19.6 percent; followed by HECO at 18.1 percent, and KIUC at 3.8 percent.

In comparison, from 2005 to 2012, the total fuel cost of the utilities and the cost of purchased electricity increased 9.1 percent per year, from $1,157 million in 2005 to $2,124 million in 2012. From 2005 to 2012, the utility fuel cost increased from $694 million to $1,391 million and the purchased power cost increased from $463 million to $732 million (Table 26).

Table 26. Hawaii Average Cost of Fuel and Purchased Power by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Fuel and purchased power cost											
State Total	$M	1,157	1,523	2,053	2,124	1,998	1,950	1,314	1,080	-17.8%	-0.6%
HECO	$M	760	1,044	1,432	1,486	1,379	1,359	899	736	-18.1%	-0.3%
HELCO	$M	168	207	259	262	254	240	169	136	-19.6%	-1.9%
MECO	$M	170	199	264	273	263	254	180	145	-19.6%	-1.4%
KIUC	$M	59	73	98	102	101	96	65	63	-3.8%	0.6%
Utility fuel cost											
State Total	$M	694	969	1,356	1,391	1,277	1,216	706	489	-30.7%	-3.1%
HECO	$M	421	631	909	945	851	821	458	305	-33.3%	-2.9%
HELCO	$M	65	93	122	117	126	117	72	55	-23.3%	-1.5%
MECO	$M	154	176	234	235	209	193	125	94	-24.4%	-4.4%
KIUC	$M	54	69	91	94	92	84	51	35	-32.2%	-4.0%
Purchased power cost											
State Total	$M	463	553	697	732	720	734	608	591	-2.9%	2.2%
HECO	$M	339	412	523	541	528	538	441	431	-2.3%	2.2%
HELCO	$M	103	113	137	145	128	123	98	81	-16.9%	-2.1%
MECO	$M	16	23	30	38	54	61	56	51	-8.8%	10.9%
KIUC	$M	5	4	8	8	10	12	14	28	97.0%	17.0%
Average fuel and purchased power cost											
State Total	$/kWh	0.110	0.152	0.206	0.220	0.210	0.207	0.140	0.116	-16.9%	0.5%
HECO	$/kWh	0.098	0.143	0.198	0.213	0.201	0.200	0.133	0.111	-16.9%	1.1%
HELCO	$/kWh	0.150	0.186	0.235	0.242	0.236	0.226	0.159	0.128	-19.8%	-1.5%
MECO	$/kWh	0.136	0.167	0.223	0.239	0.232	0.225	0.158	0.130	-18.2%	-0.4%
KIUC	$/kWh	0.131	0.169	0.226	0.236	0.235	0.224	0.151	0.143	-5.4%	0.8%
Share of fuel and purchased power cost											
State Total	%	60.0%	60.5%	65.2%	64.7%	63.4%	61.8%	53.3%	48.5%	-8.9%	-1.9%
HECO	%	63.2%	63.4%	68.0%	67.0%	65.2%	63.7%	54.9%	50.2%	-8.6%	-2.1%
HELCO	%	57.2%	55.6%	58.5%	59.7%	59.0%	57.2%	49.3%	44.0%	-10.7%	-2.4%
MECO	%	56.4%	58.0%	63.2%	62.6%	62.3%	60.4%	52.5%	47.3%	-9.9%	-1.6%
KIUC	%	45.2%	47.3%	53.9%	54.3%	54.9%	53.8%	45.7%	43.9%	-3.9%	-0.3%

Source: Hawaii Electric Utility Monthly Financial Reports.

In 2016, the average fuel and purchased electricity cost per kWh decreased 16.9 percent, from 14.0 cents to 11.6 cents. The fuel and purchased power cost share, as a percentage of the total cost of electricity sold, decreased from 53.3 percent in 2015 to 48.5 percent in 2016. In 2016, the share of fuel and purchased power cost was the highest for HECO at 50.2 percent, followed by MECO at 47.3 percent, HELCO at 44.0 percent, and KIUC at 43.9 percent.

In comparison, from 2005 to 2012, the average fuel and purchased electricity cost per kWh increased from 11.0 cents to 22.0 cents, an average increase of 10.5 percent per year. The share of fuel and purchased power cost, as a percentage of the total cost of electricity sold, increased from 60.0 percent in 2005 to 64.7 percent in 2012. In 2012, the share of fuel and purchased power cost was the highest in HECO at 67.0 percent, followed by MECO at 62.6 percent, HELCO at 59.7 percent, and KIUC at 54.3 percent.

While both the average fuel cost and average purchased power cost decreased since 2012, the average cost of purchased power decreased at a slower rate. As shown in Table 27, from 2012 to 2016, the average fuel cost to generate one kWh of net electricity (gross generation minus station use) by the utilities decreased 20.3 percent per year from 23.1 cents to 9.3 cents for the state. During the same period, the average cost of purchased electricity decreased only 7.3 percent per year, from 17.7 cents to 13.1 cents.

In comparison, from 2005 to 2012, the average fuel cost to generate one kWh of net electricity by the utilities increased 12.7 percent per year from 10.0 cents to 23.1 cents for the state. During the same period the average cost of purchased electricity increased only 7.0 percent per year from 11.0 cents to 17.7 cents. In 2005, the average cost of purchased electricity was above the average fuel cost of the utilities. In 2012, the average cost of purchased electricity was about 23.4 percent below the average fuel cost of the utilities in Hawaii. Since 2015, however, the average cost of purchased electricity was above the average fuel cost of the utilities again.

Due to the slower growth of purchased electricity costs from 2005 to 2012, the ratio of average purchased power cost to average utility fuel cost decreased from 110 percent in 2005 to 77 percent in 2012. In 2016, the ratio of average purchased power cost to average utility fuel cost increased to 140 percent. In 2016, the purchased electricity was cheapest at HECO (12.4 cents/kWh), followed by HELCO (14.0 cents/kWh), MECO (17.3 cents/kWh), and KIUC (17.7 cents/kWh).

Table 27. Utility Fuel Cost and Purchased Power Cost Comparison by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Average fuel cost of utility net generation											
State Total	$/kWh	0.100	0.150	0.211	0.231	0.222	0.221	0.129	0.093	-27.4%	-0.6%
HECO	$/kWh	0.089	0.143	0.206	0.229	0.218	0.221	0.123	0.088	-28.6%	-0.1%
HELCO	$/kWh	0.123	0.169	0.219	0.239	0.232	0.215	0.140	0.097	-30.8%	-2.1%
MECO	$/kWh	0.125	0.164	0.221	0.237	0.231	0.224	0.142	0.106	-25.3%	-1.5%
KIUC	$/kWh	0.124	0.162	0.217	0.227	0.228	0.221	0.142	0.116	-18.8%	-0.6%
Average cost of purchased electricity											
State Total	$/kWh	0.110	0.135	0.172	0.177	0.170	0.168	0.138	0.131	-5.2%	1.6%
HECO	$/kWh	0.100	0.128	0.164	0.170	0.161	0.159	0.132	0.124	-5.8%	1.9%
HELCO	$/kWh	0.149	0.176	0.218	0.213	0.207	0.207	0.154	0.140	-9.3%	-0.6%
MECO	$/kWh	0.167	0.122	0.155	0.172	0.184	0.183	0.171	0.173	1.4%	0.3%
KIUC	$/kWh	0.144	0.162	0.209	0.214	0.196	0.184	0.152	0.177	16.3%	1.9%
Ratio of purchased cost/fuel cost											
State Total	%	110%	90%	82%	77%	76%	76%	107%	140%	30.7%	2.2%
HECO	%	113%	90%	79%	74%	74%	72%	107%	141%	31.9%	2.1%
HELCO	%	121%	104%	99%	89%	89%	97%	110%	144%	31.0%	1.6%
MECO	%	134%	75%	70%	72%	80%	82%	120%	163%	35.7%	1.8%
KIUC	%	116%	100%	96%	94%	86%	83%	107%	153%	43.2%	2.6%
Ratio of fuel cost and average revenue											
State Total	%	55%	60%	67%	68%	67%	66%	49%	39%	-20.5%	-3.1%
HECO	%	57%	63%	71%	72%	71%	70%	51%	40%	-21.4%	-3.3%
HELCO	%	47%	50%	55%	59%	58%	54%	43%	33%	-22.9%	-3.0%
MECO	%	52%	57%	62%	62%	62%	60%	47%	39%	-17.7%	-2.6%
KIUC	%	43%	45%	52%	52%	53%	53%	43%	36%	-17.5%	-1.7%
Ratio of purchased power cost and average revenue											
State Total	%	60%	54%	55%	52%	51%	50%	53%	55%	4.0%	-0.9%
HECO	%	64%	56%	56%	53%	52%	51%	54%	56%	3.7%	-1.2%
HELCO	%	57%	53%	54%	53%	52%	52%	48%	48%	1.0%	-1.5%
MECO	%	69%	42%	44%	45%	49%	49%	57%	63%	11.6%	-0.9%
KIUC	%	49%	45%	50%	49%	46%	44%	46%	54%	18.2%	0.9%

Source: Hawaii Electric Utility Monthly Financial Reports.

In addition to fuel and purchased power costs, the cost of electricity is also affected by four other components. As shown in Table 28, the operating income of the utilities accounted for about 9.2 percent, taxes accounted for about 13.5 percent, depreciation and amortization accounted for about 9.2 percent, and other utility operating expenses accounted for about 19.9 percent of the total electricity cost paid by consumers in 2016.

From 2005 to 2016, the costs of the four components together increased from $777 million to $1,155 million, an average annual increase of 3.7 percent. This growth rate was higher than the 2.7 percent average inflation rate (Honolulu CPI-U) during the same period. Among the four components of other electricity costs, other utility operating expenses increased the most at 4.1 percent per year, followed by operating income at 4.0 percent per year, depreciation and amortization at 3.7 percent per year, and taxes at 2.9 percent per year.

Table 28. Other Major Costs of Electricity by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Operating income											
State Total	$M	134	138	173	191	192	209	203	206	1.1%	4.0%
HECO	$M	65	75	90	117	115	129	129	133	2.8%	6.6%
HELCO	$M	22	27	38	31	31	29	31	32	1.9%	3.5%
MECO	$M	27	18	27	24	30	32	31	29	-6.8%	0.8%
KIUC	$M	21	18	18	19	16	18	12	12	1.8%	-4.5%
Taxes											
State Total	$M	220	280	355	379	361	374	316	301	-4.7%	2.9%
HECO	$M	137	185	232	260	243	255	213	204	-3.9%	3.7%
HELCO	$M	33	45	58	53	50	50	45	42	-7.0%	2.1%
MECO	$M	39	38	50	51	52	53	47	43	-8.5%	0.8%
KIUC	$M	11	13	15	16	16	15	12	13	3.5%	1.3%
Depreciation and amortization											
State Total	$M	137	162	154	156	166	179	192	205	6.5%	3.7%
HECO	$M	70	85	88	90	99	108	116	126	8.2%	5.6%
HELCO	$M	27	36	32	33	34	35	37	38	2.8%	3.2%
MECO	$M	25	26	21	20	20	21	22	23	5.9%	-0.5%
KIUC	$M	16	15	13	13	14	15	17	18	3.5%	0.7%
Other utility operating expenses											
State Total	$M	286	420	421	440	446	452	451	443	-1.7%	4.1%
HECO	$M	173	261	268	269	286	288	286	273	-4.5%	4.2%
HELCO	$M	45	59	57	61	63	67	63	64	1.0%	3.2%
MECO	$M	43	64	58	72	59	62	65	68	5.0%	4.4%
KIUC	$M	25	36	38	38	38	35	37	38	3.5%	3.8%
All others											
State Total	$M	777	1,000	1,103	1,167	1,166	1,215	1,163	1,155	-0.7%	3.7%
HECO	$M	445	606	679	736	744	781	744	736	-1.1%	4.7%
HELCO	$M	126	166	185	178	178	181	176	175	-0.5%	3.0%
MECO	$M	133	146	155	166	161	169	165	164	-1.0%	1.9%
KIUC	$M	73	82	84	86	83	83	78	81	3.2%	0.9%
% of operating income											
State Total	%	7.0%	5.5%	5.5%	5.8%	6.1%	6.6%	8.2%	9.2%		
HECO	%	5.4%	4.5%	4.3%	5.3%	5.4%	6.1%	7.9%	9.0%		
HELCO	%	7.3%	7.1%	8.6%	7.0%	7.2%	7.0%	9.0%	10.2%		
MECO	%	8.8%	5.4%	6.4%	5.5%	7.1%	7.6%	9.1%	9.5%		
KIUC	%	15.8%	11.8%	9.7%	9.9%	8.5%	10.1%	8.5%	8.7%		
% of taxes											
State Total	%	11.4%	11.1%	11.3%	11.6%	11.5%	11.9%	12.8%	13.5%		
HECO	%	11.4%	11.2%	11.0%	11.7%	11.5%	12.0%	13.0%	13.9%		
HELCO	%	11.3%	12.1%	13.0%	12.1%	11.7%	11.9%	13.0%	13.4%		
MECO	%	13.0%	11.0%	12.0%	11.6%	12.4%	12.7%	13.6%	14.0%		
KIUC	%	8.3%	8.4%	8.4%	8.4%	8.4%	8.4%	8.5%	8.8%		
% of depreciation and amortization											
State Total	%	7.1%	6.4%	4.9%	4.8%	5.3%	5.7%	7.8%	9.2%		
HECO	%	5.8%	5.2%	4.2%	4.1%	4.7%	5.1%	7.1%	8.6%		
HELCO	%	9.1%	9.7%	7.3%	7.5%	7.8%	8.4%	10.7%	12.2%		
MECO	%	8.1%	7.5%	4.9%	4.6%	4.7%	5.0%	6.4%	7.6%		
KIUC	%	12.6%	9.4%	7.3%	7.1%	7.5%	8.3%	11.9%	12.3%		
% of other utility operating expenses											
State Total	%	14.9%	16.7%	13.4%	13.4%	14.2%	14.3%	18.3%	19.9%		
HECO	%	14.4%	15.9%	12.7%	12.2%	13.5%	13.5%	17.5%	18.6%		
HELCO	%	15.3%	15.8%	12.8%	13.9%	14.5%	15.8%	18.4%	20.6%		
MECO	%	14.1%	18.6%	13.9%	16.4%	14.0%	14.8%	18.9%	22.3%		
KIUC	%	19.5%	23.2%	20.9%	20.4%	20.7%	19.7%	25.8%	26.7%		

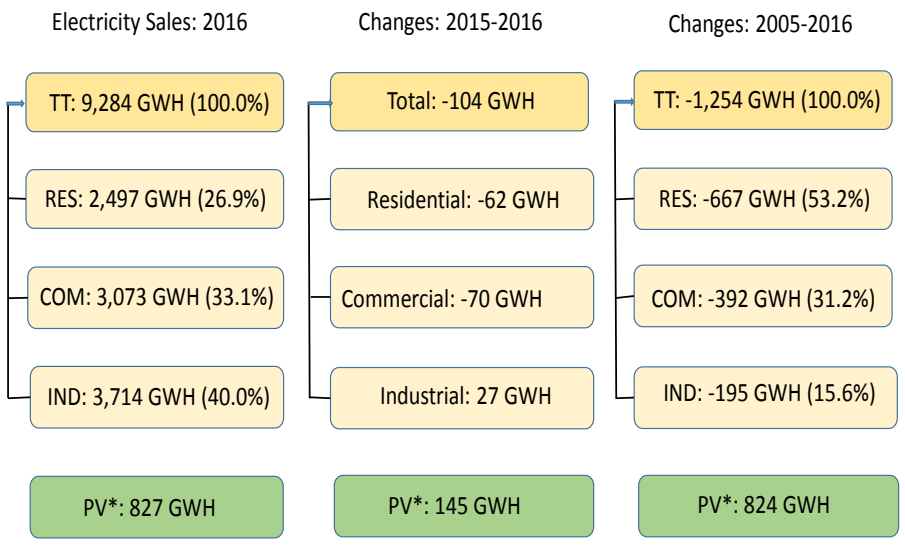
Source: Hawaii Electric Utility Monthly Financial Reports.

5. Electricity Consumption by Sector

Electricity sold by the utilities can be classified into three sectors. First is the residential sector, which includes all residential customers' and utility employees' accounts. Second is the industrial sector, which includes the large power customers. Third is the commercial sector, which includes all other customers.

As shown in Figure 10, total electricity sold by the utilities in Hawaii was about 9,284 GWH in 2016, 2,497 GWH or 26.9 percent was sold to the residential sector, 3,073 GWH or 33.1 percent was sold to the commercial sector, and 3,714 GWH or 40.0 percent was sold to the industrial sector. In 2016, total electricity sold by the utilities decreased 104 GWH; sales to the residential sector decreased 62 GWH, sales to the commercial sector decreased 70 GWH, and sales to the industrial sector increased 27 GWH. From 2005 to 2016, total electricity sold by the utilities decreased 1,254 GWH; sales to the residential sector decreased 667 GWH or 53.2 percent of the reduced sales, sales to the commercial sector decreased 392 GWH or 31.2 percent, and sales to the industrial sector decreased 195 GWH or 15.6 percent.

Figure 10. Electricity Consumption by Sectors in Hawaii



* Customer-sited grid-connected PV.

The larger decrease in residential electricity sales was due to the installation of customer-sited solar systems. Since most of the customer-sited solar systems were installed by residential customers, electricity sold to residential customers decreased more than that of the other sectors. As shown in Table 29, from 2005 to 2016, total electricity sold decreased an average 1.1 percent per year in Hawaii, while electricity sold to the residential sector decreased an average 2.1 percent per year from 3,164 GWH to 2,497 GWH. In comparison, electricity sold to the commercial sector and the industrial sector only decreased an average 1.1 percent and 0.5 percent per year, respectively, over the same period. As a result, the residential sector share of total electricity sold decreased from 30.0 percent in 2005 to 26.9 percent in 2016. In 2016, the residential sector's electricity sales decreased 2.4 percent over the previous year.

At the county level, from 2005 to 2016, residential sales in the HECO system decreased the most at 2.7 percent per year; followed by MECO (decreased 1.7 percent per year), and HELCO (decreased 0.8 percent per year). Residential sales of KIUC increased slightly during the same period.

It appears that the decrease in electricity consumption in recent years was due to decreased consumption per customer, rather than a decrease in the number of customers. As shown in Table 30, from 2005 to 2016, total utility customers for the state increased an average 0.6 percent per year. The number of residential customers increased 0.7 percent per year from 398,332 customers to 431,496 customers, the number of commercial customers increased 0.1 percent per year from 64,072 to 65,005, and the number of industrial customers increased 1.3 percent per year from 684 to 791.

At the county utility level, the number of customers increased slower at HECO compared with the other utilities. From 2005 to 2016, the share of HECO customers as a percentage of total statewide utility customers decreased 1.8 percentage points, from 63.0 percent to 61.2 percent.

Table 29. Electricity Consumption by Sector and by Utility

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total											
State Total	GWH	10,539	10,013	9,962	9,639	9,501	9,406	9,389	9,284	-1.1%	-1.1%
HECO	GWH	7,721	7,277	7,242	6,976	6,859	6,782	6,754	6,660	-1.4%	-1.3%
HELCO	GWH	1,116	1,110	1,104	1,085	1,076	1,063	1,065	1,067	0.2%	-0.4%
MECO	GWH	1,252	1,192	1,181	1,145	1,135	1,132	1,138	1,118	-1.7%	-1.0%
KIUC	GWH	449	435	435	433	431	430	432	439	1.6%	-0.2%
Residential											
State Total	GWH	3,164	2,989	2,929	2,739	2,609	2,539	2,558	2,497	-2.4%	-2.1%
HECO	GWH	2,143	1,976	1,925	1,777	1,667	1,611	1,627	1,580	-2.9%	-2.7%
HELCO	GWH	423	431	427	410	396	387	388	386	-0.6%	-0.8%
MECO	GWH	442	423	418	395	388	382	381	366	-3.9%	-1.7%
KIUC	GWH	156	159	159	157	158	159	162	164	1.3%	0.5%
Commercial											
State Total	GWH	3,465	3,351	3,368	3,238	3,269	3,185	3,143	3,073	-2.2%	-1.1%
HECO	GWH	2,480	2,415	2,429	2,320	2,341	2,270	2,221	2,171	-2.3%	-1.2%
HELCO	GWH	453	443	446	430	435	428	432	423	-2.1%	-0.6%
MECO	GWH	406	378	379	374	379	374	374	364	-2.6%	-1.0%
KIUC	GWH	125	116	114	114	113	114	116	116	0.2%	-0.7%
Industrial											
State Total	GWH	3,909	3,672	3,665	3,662	3,623	3,682	3,687	3,714	0.7%	-0.5%
HECO	GWH	3,098	2,887	2,888	2,879	2,850	2,900	2,906	2,909	0.1%	-0.6%
HELCO	GWH	240	236	231	245	245	248	244	259	5.8%	0.7%
MECO	GWH	404	390	384	375	368	376	383	388	1.3%	-0.4%
KIUC	GWH	167	160	161	162	160	157	155	159	3.0%	-0.5%
% of Residential											
State Total	%	30.0%	29.9%	29.4%	28.4%	27.5%	27.0%	27.2%	26.9%		
HECO	%	27.7%	27.1%	26.6%	25.5%	24.3%	23.8%	24.1%	23.7%		
HELCO	%	37.9%	38.8%	38.7%	37.8%	36.8%	36.4%	36.5%	36.2%		
MECO	%	35.3%	35.5%	35.4%	34.5%	34.2%	33.7%	33.5%	32.8%		
KIUC	%	34.8%	36.7%	36.6%	36.3%	36.6%	37.0%	37.5%	37.3%		
% of Commercial											
State Total	%	32.9%	33.5%	33.8%	33.6%	34.4%	33.9%	33.5%	33.1%		
HECO	%	32.1%	33.2%	33.5%	33.3%	34.1%	33.5%	32.9%	32.6%		
HELCO	%	40.6%	39.9%	40.4%	39.6%	40.4%	40.2%	40.6%	39.6%		
MECO	%	32.4%	31.7%	32.1%	32.7%	33.4%	33.0%	32.9%	32.6%		
KIUC	%	27.9%	26.6%	26.3%	26.4%	26.3%	26.4%	26.8%	26.4%		
County % of Total											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	73.3%	72.7%	72.7%	72.4%	72.2%	72.1%	71.9%	71.7%		
HELCO	%	10.6%	11.1%	11.1%	11.3%	11.3%	11.3%	11.3%	11.5%		
MECO	%	11.9%	11.9%	11.9%	11.9%	11.9%	12.0%	12.1%	12.0%		
KIUC	%	4.3%	4.3%	4.4%	4.5%	4.5%	4.6%	4.6%	4.7%		
County % of Residential											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	67.7%	66.1%	65.7%	64.9%	63.9%	63.5%	63.6%	63.3%		
HELCO	%	13.4%	14.4%	14.6%	15.0%	15.2%	15.2%	15.2%	15.5%		
MECO	%	14.0%	14.2%	14.3%	14.4%	14.9%	15.0%	14.9%	14.7%		
KIUC	%	4.9%	5.3%	5.4%	5.7%	6.1%	6.3%	6.3%	6.6%		

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 30. Number of Retail Customers by Sector in Hawaii

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total											
State Total		463,088	480,918	482,498	484,716	488,456	492,358	494,631	497,292	0.5%	0.6%
HECO		291,580	296,422	296,800	297,529	299,528	301,953	302,958	304,261	0.4%	0.4%
HELCO		73,835	80,695	81,199	81,792	82,637	83,421	84,308	85,029	0.9%	1.3%
MECO		63,901	67,739	68,230	68,922	69,577	70,042	70,533	70,872	0.5%	0.9%
KIUC		33,772	36,062	36,269	36,473	36,714	36,942	36,832	37,130	0.8%	0.9%
Residential											
State Total		398,332	416,141	418,174	420,240	423,281	426,862	429,084	431,496	0.6%	0.7%
HECO		257,804	262,635	263,384	264,047	265,772	268,056	269,207	270,451	0.5%	0.4%
HELCO		60,699	67,837	68,423	69,099	69,719	70,398	71,216	71,892	0.9%	1.6%
MECO		54,135	57,835	58,326	58,879	59,419	59,802	60,231	60,475	0.4%	1.0%
KIUC		25,694	27,834	28,041	28,215	28,371	28,606	28,430	28,678	0.9%	1.0%
Commercial											
State Total		64,072	64,105	63,625	63,772	64,498	64,777	64,769	65,005	0.4%	0.1%
HECO		33,416	33,444	33,058	33,116	33,412	33,521	33,333	33,373	0.1%	0.0%
HELCO		13,071	12,792	12,702	12,617	12,839	12,940	13,001	13,046	0.3%	0.0%
MECO		9,632	9,765	9,769	9,908	10,025	10,103	10,152	10,255	1.0%	0.6%
KIUC		7,953	8,104	8,096	8,131	8,222	8,213	8,283	8,331	0.6%	0.4%
Industrial											
State Total		684	672	699	704	677	719	778	791	1.7%	1.3%
HECO		360	343	358	366	344	376	418	437	4.5%	1.8%
HELCO		65	66	74	76	79	83	91	91	0.0%	3.1%
MECO		134	139	135	135	133	137	150	142	-5.3%	0.5%
KIUC		125	124	132	127	121	123	119	121	1.7%	-0.3%
% of Residential											
State Total	%	86.0%	86.5%	86.7%	86.7%	86.7%	86.7%	86.7%	86.8%		
HECO	%	88.4%	88.6%	88.7%	88.7%	88.7%	88.8%	88.9%	88.9%		
HELCO	%	82.2%	84.1%	84.3%	84.5%	84.4%	84.4%	84.5%	84.5%		
MECO	%	84.7%	85.4%	85.5%	85.4%	85.4%	85.4%	85.4%	85.3%		
KIUC	%	76.1%	77.2%	77.3%	77.4%	77.3%	77.4%	77.2%	77.2%		
% of Commercial											
State Total	%	13.8%	13.3%	13.2%	13.2%	13.2%	13.2%	13.1%	13.1%		
HECO	%	11.5%	11.3%	11.1%	11.1%	11.2%	11.1%	11.0%	11.0%		
HELCO	%	17.7%	15.9%	15.6%	15.4%	15.5%	15.5%	15.4%	15.3%		
MECO	%	15.1%	14.4%	14.3%	14.4%	14.4%	14.4%	14.4%	14.5%		
KIUC	%	23.5%	22.5%	22.3%	22.3%	22.4%	22.2%	22.5%	22.4%		
County % of Total											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	63.0%	61.6%	61.5%	61.4%	61.3%	61.3%	61.2%	61.2%		
HELCO	%	15.9%	16.8%	16.8%	16.9%	16.9%	16.9%	17.0%	17.1%		
MECO	%	13.8%	14.1%	14.1%	14.2%	14.2%	14.2%	14.3%	14.3%		
KIUC	%	7.3%	7.5%	7.5%	7.5%	7.5%	7.5%	7.4%	7.5%		

Source: Hawaii Electric Utility Monthly Financial Reports.

From 2005 to 2016, electricity consumption per customer in Hawaii decreased an annual average of 1.8 percent from 22,757 kWh to 18,670 kWh (Table 31). Annual electricity consumption per residential customer decreased an average 2.8 percent per year, from 7,943 kWh to 5,786 kWh; annual electricity consumption per commercial customer decreased an average 1.2 percent per year, from 54,081 kWh to 47,279 kWh; and annual electricity consumption by industrial customers decreased 1.8 percent per year, from 5,715,476 kWh to 4,695,780 kWh.

At the county level, MECO had the highest annual electricity consumption per residential customer in 2016 at 6,058 kWh. This was followed by HECO at 5,844 kWh, KIUC at 5,717 kWh, and HELCO at 5,369 kWh. However, the difference between the utilities' average residential electricity consumption per customer has been decreasing over time, with HECO's residential consumption per customer decreasing faster than others. From 2005 to 2016, residential consumption per customer decreased an average 3.2 percent per year at HECO, decreased 2.7 percent per year at MECO, decreased 2.4 percent per year at HELCO, and decreased 0.5 percent per year at KIUC.

Table 31. Annual Electricity Consumption per Customer by Sector

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total											
State Total	kWh/C	22,757	20,821	20,646	19,886	19,451	19,104	18,981	18,670	-1.6%	-1.8%
HECO	kWh/C	26,481	24,550	24,401	23,446	22,898	22,459	22,294	21,890	-1.8%	-1.7%
HELCO	kWh/C	15,121	13,753	13,591	13,267	13,022	12,737	12,630	12,553	-0.6%	-1.7%
MECO	kWh/C	19,595	17,590	17,309	16,611	16,311	16,163	16,129	15,771	-2.2%	-2.0%
KIUC	kWh/C	13,284	12,050	11,987	11,876	11,752	11,638	11,731	11,826	0.8%	-1.1%
Residential											
State Total	kWh/C	7,943	7,184	7,004	6,518	6,163	5,948	5,962	5,786	-3.0%	-2.8%
HECO	kWh/C	8,311	7,523	7,309	6,729	6,273	6,010	6,043	5,844	-3.3%	-3.2%
HELCO	kWh/C	6,977	6,353	6,238	5,931	5,676	5,491	5,453	5,369	-1.6%	-2.4%
MECO	kWh/C	8,165	7,320	7,165	6,715	6,528	6,387	6,328	6,058	-4.3%	-2.7%
KIUC	kWh/C	6,072	5,728	5,673	5,574	5,564	5,564	5,692	5,717	0.4%	-0.5%
Commercial											
State Total	kWh/C	54,081	52,279	52,939	50,780	50,689	49,176	48,524	47,279	-2.6%	-1.2%
HECO	kWh/C	74,227	72,199	73,475	70,053	70,072	67,734	66,641	65,044	-2.4%	-1.2%
HELCO	kWh/C	34,685	34,636	35,089	34,095	33,892	33,040	33,234	32,417	-2.5%	-0.6%
MECO	kWh/C	42,163	38,716	38,811	37,758	37,851	37,013	36,816	35,480	-3.6%	-1.6%
KIUC	kWh/C	15,749	14,264	14,139	14,046	13,804	13,820	13,967	13,911	-0.4%	-1.1%
Industrial											
State Total	kWh/C	5,715,476	5,464,790	5,242,739	5,201,000	5,351,326	5,120,741	4,739,613	4,695,780	-0.9%	-1.8%
HECO	kWh/C	8,606,672	8,416,539	8,068,244	7,866,900	8,284,797	7,712,821	6,951,690	6,656,945	-4.2%	-2.3%
HELCO	kWh/C	3,686,703	3,572,454	3,122,719	3,225,790	3,104,552	2,992,745	2,685,072	2,840,736	5.8%	-2.3%
MECO	kWh/C	3,014,884	2,806,990	2,844,143	2,780,620	2,763,182	2,745,471	2,551,411	2,729,124	7.0%	-0.9%
KIUC	kWh/C	1,338,824	1,286,392	1,221,235	1,273,029	1,323,260	1,278,578	1,298,817	1,315,987	1.3%	-0.2%

Source: Hawaii Electric Utility Monthly Financial Reports.

Due to rapid growth of electricity prices from 2005 to 2012, total revenue from retail electricity increased substantially. This occurred in spite of a decrease in the kWh of electricity sold over the same period. From 2005 to 2012, the total revenue generated from retail electricity sales increased an average 7.9 percent per year for the state, revenue from residential sales increased an average 6.6 percent per year from $653 million to $1,023 million, and revenue from commercial and industrial sales (separate revenues from the commercial sector and the industrial sector are not available in the MFR) increased an average 8.5 percent per year from $1,274 million to $2,258 million.

Table 32. Revenue from Retail Electricity Sales by Sector in Hawaii

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total											
State Total	$M	1,927	2,516	3,147	3,281	3,153	3,154	2,467	2,226	-9.8%	1.3%
HECO	$M	1,201	1,645	2,104	2,217	2,116	2,134	1,636	1,466	-10.4%	1.8%
HELCO	$M	294	372	443	439	430	421	344	310	-10.0%	0.5%
MECO	$M	302	344	417	437	422	421	344	307	-10.8%	0.1%
KIUC	$M	130	155	182	188	184	179	143	143	0.0%	0.8%
Residential											
State Total	$M	653	840	1,016	1,023	962	948	765	695	-9.3%	0.6%
HECO	$M	379	503	617	624	577	572	456	412	-9.6%	0.8%
HELCO	$M	118	152	179	174	167	162	135	122	-9.6%	0.3%
MECO	$M	110	126	151	154	148	146	119	105	-12.0%	-0.4%
KIUC	$M	46	59	69	71	70	68	56	56	0.5%	1.7%
Others											
State Total	$M	1,274	1,676	2,131	2,258	2,191	2,206	1,701	1,531	-10.0%	1.7%
HECO	$M	823	1,142	1,487	1,593	1,539	1,562	1,180	1,054	-10.7%	2.3%
HELCO	$M	176	220	264	265	263	259	209	188	-10.2%	0.6%
MECO	$M	192	218	266	282	274	275	224	202	-10.1%	0.5%
KIUC	$M	84	96	113	118	115	110	87	87	-0.2%	0.3%
% of Residential											
State Total	%	33.9%	33.4%	32.3%	31.2%	30.5%	30.1%	31.0%	31.2%		
HECO	%	31.5%	30.6%	29.3%	28.1%	27.3%	26.8%	27.9%	28.1%		
HELCO	%	40.2%	40.9%	40.4%	39.6%	38.8%	38.5%	39.1%	39.3%		
MECO	%	36.5%	36.7%	36.2%	35.3%	35.1%	34.7%	34.8%	34.3%		
KIUC	%	35.5%	37.8%	37.8%	37.6%	37.9%	38.3%	38.8%	39.0%		
County % of Total											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	62.3%	65.4%	66.9%	67.6%	67.1%	67.7%	66.3%	65.9%		
HELCO	%	15.2%	14.8%	14.1%	13.4%	13.6%	13.3%	13.9%	13.9%		
MECO	%	15.7%	13.7%	13.3%	13.3%	13.4%	13.3%	13.9%	13.8%		
KIUC	%	6.8%	6.2%	5.8%	5.7%	5.9%	5.7%	5.8%	6.4%		

Source: Hawaii Electric Utility Monthly Financial Reports.

The higher growth in commercial and industrial electricity revenue, compared with residential revenue from 2005 to 2012, was due to the higher growth in commercial and industrial electricity prices. From 2005 to 2012, the average electricity price increased an average of 9.3 percent per year, from 18.3 cents per kWh to 34.0 cents per kWh. For the 2005 to 2012 period, the average residential electricity price increased 8.8 percent per year, from 20.6 cents per kWh to 37.3 cents per kWh, and the average commercial and industrial electricity price increased 9.6 percent per year, from 17.3 cents per kWh to 32.7 cents per kWh (Table 33).

From 2012 to 2016, total revenue from electricity sales decreased 9.2 percent per year, with decreases in revenue from residential sales and in revenues from commercial and industrial sales were about the same. During the same period, the average residential electricity price decreased 7.1 percent and the average commercial and industrial electricity price decreased 8.9 percent.

Table 33. Average Electricity Price by County in Hawaii

		2005	2010	2011	2012	2013	2014	2015	2016	Growth 2016	Avg. ann. Growth 2005 - 2016
Total											
State Total	$/kWh	0.183	0.251	0.316	0.340	0.332	0.335	0.263	0.240	-8.8%	2.5%
HECO	$/kWh	0.156	0.226	0.290	0.318	0.309	0.315	0.242	0.220	-9.1%	3.2%
HELCO	$/kWh	0.263	0.335	0.402	0.405	0.400	0.396	0.323	0.290	-10.2%	0.9%
MECO	$/kWh	0.241	0.288	0.353	0.382	0.372	0.372	0.302	0.274	-9.2%	1.2%
KIUC	$/kWh	0.291	0.357	0.420	0.435	0.428	0.416	0.331	0.326	-1.6%	1.0%
Residential											
State Total	$/kWh	0.206	0.281	0.347	0.373	0.369	0.373	0.299	0.278	-7.0%	2.7%
HECO	$/kWh	0.177	0.255	0.320	0.351	0.346	0.355	0.280	0.261	-7.0%	3.6%
HELCO	$/kWh	0.279	0.353	0.419	0.425	0.422	0.419	0.346	0.315	-9.0%	1.1%
MECO	$/kWh	0.249	0.298	0.361	0.391	0.382	0.382	0.313	0.287	-8.4%	1.3%
KIUC	$/kWh	0.297	0.368	0.434	0.450	0.443	0.430	0.343	0.340	-0.8%	1.3%
Others											
State Total	$/kWh	0.173	0.239	0.303	0.327	0.318	0.321	0.249	0.226	-9.5%	2.5%
HECO	$/kWh	0.147	0.215	0.280	0.306	0.296	0.302	0.230	0.208	-9.9%	3.2%
HELCO	$/kWh	0.253	0.323	0.391	0.393	0.387	0.383	0.309	0.276	-10.9%	0.8%
MECO	$/kWh	0.236	0.283	0.349	0.377	0.367	0.366	0.296	0.268	-9.5%	1.2%
KIUC	$/kWh	0.287	0.351	0.411	0.426	0.419	0.407	0.324	0.317	-2.0%	0.9%

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 34 shows the statewide average electricity price by sector in Hawaii, sourced from EIA data. The data shows prices by sector from 1990 to 2015 are provided.

Table 34. Average Electricity Price by Sector in Hawaii

Year	Residential Cents/kWh	Commercial Cents/kWh	Industrial Cents/kWh	Other Cents/kWh	Total Cents/kWh
1990	10.26	10.18	7.57	9.40	9.02
1991	10.52	10.33	7.71	9.56	9.22
1992	10.90	10.53	7.83	9.71	9.44
1993	12.28	11.68	8.95	11.26	10.66
1994	12.45	11.67	8.82	11.21	10.68
1995	13.32	12.16	9.27	12.11	11.29
1996	14.26	12.99	10.03	12.91	12.12
1997	14.80	13.26	10.32	13.20	12.49
1998	13.82	12.31	9.41	12.28	11.56
1999	14.30	12.74	9.70	12.66	11.97
2000	16.41	14.81	11.69	14.76	14.03
2001	16.34	14.81	11.68	16.81	14.05
2002	15.63	14.11	11.02	16.85	13.39
2003	16.73	15.02	12.20	NA	14.47
2004	18.06	16.19	13.35	NA	15.70
2005	20.70	19.04	15.79	NA	18.33
2006	23.35	21.42	17.96	NA	20.72
2007	24.12	21.91	18.38	NA	21.29
2008	32.50	29.72	26.05	NA	29.20
2009	24.20	21.86	18.14	NA	21.21
2010	28.10	25.93	21.94	NA	25.12
2011	34.68	32.37	28.40	NA	31.59
2012	37.34	34.88	30.82	NA	34.04
2013	36.98	34.05	29.87	NA	33.26
2014	37.04	34.21	30.22	NA	33.43
2015	29.60	26.93	23.06	NA	26.17

Source: Energy Information Administration, State Energy Data System

6. Electricity Demand

The overall demand for electricity can be met through several alternative channels. Electricity users can purchase electricity from the utilities (generated by utility and non-utility producers) and/or generate electricity by themselves. Another option is to reduce electricity demand through electricity savings displacement projects including solar water heating (SWH) and energy efficiency technologies such as the demand-side-management (DSM) programs. Total electricity generated by the electric power industry (including both utility and non-utility producers) includes electricity sold by the utilities, system losses, and station use by both utility and non-utility electricity producers. Data for electricity sold by the utilities, system losses and station use of utilities was available; however, the station use of purchased electricity from non-utility producers was not available. Therefore, we estimated this value with the assumption that the percentage of station use in gross generation for non-utility producers was the same as that for utility producers.

For the data on electricity generated and consumed by the final users, only the electricity generated from PV systems was available. The electricity saved from the SWH and DSM programs were available up to 2014. The values of electricity saved from the SWH and DSM programs in 2015 and 2016 were estimated based on the historical trend. In this study, we define total electricity demand as the sum of gross generation by the electric power industry, electricity generated and consumed by the customers (mainly from the customer-sited solar systems), and electricity saved by the SWH and DSM programs.

From 2005 to 2016, total electricity demand in Hawaii increased only slightly, with an average annual increase of 0.5 percent per year from about 12,280 GWH to 12,951 GWH (Table 35). Decreased gross generation by the electric power industry was offset by electricity savings and customer-sited generations. Over this period, electricity generation by the electric power industry decreased 1.2 percent per year from 11,755 GWH to 10,311 GWH, electricity generated by user owned PV systems increased 69.9 percent per year from 2 GWH to 827 GWH; electricity replaced by SWH increased 7.4 percent per year from 84 GWH to 184 GWH; and electricity replaced by DSM programs increased 15.8 percent per year from 439 GWH to 1,629 GWH. This analysis estimated that the share of gross electricity generation produced by the electric power industry decreased from 95.7 percent in 2005 to 79.6 percent in 2016, a decrease of 16.1 percentage points.

Table 35. Total Electricity Demand in Hawaii

Electricity Generation and Conservation (Demand-Side-Management)						
		Units: GWH				
	Gross 1/	By Users				Gross
Year	Generation	PV	SWH	DSM	Sub-Total	Total
2005	11,755	2	84	439	525	12,280
2006	11,803	4	95	497	596	12,399
2007	11,822	8	109	619	736	12,558
2008	11,601	12	117	750	880	12,481
2009	11,282	33	130	809	972	12,254
2010	11,194	53	172	916	1,141	12,335
2011	11,104	90	180	1,027	1,298	12,402
2012	10,758	190	185	1,210	1,584	12,342
2013	10,598	356	174	1,320	1,850	12,447
2014	10,467	532	160	1,416	2,108	12,575
2015 2/	10,450	681	172	1,518	2,372	12,822
2016 2/	10,311	827	184	1,629	2,640	12,951
Growth 05-16	-1.2%	69.9%	7.4%	12.7%	15.8%	0.5%
Changes 05-16	(1,444)	824	100	1,190	2,115	670

Electricity Generation and Conservation (Demand-Side-Management)						
		Units: % in Gross Total				
	Gross 1/	By Users				Gross
Year	Generation	PV	SWH	DSM	Sub-Total	Total
2005	95.7	0.02	0.68	3.57	4.3	100.00
2006	95.2	0.03	0.77	4.01	4.8	100.00
2007	94.1	0.06	0.87	4.93	5.9	100.00
2008	93.0	0.10	0.94	6.01	7.0	100.00
2009	92.1	0.27	1.06	6.60	7.9	100.00
2010	90.7	0.43	1.39	7.43	9.3	100.00
2011	89.5	0.73	1.45	8.28	10.5	100.00
2012	87.2	1.54	1.50	9.80	12.8	100.00
2013	85.1	2.86	1.40	10.60	14.9	100.00
2014	83.2	4.23	1.28	11.26	16.8	100.00
2015 2/	81.5	5.31	1.34	11.84	18.5	100.00
2016 2/	79.6	6.38	1.42	12.58	20.4	100.00

1/ Including station use of non-utility producers. Estimated by DBEDT.

2/ 2015 and 2016 SWH and DSM data are estimated by DBEDT

Source: HECO and KIUC Renewable Portfolio Standard Status Report and DBEDT estimate.

7. Conclusions

In recent years, electricity generated by utilities as a percentage of the total electricity generated by the electric power industry has decreased significantly. From 1990 to 2016, the share of utility generated electricity decreased 31.7 percentage points, from 82.4 percent to 50.7 percent. Before 2015, the average cost of electricity purchased by the utility was below the average fuel cost of utility generated electricity in most of the years, the increased share of purchased electricity has helped reduce the cost of electricity sold by the utility. In 2015 and 2016, however, the average cost of electricity purchased by the utility was above the average fuel cost of utility generated electricity due to decreased petroleum prices.

In 2016, gross generation in Hawaii was estimated to be about 11,138 GWH. Not all the electricity generated was sold to the utility customers. In 2016, about 5.0 percent of the gross generation in Hawaii was consumed by the power stations. In addition, about 4.2 percent of gross generation was lost during electricity transmission and distribution, and about 7.4 percent of gross generation was generated and consumed by the customers. Therefore, only about 9,284 GWH or 83.4 percent of the gross generation was sold to utility customers.

Before 2015, purchased electricity was cheaper than the fuel cost of utility generated electricity in most years, however, since 2015 purchased electricity was more expensive than the fuel cost of utility generated electricity. From 2005 to 2012, the average fuel cost to generate one kWh of net electricity by the utilities increased 12.7 percent per year from 10.0 cents to 23.1 cents for the state. During the same period the average cost of purchased electricity increased only 7.0 percent per year, from 11.0 cents to 17.7 cents. In 2005, the average cost of purchased electricity was above the average fuel cost of the utilities. In 2012, the average cost of purchased electricity was about 23.4 percent below the average fuel cost of the utilities in Hawaii. Since 2015, however, the average cost of purchased electricity was above the average fuel cost of the utilities again. In 2016, the average cost of purchased electricity was 40 percent above the average fuel cost of the utility generated electricity.

The average cost of purchased electricity in 2016 was the lowest at HECO at about 12.4 cents/kWh. The lower average cost of purchased power at HECO was partially due to the lower purchased power cost from coal generated electricity. The average cost of purchased power from coal generated electricity was less than 10 cents/kWh, lower than the average cost of purchased power by HECO.

The relatively slower growth of purchased power prices from 2005 to 2012 was due to the rapid growth of petroleum prices and a higher share of electricity being generated from non-petroleum sources including coal and renewable energy by non-utility producers. In 2012, about 95.6 percent of utility generated electricity was from petroleum; in contrast, only 39.0 percent of non-utility generated electricity was from petroleum.

The average unit cost of petroleum used for utility electricity generation increased rapidly from 2005 to 2012, with the growth rate being significantly higher than the growth rate of crude oil prices. In this period, the average unit petroleum cost for the four electric utilities in Hawaii increased an average of 13.3 percent per year from $57.57 per BBL to $137.74 per BBL. Fuel oil costs increased an average 14.9 percent per year from $51.22 per BBL to $135.72 per BBL, and diesel oil costs increased an average 9.3 percent per year from $77.36 per BBL to $143.93 per BBL. In comparison, the average crude oil price increased an average 7.6 percent per year during the same period. From 2012 to 2016, the unit fuel oil cost decreased 22.5 percent per year on average, and the unit diesel cost decreased 17.0 percent per year. In 2016, the unit fuel oil costs were highest at HECO, followed by MECO and HELCO. Unit diesel costs were highest at HECO, followed by HELCO, MECO, and KIUC.

From 2005 to 2012, the average revenue from electricity sold in Hawaii increased 9.3 percent per year, from 18.3 cents/kWh to 34.0 cents/kWh. From 2012 to 2016, the average revenue from electricity sold in Hawaii decreased 8.4 percent per year, from 34.0 cents/kWh to 24.0 cents/kWh.

In addition to fuel and purchased power costs, the cost of electricity is also affected by four other components. The operating income of the utilities accounted for about 9.2 percent, taxes accounted for about 13.5 percent, depreciation and amortization accounted for about 9.2 percent, and other utility operating expenses accounted for about 19.9 percent of the total electricity cost paid by consumers in 2016. Other utility operating expenses include other operation and maintenance expense, transmission and distribution expenses, customer accounts and service expenses, and administration and general expenses. From 2005 to 2016, the costs of the four components together increased from $777 million to $1,155 million, an average annual increase of 3.7 percent. This growth rate was higher than the 2.7 percent average inflation rate (Honolulu CPI-U) during the same period.

Total electricity sold by utilities decreased over the period analyzed. A large part of this decrease was due to reduced consumption caused by the installation of customer-sited solar systems. From 2005 to 2016, total electricity sold decreased an average 1.1 percent per year in Hawaii. The largest decrease during this period was for residential customers, which decreased an average 2.1 percent per year from 3,164 GWH to 2,495 GWH. In contrast, electricity sold to the commercial sector and the industrial sector only decreased an average 1.1 percent and 0.5 percent per year, respectively. As a result, the residential sector share of total electricity sold decreased from 30.0 percent in 2005 to 26.9 percent in 2016.

The analysis showed that the decrease in electricity consumption was due to a decrease in consumption per customer, rather than a decrease in the number of customers. From 2005 to 2016, total utility customers for the state increased 0.6 percent per year. Industrial customers increased the most at 1.3 percent per year. This was followed by residential customers with an increase of 0.7 percent per year and commercial customers which increased 0.1 percent per year.

Electricity demand can be met by both electricity generated from the electric power industry (including both utility and non-utility producers), energy conservation (such as the DSM programs), electricity savings displacement projects (such as SWH), and customer generated electricity (such as customer-sited PV systems). From 2005 to 2016, the total share of electricity generated by the electric power industry as a percentage of total electricity demand in Hawaii decreased 16.1 percentage points, from 95.7 percent to 79.6 percent. Without the electricity generated and conserved by users, total electricity expenditure in Hawaii would have been higher.