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State of Hawaii - Department of Business, Economic Development & Tourism
Research & Economic Analysis Division

State of Hawaii Electricity Generation and Consumption in 2013 and Recent Trends

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Executive Summary

- Total electricity demand in Hawaii is estimated to be 12,447 GWH in 2013. Of this amount, 1,850 GWH or 14.9 percent was fulfilled by 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 10,598 GWH. Electricity station use and transmission and distribution lost accounted for 10.3 percent, or 1,097 GWH, of the total electricity generated. Total electricity sold to consumers in 2013 was 9,501 GWH.
- From 2005 to 2013, total electricity demand in Hawaii increased an average 0.2 percent per year, from 12,280 GWH to 12,447 GWH. Electricity generation by the electric power industry decreased 1.3 percent per year from 11,755 GWH to 10,598 GWH; electricity generated by user owned PV systems increased 86.6 percent per year from 2 GWH to 356 GWH; electricity replaced by SWH increased 9.5 percent per year from 84 GWH to 174 GWH; and electricity replaced by DSM programs increased 14.8 percent per year from 439 GWH to 1,320 GWH.
- The average price of electricity in 2013 was 33.2 cents/KWH statewide. Kauai consumers paid the highest electricity rate at 42.8 cents/KWH, followed by Big Island consumers at 40.0 cents/KWH, Maui consumers at 37.2 cents/KWH, and Oahu consumers at 30.9 cents/KWH.
- In 2013, 38.1 percent of the electricity was consumed by the industrial sector, 34.4 percent by the commercial sector, and 27.5 percent by the residential sector. From 2005 to 2013, electricity sold to the residential sector decreased 2.4 percent per year. In comparison, electricity sold to the commercial sector and the industrial sector only decreased an average 0.7 percent and 0.9 percent per year, respectively, over the same period.
- According to the most recent data from EIA, about 71.5 percent of the electricity was generated using petroleum in 2012, representing a decrease of 18.5 percentage points from 1990 when 90.0 percent of the electricity was produced by petroleum. In 2013, renewable sources contributed 14.2 percent of the total electricity sold.
- The utility companies (HECO, MECO, HELCO, and KIUC) generated 57.6 percent of the total electricity in 2013 and purchased the rest from IPPs and CHPs. This was a 24.8 percentage point decrease from 1990, when utilities generated 82.4 percent of the total electricity.

1. Introduction

Electricity plays an important role in Hawaii's economy. Because of the state's heavy reliance on imported petroleum and the rapid increase in petroleum prices in recent years, Hawaii's total expenditures on electricity reached a peak of about $3.3 billion in 2012. From 2005 to 2012, total electricity expenditures 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% CPI growth during the same period. In 2013, total electricity expenditures decreased 3.9 percent due to decreased petroleum prices and reduced electricity sales from the utilities. Sales of electricity decreased in 2013 due to increased electricity generation from the customer-sited solar systems, which was not included in the electricity sales.

In November 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 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?

The data provided in this report are primarily from two major sources. The first source is publicly available state level energy data from the U.S. Energy Information Administration (EIA). Another major source of data is the Hawaii electric utility Monthly Financial Reports (MFR). The MFR provide 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: the 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.

Table 1. Total Electricity Generation by Producer

	State Total Generation 1/	% in Total Generation Units: %				
				CHP		
Year	GWh	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

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

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. As shown in Table 1, based on the most recent EIA data available, electric utilities accounted for about 57.4 percent of the 10,469 GWH of electricity generation by the electric power industry in 2012, the four types of non-utility producers accounted for about 42.6 percent of total generation. From 1990 to 2012, the share of the electric utilities in total generation decreased from 82.4 percent to 57.4 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. For example, the 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 from 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 2012, total utility generation (including station use) and purchased electricity in Hawaii was 10,508 GWH based on the utility MFR, slightly higher than the total electricity generation from the EIA data (10,469 GWH). It appears that the station use of non-utility producers is not included in the total electricity generation data provided by EIA.

Total electricity sold by the utilities includes utility net generation plus electricity purchased from non-utility producers minus utility lose. Utility net generation is utility total generation minus utility station use. In general, total utility generation has been decreasing in recent years. As shown in Table 2, the four electric utilities in Hawaii generated (including station use) about 6,100 GWH of electricity in 2013, decreased 4.3 percent or 277 GWH from the previous year. From 2005 to 2013, utility total generation decreased about 2.2 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. In 2013, station use for the state accounted for about 5.7 percent or 345 GWH of utility total generation. From 2005 to 2013, utility station use decreased 1.5 percent per year, less than the 2.2 percent decrease in total generation. As a result, the share of station use increased from 5.3 percent in 2005 to 5.7 percent in 2013 for the state. The share of station use was highest at HECO, followed by HELCO, MECO, and KIUC.

From 2005 to 2013, utility net generation decreased 2.3 percent per year on average, from 6,920 GWH in 2005 to 5,755 GWH in 2013. About 67.9 percent of Hawaii's utility net generation in 2013 was produced by HECO, 15.7 percent by MECO, 9.4 percent by HELCO, and 7.0 percent by KIUC.

Table 2. Hawaii Net Electricity Generation by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013
Total utility generation											
State Total	GWh	7,309	7,441	7,328	7,083	6,889	6,861	6,818	6,377	6,100	-4.3%
HECO	GWh	5,021	5,159	5,153	4,975	4,779	4,720	4,699	4,399	4,170	-5.2%
HELCO	GWh	561	596	516	490	546	584	586	518	571	10.2%
MECO	GWh	1,279	1,233	1,184	1,159	1,126	1,119	1,104	1,034	945	-8.6%
KIUC	GWh	448	453	475	459	438	438	429	426	415	-2.6%
Utility station use											
State Total	GWh	389	389	388	375	371	382	379	362	345	-4.6%
HECO	GWh	300	304	302	291	284	293	293	278	263	-5.6%
HELCO	GWh	31	30	27	26	30	31	31	29	30	5.6%
MECO	GWh	45	43	45	45	45	45	43	43	40	-5.5%
KIUC	GWh	13	12	13	13	12	13	13	12	12	-2.3%
Utility net generation											
State Total	GWh	6,920	7,052	6,941	6,708	6,518	6,479	6,439	6,016	5,755	-4.3%
HECO	GWh	4,721	4,855	4,851	4,684	4,495	4,426	4,406	4,121	3,907	-5.2%
HELCO	GWh	530	566	490	464	516	553	555	489	540	10.5%
MECO	GWh	1,234	1,190	1,138	1,114	1,081	1,074	1,060	992	905	-8.8%
KIUC	GWh	435	441	462	446	426	425	417	414	403	-2.6%
Utility share in net generation											
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
HECO	%	68.2%	68.8%	69.9%	69.8%	69.0%	68.3%	68.4%	68.5%	67.9%	
HELCO	%	7.7%	8.0%	7.1%	6.9%	7.9%	8.5%	8.6%	8.1%	9.4%	
MECO	%	17.8%	16.9%	16.4%	16.6%	16.6%	16.6%	16.5%	16.5%	15.7%	
KIUC	%	6.3%	6.3%	6.7%	6.7%	6.5%	6.6%	6.5%	6.9%	7.0%	
% of station use in utility generation											
State Total	%	5.3%	5.2%	5.3%	5.3%	5.4%	5.6%	5.6%	5.7%	5.7%	
HECO	%	6.0%	5.9%	5.9%	5.8%	5.9%	6.2%	6.2%	6.3%	6.3%	
HELCO	%	5.5%	5.1%	5.1%	5.3%	5.5%	5.3%	5.2%	5.5%	5.3%	
MECO	%	3.5%	3.5%	3.8%	3.9%	4.0%	4.0%	3.9%	4.1%	4.3%	
KIUC	%	2.9%	2.6%	2.8%	2.7%	2.6%	2.9%	2.9%	2.8%	2.8%	

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 3 shows that electricity purchased by the utilities increased from 4,202 GWH in 2005 to 4,244 GWH in 2013, an increase of only 42 GWH. This increase is in contrast to the 1,165 GWH decrease in net utility generation during the same period. Electricity purchased decreased from 2005 to 2011, but increased from 2011 to 2013. In 2013, electricity purchased increased 2.7 percent or 113 GWH. 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 42.4 percent in 2013.

Table 3. Hawaii Electricity Sales by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013
Electricity purchased											
State Total	GWh	4,202	4,129	4,255	4,277	4,154	4,090	4,046	4,131	4,244	2.7%
HECO	GWh	3,383	3,250	3,238	3,266	3,267	3,231	3,187	3,190	3,281	2.8%
HELCO	GWh	688	689	769	781	669	641	631	681	619	-9.2%
MECO	GWh	97	156	221	201	185	191	191	222	296	33.5%
KIUC	GWh	35	34	27	29	34	27	37	38	49	28.7%
Electricity net to system											
State Total	GWh	11,122	11,181	11,195	10,985	10,672	10,569	10,485	10,147	9,999	-1.5%
HECO	GWh	8,104	8,105	8,089	7,951	7,762	7,657	7,594	7,311	7,187	-1.7%
HELCO	GWh	1,217	1,255	1,259	1,245	1,184	1,194	1,187	1,170	1,159	-1.0%
MECO	GWh	1,331	1,346	1,359	1,315	1,266	1,265	1,252	1,214	1,201	-1.0%
KIUC	GWh	470	476	489	475	460	453	453	452	452	0.0%
Utility loss											
State Total	GWh	584	613	610	595	546	556	524	508	498	-1.9%
HECO	GWh	383	404	414	395	384	380	352	335	329	-1.9%
HELCO	GWh	101	106	96	104	64	84	83	85	83	-2.7%
MECO	GWh	79	79	79	75	74	74	70	69	66	-4.0%
KIUC	GWh	21	24	22	22	24	18	19	19	20	8.8%
Total electricity sold											
State Total	GWh	10,539	10,568	10,585	10,390	10,126	10,013	9,962	9,639	9,501	-1.4%
HECO	GWh	7,721	7,701	7,675	7,556	7,378	7,277	7,242	6,976	6,859	-1.7%
HELCO	GWh	1,116	1,149	1,163	1,141	1,120	1,110	1,104	1,085	1,076	-0.8%
MECO	GWh	1,252	1,266	1,280	1,239	1,192	1,192	1,181	1,145	1,135	-0.9%
KIUC	GWh	449	452	467	454	437	435	435	433	431	-0.4%
Share of purchased in net to system											
State Total	%	37.8%	36.9%	38.0%	38.9%	38.9%	38.7%	38.6%	40.7%	42.4%	
HECO	%	41.7%	40.1%	40.0%	41.1%	42.1%	42.2%	42.0%	43.6%	45.6%	
HELCO	%	56.5%	54.9%	61.1%	62.7%	56.5%	53.7%	53.2%	58.2%	53.4%	
MECO	%	7.3%	11.6%	16.2%	15.3%	14.6%	15.1%	15.3%	18.3%	24.7%	
KIUC	%	7.4%	7.2%	5.5%	6.1%	7.5%	6.1%	8.1%	8.4%	10.8%	
Share of loss in net to system											
State Total	%	5.2%	5.5%	5.5%	5.4%	5.1%	5.3%	5.0%	5.0%	5.0%	
HECO	%	4.7%	5.0%	5.1%	5.0%	4.9%	5.0%	4.6%	4.6%	4.6%	
HELCO	%	8.3%	8.4%	7.6%	8.3%	5.4%	7.1%	7.0%	7.3%	7.2%	
MECO	%	5.9%	5.9%	5.8%	5.7%	5.8%	5.8%	5.6%	5.7%	5.5%	
KIUC	%	4.5%	5.0%	4.5%	4.5%	5.2%	4.0%	4.1%	4.1%	4.5%	

Source: Hawaii Electric Utility Monthly Financial Reports.

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 5.0 percent of the electricity sent to the system was lost in 2013. The percent of loss is highest in the HELCO system (7.2%), followed by MECO (5.5%), HECO (4.6%), and KIUC (4.5%). Total electricity sold is electricity net to system minus electricity lost. From 2005 to 2013, total electricity sold decreased 1.3 percent per year on average from 10,539 GWH to 9,501 GWH. The system loss share of electricity net to system has been fairly constant at around 5 percent for the state over this period.

Table 4 shows that utility station use and loss decreased from 972 GWH in 2005 to 843 GWH in 2013, a decrease of 1.8 percent per year on average. The share of utility station usage and loss as a percentage of total utility generation and purchased electricity decreased slightly from 8.4 percent in 2005 to 8.1 percent in 2013.

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

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013
Total utility generation and purchased 1/											
State Total	GWh	11,511	11,570	11,583	11,360	11,043	10,951	10,864	10,508	10,344	-1.6%
HECO	GWh	8,404	8,409	8,392	8,242	8,046	7,950	7,886	7,589	7,450	-1.8%
HELCO	GWh	1,248	1,285	1,285	1,271	1,214	1,225	1,217	1,199	1,189	-0.8%
MECO	GWh	1,376	1,389	1,404	1,360	1,311	1,310	1,295	1,256	1,241	-1.2%
KIUC	GWh	482	487	502	488	472	465	466	464	463	-0.1%
Station use and loss											
State Total	GWh	972	1,002	998	970	916	938	903	869	843	-3.0%
HECO	GWh	683	708	716	686	668	673	644	613	592	-3.5%
HELCO	GWh	132	136	123	130	94	115	114	114	113	-0.6%
MECO	GWh	124	122	124	120	118	119	114	111	106	-4.6%
KIUC	GWh	34	35	35	34	35	31	31	31	32	4.4%
% of station use and loss											
State Total	%	8.4%	8.7%	8.6%	8.5%	8.3%	8.6%	8.3%	8.3%	8.1%	-1.5%
HECO	%	8.1%	8.4%	8.5%	8.3%	8.3%	8.5%	8.2%	8.1%	7.9%	-1.7%
HELCO	%	10.5%	10.6%	9.5%	10.2%	7.8%	9.4%	9.3%	9.5%	9.5%	0.2%
MECO	%	9.0%	8.8%	8.8%	8.8%	9.0%	9.1%	8.8%	8.9%	8.6%	-3.4%
KIUC	%	7.0%	7.2%	7.0%	7.0%	7.5%	6.6%	6.7%	6.6%	6.9%	4.5%

1/ Excluding station use of non-utility producers.
Source: Hawaii Electric Utility Monthly Financial Reports.

Since the station use of non-utility producers is not available, the percentage of station use and loss calculated above underestimates the true share of station use and loss as a percentage of the whole electric system of Hawaii. If we assume that the share of station use of the non-utility producers as a percentage of purchased electricity is similar to that of the share of utility station use in net generation as shown in Table 5, the share of total station use and loss in gross generation would be about 10.3 percent in 2013.

Hawaii's gross electricity generation in 2013 was estimated to be about 10,598 GWH. In 2013, about 72 percent of the gross generation was produced by the HECO system (including both utility and non-utility producers), while HELCO and MECO each accounted for about 12 percent of gross generation, and KIUC accounted for about 4 percent. From 2005 to 2013, the county utilities' shares in gross generation were rather stable.

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

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013
Station use of non-utility											
State Total	GWh	244	233	239	241	239	243	240	250	254	1.5%
HECO	GWh	202	192	190	191	194	201	198	202	207	2.5%
HELCO	GWh	38	35	40	42	37	34	33	38	33	-13.1%
MECO	GWh	3	5	8	8	7	8	8	9	13	38.1%
KIUC	GWh	1	1	1	1	1	1	1	1	1	29.0%
Total gross generation 1/											
State Total	GWh	11,755	11,803	11,822	11,601	11,282	11,194	11,104	10,758	10,598	-1.5%
HECO	GWh	8,606	8,601	8,582	8,433	8,240	8,151	8,085	7,791	7,657	-1.7%
HELCO	GWh	1,286	1,320	1,325	1,313	1,251	1,259	1,250	1,237	1,222	-1.2%
MECO	GWh	1,379	1,394	1,413	1,367	1,318	1,318	1,302	1,265	1,254	-0.9%
KIUC	GWh	484	488	503	489	473	466	467	465	465	0.0%
Share in gross generation											
State Total	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	0.0%
HECO	%	73%	73%	73%	73%	73%	73%	73%	72%	72%	-0.2%
HELCO	%	11%	11%	11%	11%	11%	11%	11%	11%	12%	0.3%
MECO	%	12%	12%	12%	12%	12%	12%	12%	12%	12%	0.6%
KIUC	%	4%	4%	4%	4%	4%	4%	4%	4%	4%	1.5%
Total station use and loss											
State Total	GWh	1,217	1,235	1,237	1,211	1,156	1,181	1,143	1,119	1,097	-2.0%
HECO	GWh	885	900	906	877	863	874	842	815	799	-2.1%
HELCO	GWh	169	171	162	172	131	149	147	152	146	-3.7%
MECO	GWh	127	128	133	128	126	126	121	120	119	-1.4%
KIUC	GWh	35	36	36	35	36	32	32	32	33	5.3%
% of station use and loss											
State Total	%	10.3%	10.5%	10.5%	10.4%	10.2%	10.5%	10.3%	10.4%	10.3%	-0.5%
HECO	%	10.3%	10.5%	10.6%	10.4%	10.5%	10.7%	10.4%	10.5%	10.4%	-0.3%
HELCO	%	13.2%	13.0%	12.2%	13.1%	10.5%	11.8%	11.7%	12.3%	12.0%	-2.5%
MECO	%	9.2%	9.1%	9.4%	9.4%	9.5%	9.6%	9.3%	9.5%	9.5%	-0.5%
KIUC	%	7.2%	7.4%	7.1%	7.1%	7.7%	6.8%	6.9%	6.8%	7.2%	5.3%

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 high and rapidly growing electricity prices are mainly due to its heavy dependence on imported petroleum as the major fuel for electricity generation. Before 1990, Hawaii's electricity was almost all generated from petroleum products. However, since 1990, electricity generated from waste, coal, and geothermal energy became more significant. Nevertheless, petroleum remains the dominant fuel in Hawaii's electricity generation and is the primary driver for the rapid growth of electricity prices in Hawaii.

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

	Total Electricity Generation	% in Total Electricity Generation								
Year	GWH	Petroleum	Coal	Other Gases 1/	Biomass	Geotherma	Hydro	Wind	Solar	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	1.5	0.6	0.2	-	-
1994	10,109	75.6	13.1	0.7	7.2	1.8	1.4	0.2	-	-
1995	10,304	74.5	15.2	0.7	6.2	2.3	0.9	0.2	-	0.0
1996	10,628	74.9	15.5	0.6	5.6	2.3	1.0	0.2	-	-
1997	10,312	74.6	15.3	0.6	5.9	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	0.00	1.4
2009	11,011	75.3	13.6	0.2	2.6	1.5	1.0	2.3	0.01	3.5
2010	10,836	74.6	14.3	0.2	2.6	1.9	0.6	2.4	0.02	3.4
2011	10,723	73.9	13.3	0.3	2.9	2.1	0.9	3.2	0.03	3.4
2012	10,469	71.5	14.7	0.4	2.7	2.5	1.1	3.6	0.04	3.5

1/ Other gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.
Source: Energy Information Administration, State Energy Data System

As shown in Table 6, from 1990 to 2012, the share of petroleum generated electricity in Hawaii (including both utility and non-utility producers) decreased from 90.0 percent to 71.5 percent; the share of coal generated electricity increased from 0.0 percent to 14.7 percent; the share

of wind generated electricity increased from 0.3 percent to 3.6 percent; the share of geothermal generated electricity increased from 0.0 to 2.5 percent; and the share of biomass decreased from 8.7 percent to 2.7 percent. In 2012, total renewable electricity (excluding customer-sited solar) accounted for about 10 percent of total electricity generation.

Since most of the non-petroleum generated electricity was produced by non-utility producers, the high petroleum price affected the average cost of purchased electricity less than the fuel cost of utility generated electricity. As shown in Table 7, almost all electricity generated from the utilities was from petroleum. From 1990 to 2012, the share of petroleum generated electricity as a percentage of total utility generated electricity decreased from 99.6 percent to 95.6 percent; the share of utility petroleum generated electricity as a percentage of total petroleum generated electricity decreased from 91.2 percent to 76.8 percent.

Table 7. Electricity Generation by Utilities

	Total Electricity Generation	% in Total Electricity Generation								
Year	GWH	Petroleum	Coal	Other Gases 1/	Biomass	Geotherma	Hydro	Wind	Solar	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

1/ Other gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.
Source: Energy Information Administration, State Energy Data System

As shown in Table 8, from 1990 to 2012, the share of petroleum generated electricity in non-utility generated electricity decreased from 45.0 percent to 39.0 percent; the share of coal generated electricity increased from 0.1 percent to 34.5 percent; the share of wind generated electricity increased from 1.7 percent to 8.5 percent; the share of geothermal electricity increased from 0.0 to 5.9 percent; and the share of biomass decreased from 48.9 percent to 5.8 percent.

The increased share of non-petroleum generated electricity contributed to a lower growth rate of purchased electricity costs. For example, the average cost of coal-fired electricity purchased by HECO was only about 10 cents per kWh and this was below the average price of HECO electricity of about 31 cents per kWh. The average fuel cost of HECO generated electricity was about 22 cents per kWh, and the average cost of HECO purchased power was 16 cents per kWh in 2013.

Table 8. Electricity Generation IPP & CHP

Year	Total Electricity Generation GWH	% in Total Electricity Generation								
		Petroleum	Coal	Other Gases 1/	Biomass	Geotherma	Hydro	Wind	Solar	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	3.9	1.1	0.6	-	-
1994	4,054	39.6	32.7	1.6	18.0	4.6	3.0	0.5	-	-
1995	4,113	36.6	38.0	1.7	15.6	5.7	2.0	0.5	-	0.1
1996	4,208	37.1	39.0	1.4	14.1	5.8	2.0	0.5	-	-
1997	4,100	36.5	38.4	1.6	14.8	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	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

1/ Other gases includes blast furnace gas, propane gas, and other manufactured and waste gases derived from fossil fuels.
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 2,982 MW in 2012, an increase of 1.9 percent per year on average. As shown in Table 9, coal-fired capacity increased from 24 MW to 203 MW or 10.2 percent per year over the period, wind capacity increased from 23 MW to 206 MW or 10.4 percent per year on average, petroleum generation capacity increased from 1,692 MW to 2,181 MW or an average of 1.2 percent over the period, and biomass capacity increased from 211 MW to 227 MW or a 0.3 percent average per year.

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

	Power Generating Capacity Units: MW									
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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	-	-	2,556
2001	2,093	227	9	151	35	26	11	-	-	2,552
2002	2,093	227	9	110	35	25	11	-	-	2,509
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	-	-	2,648
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

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 1,945 MW in 2012, an increase of 1.1 percent per year on average. The generating capacity added by the utilities from 1990 to 2012 was mainly petroleum and biomass-fired (utilizing biodiesel) capacity. In 2013, the average cost of biodiesel for HECO was about 63 cents per kWh, much higher than the HECO average cost of diesel at about 51 cents per kWh.

Table 10. Power Generating Capacity: Electric Utilities

	Power Generating Capacity Units: MW									
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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	-	-	1,711
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	-	-	1,840
2007	1,838	-	-	-	-	4	2	-	-	1,845
2008	1,838	-	-	-	-	4	2	-	-	1,845
2009	1,856	-	-	113	-	4	2	-	-	1,976
2010	1,827	-	-	113	-	4	-	-	-	1,945
2011	1,827	-	-	113	-	4	-	-	-	1,945
2012	1,788	-	-	113	-	4	-	-	39	1,945

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 1,037 MW in 2012, an increase of 4.0 percent per year on average. The growth rate of wind capacity was the highest during this period at 10.4 percent on average per year. Wind was followed by coal-fired capacity at 10.2 percent per year and petroleum capacity at 4.4 percent per year. Geothermal capacity increased from zero to 51 MW, but the biomass capacity decreased from 211 MW to 114 MW over the period.

Table 11. Power Generating Capacity: IPP and CHP

	Power Generating Capacity Units: MW									
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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	-	-	845
2001	390	227	9	151	35	23	9	-	-	844
2002	391	227	9	110	35	23	9	-	-	803
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	-	-	808
2007	386	203	9	114	35	21	62	-	-	829
2008	386	203	9	114	35	21	62	1	-	830
2009	386	203	9	114	35	21	62	1	-	829
2010	387	203	9	114	35	21	62	2	-	831
2011	386	203	12	114	35	21	92	2	-	865
2012	393	203	6	114	51	22	206	7	36	1,037

Source: Energy Information Administration, State Energy Data System

The detailed power generating capacity by county in 2013 is provided in Table 12. Currently, the state of Hawaii has about 2,433 MW firm capacity; 1,731 MW in Honolulu, 286 MW in Hawaii County, 290 MW in Maui County, and 125 MW in Kauai County. About 82.4 percent of the firm capacity use petroleum, 7.4 percent use coal, and 8.6 percent use biofuel or waste.

The state also installed about 269 MW non-firm capacity, mostly by non-utility producers; 138 MW in Honolulu, 49 MW in Hawaii County, 74 MW in Maui County, and 8 MW in Kauai County. Wind accounted for about 75.6 percent of the non-firm capacity; followed by hydro at 9.2 percent, petroleum at 6.9 percent, and solar at 4.8 percent. In addition, about 303 MW customer-sited solar was installed in Hawaii; 210 MW in Honolulu, 38 MW in Hawaii County, 41 MW in Maui County, and 14 MW in Kauai County. Most of the electricity generated by these systems are directly consumed by the consumers and not included in the utility electricity sales.

Table 12. Power Generating Capacity by Type in 2013

	Petroleum	Coal	Other Gases	Biofuel Waste	Geothermal	Hydro	Wind	Solar	Total
State Total MW	2,023	180	10	209	38	26	203	13	2,701
State Total Firm MW	2,004	180	-	209	38	1	-	-	2,433
State Total Non-Firm MW	19	-	10	-	-	25	203	13	269
State Total Customer-Sited Sola	-	-	-	-	-	-	-	303	303
State Total MW	2,023	180	10	209	38	26	203	13	2,701
Honolulu	1,377	180	10	193	-	-	99	11	1,869
Hawaii	248	-	-	-	38	16	32	1	335
Maui	274	-	-	16	-	1	72	1	364
Kauai	124	-	-	-	-	9	-	-	133
State Total Firm MW	2,004	180	-	209	38	1	-	-	2,433
Honolulu	1,358	180	-	193	-	-	-	-	1,731
Hawaii	248	-	-	-	38	-	-	-	286
Maui	274	-	-	16	-	-	-	-	290
Kauai	124	-	-	-	-	1	-	-	125
State Total Non-Firm MW	19	-	10	-	-	25	203	13	269
Honolulu	19	-	10	-	-	-	99	11	138
Hawaii	-	-	-	-	-	16	32	1	49
Maui	-	-	-	-	-	1	72	1	74
Kauai	-	-	-	-	-	8	-	-	8
State Total Customer-Sited Sola	-	-	-	-	-	-	-	303	303
Honolulu	-	-	-	-	-	-	-	210	210
Hawaii	-	-	-	-	-	-	-	38	38
Maui	-	-	-	-	-	-	-	41	41
Kauai	-	-	-	-	-	-	-	14	14

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 base load needs have higher average operating hours per year, and the average cost per kWh is normally lower that the average cost of the units serving peak loads.

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	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	3,509	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	3,554	6,177	5,052	902	-	4,047
1995	3,887	6,853	7,701	3,314	6,701	3,384	932	-	4,136
1996	4,014	7,213	6,707	3,071	6,914	3,600	1,023	-	4,252
1997	3,899	6,913	7,265	3,406	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	-	4,145
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	-	4,648
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	-	4,365
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

Source: Energy Information Administration, State Energy Data System

As shown in Table 13, for the whole electric power industry in 2012, other gases-fueled generating units have the highest average operating hours at 7,839 hours per year, followed by coal-fired capacity at 7,573 hours per year, and geothermal units at 5,118 hours per year. The coal and geothermal units serve base load needs. Hydro and petroleum units have average operating hours of around 3,400-4,400 hours per year, similar to the average operating hours of all units at 3,511 hours per year. 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 and Table 15 compare the average operating hours of utility generating units and non-utility generating units. For all generating capacity, the average operating hours of utility-based units decreased from 5,187 hours per year in 1990 to 3,092 hours per year in 2012, a decrease of 2.3 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 4,296 hours per year in 2012, an increase of 0.4 percent per year on average.

Table 14. Average Operating Hours: Electric Utilities

	Average Operating Hours Units: Hours/Year								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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	-	3,819
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	-	3,826
2007	3,761	-	-	-	-	3,682	219	-	3,755
2008	3,636	-	-	-	-	4,468	86	-	3,632
2009	3,374	-	-	29	-	7,152	43	-	3,294
2010	3,382	-	-	14	-	4,180	-	-	3,299
2011	3,342	-	-	343	-	4,878	-	-	3,279
2012	3,213	-	-	191	-	7,059	-	-	3,092

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 3,213 hours per year in 2012, an average decrease of 2.1 percent per year. The average operating hours of non-utility units decreased from 5,000 hours per year in 1990 to 4,423 hours per year in 2012, an average decrease of 0.6 percent per year.

Table 15. Average Operating Hours: IPP and CHP

	Average Operating Hours Units: Hours/Year								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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	3,509	71	3,502	1,006	-	3,458
1993	4,134	6,493	7,008	3,500	5,075	2,900	973	-	4,561
1994	5,011	5,824	7,302	3,554	6,177	4,974	902	-	4,830
1995	4,697	6,853	7,701	3,314	6,701	3,204	932	-	4,941
1996	4,874	7,213	6,707	3,071	6,914	3,372	1,023	-	5,054
1997	4,669	6,913	7,265	3,406	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	-	4,803
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	-	5,168
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	-	5,592
2007	5,184	7,778	5,025	2,502	6,568	3,696	3,835	-	5,555
2008	5,149	8,116	4,286	2,653	6,695	3,165	3,869	18	5,633
2009	5,251	7,390	2,483	2,466	4,788	4,002	4,054	1,390	5,429
2010	4,932	7,613	2,435	2,473	5,731	2,557	4,212	885	5,319
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

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 in electricity generation decreased from about 16.0 million barrels (BBLs) in 1990 to 11.2 million BBLs in 2012, an average decrease of 1.6 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 2012, total electricity generated by petroleum decreased an average of 0.7 percent per year and petroleum consumption per MWH of electricity decreased 0.9 percent per year, from 1.84 BBL per MWH in 1990 to 1.50 BBL per MWH in 2012.

Table 16. Fuel Consumption by All Electricity Producers

	Fuel Consumption			Fuel Consumption Per MWH		
	Petroleum	Coal	Other Gases	Petroleum	Coal	Other Gases
Year	BBL	ST	Billion BTU	BBL	ST	Billion BTU
1990	16,033,262	2,013	211	1.84	0.85	0.01
1991	13,464,028	5,555	729	1.75	0.73	0.01
1992	14,220,256	265,043	1,027	1.71	0.48	0.02
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

Source: Energy Information Administration, State Energy Data System

Coal used for electricity generation in Hawaii was very limited before 1993. From 1993 to 2012, total coal used for electricity generation increased from 603,669 short tons (STs) to 756,726 STs, an average increase of 1.2 percent per year. During this period, total coal generated electricity increased only 0.2 percent per year, but coal consumption per MWH produced increased 1.0 percent per year on average from 0.41 ST per MWH to 0.49 ST per MWH.

The utilities account for about 86 percent of the petroleum used to generate electricity in Hawaii. As shown in Table 17, petroleum consumption per MWH was has been fairly stable over the period analyzed for utility units. From 1990 to 2012, petroleum consumption per MWH decreased only slightly from 1.73 BBL per MWH to 1.68 BBL per MWH.

Table 17. Fuel Consumption by Electric Utility

	Fuel Consumption			Fuel 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	-	-
1991	12,695,906	-	-	1.74	-	-
1992	11,988,722	-	-	1.75	-	-
1993	10,656,101	-	-	1.76	-	-
1994	10,409,083	-	-	1.72	-	-
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	-	-

Source: Energy Information Administration, State Energy Data System

For non-utility producers, petroleum consumption per MWH produced decreased significantly over time. From 1990 to 2012, petroleum consumption per MWH decreased an average of 5.3 percent per year from 2.95 BBL to 0.89 BBL. In 2012, the per unit petroleum consumption for non-utility producers was only about 53 percent of the unit consumption by utility producers.

Table 18. Fuel Consumption by IPP and CHP

	Fuel Consumption			Fuel 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
1991	768,122	5,555	729	1.91	0.73	0.01
1992	2,231,534	265,043	1,027	1.50	0.48	0.02
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

Source: Energy Information Administration, State Energy Data System

Fuel consumption data provided by EIA is only available at the state level, and the most recent data available is the 2011 data. Conversely, data available from the utility MFR includes fuel consumption by individual utility producers, and the average price of fuel data is available up to 2013. The fuel cost of non-utility producers, however, is not available in the utility MFR.

As shown in Table 19, from 2005 to 2013, total petroleum consumption by the four electric utilities in Hawaii decreased an average 2.8 percent per year from about 12.0 million BBLs to about 9.6 million BBLs; fuel oil consumption decreased an average 2.9 percent per year from 9.1 million BBLs to 7.2 million BBLs; diesel oil (excluding biodiesel) consumption decreased an average 2.3 percent per year from 2.9 million BBLs to 2.4 million BBLs. In 2013, petroleum consumption by the utilities decreased 3.9 percent from the previous year; fuel oil decreased 5.3 percent, while diesel increased 0.4 percent.

Table 19. Hawaii Utility Fuel Consumption

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2013
Petroleum									
State Total	BBL	12,046,758	12,045,419	11,244,809	10,873,734	10,027,770	9,633,073	-3.9%	-2.8%
HECO	BBL	7,993,010	8,195,607	7,555,082	7,312,962	6,719,585	6,408,203	-4.6%	-2.7%
HELCO	BBL	1,136,268	1,067,210	1,089,738	1,031,711	904,034	997,659	10.4%	-1.6%
MECO	BBL	2,170,554	1,959,432	1,869,575	1,806,667	1,697,767	1,539,175	-9.3%	-4.2%
KIUC	BBL	746,926	823,170	730,414	722,394	706,384	688,036	-2.6%	-1.0%
Fuel Oil									
State Total	BBL	9,120,687	9,358,136	8,617,627	8,263,907	7,612,236	7,207,891	-5.3%	-2.9%
HECO	BBL	7,874,530	8,098,475	7,411,899	7,285,178	6,703,981	6,391,243	-4.7%	-2.6%
HELCO	BBL	726,866	787,051	734,535	577,107	533,394	533,483	0.0%	-3.8%
MECO	BBL	519,291	472,610	471,193	401,622	374,861	283,165	-24.5%	-7.3%
KIUC	BBL	-	-	-	-	-	-		
Diesel									
State Total	BBL	2,926,071	2,687,283	2,627,182	2,609,827	2,415,534	2,425,182	0.4%	-2.3%
HECO	BBL	118,480	97,132	143,183	27,784	15,604	16,960	8.7%	-21.6%
HELCO	BBL	409,402	280,159	355,203	454,604	370,640	464,176	25.2%	1.6%
MECO	BBL	1,651,263	1,486,822	1,398,382	1,405,045	1,322,906	1,256,010	-5.1%	-3.4%
KIUC	BBL	746,926	823,170	730,414	722,394	706,384	688,036	-2.6%	-1.0%
% of Fuel Oil									
State Total	%	75.7%	77.7%	76.6%	76.0%	75.9%	74.8%		
HECO	%	98.5%	98.8%	98.1%	99.6%	99.8%	99.7%		
HELCO	%	64.0%	73.7%	67.4%	55.9%	59.0%	53.5%		
MECO	%	23.9%	24.1%	25.2%	22.2%	22.1%	18.4%		
KIUC	%	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%		
HECO	%	86.3%	86.5%	86.0%	88.2%	88.1%	88.7%		
HELCO	%	8.0%	8.4%	8.5%	7.0%	7.0%	7.4%		
MECO	%	5.7%	5.1%	5.5%	4.9%	4.9%	3.9%		
KIUC	%	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%		
HECO	%	4.0%	3.6%	5.5%	1.1%	0.6%	0.7%		
HELCO	%	14.0%	10.4%	13.5%	17.4%	15.3%	19.1%		
MECO	%	56.4%	55.3%	53.2%	53.8%	54.8%	51.8%		
KIUC	%	25.5%	30.6%	27.8%	27.7%	29.2%	28.4%		

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 19 also shows how the fuel oil share of total petroleum consumption for electricity production was stable at about 75-76 percent over the period analyzed. For HECO, almost all the petroleum consumed was fuel oil. Fuel oil also accounted for more than half of total petroleum consumption at HELCO. Fuel oil only accounted for about 18 percent of total petroleum consumption at MECO, and 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 were significantly higher than the growth rates of diesel costs.

Table 20. Hawaii Utility Fuel Cost

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2012
Petroleum									
State Total	$M	694	850	724	1,339	1,373	1,259	-8.2%	10.2%
HECO	$M	421	526	460	892	926	833	-10.0%	11.9%
HELCO	$M	65	75	74	122	117	126	7.4%	8.7%
MECO	$M	154	174	137	234	235	209	-11.3%	6.3%
KIUC	$M	54	76	52	91	94	92	-2.4%	8.3%
Fuel Oil									
State Total	$M	467	592	519	993	1,033	922	-10.8%	12.0%
HECO	$M	412	516	447	889	924	831	-10.1%	12.3%
HELCO	$M	33	48	44	62	65	60	-7.9%	9.9%
MECO	$M	22	28	28	42	44	31	-30.1%	10.2%
KIUC	$M	-	-	-	-	-	-		
Diesel									
State Total	$M	226	258	205	346	339	338	-0.5%	6.0%
HECO	$M	9	9	13	3	2	2	11.9%	-19.3%
HELCO	$M	32	27	30	60	52	66	26.4%	7.3%
MECO	$M	132	145	110	192	191	178	-7.0%	5.5%
KIUC	$M	54	76	52	91	94	92	-2.4%	8.3%
% of Fuel Oil									
State Total	%	67.4%	69.6%	71.7%	74.2%	75.3%	73.2%		
HECO	%	97.9%	98.2%	97.2%	99.7%	99.8%	99.7%		
HELCO	%	51.2%	63.5%	59.1%	50.6%	55.4%	47.5%		
MECO	%	14.5%	16.2%	20.3%	18.0%	18.7%	14.7%		
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%		

Source: Hawaii Electric Utility Monthly Financial Reports.

As shown in Table 20 above, from 2005 to 2012, total petroleum costs by the utilities in Hawaii increased an average 10.2 percent per year from $694 million to $1,373 million; fuel oil costs increased an average 12.0 percent per year from $467 million to $1,033 million; diesel oil (excluding biodiesel) costs increased an average 6.0 percent per year from $226 million to $339 million. Due to the faster growth in fuel oil expenditures, the share of fuel oil in total utility petroleum expenditures increased from 67.4 percent in 2005 to 75.3 percent in 2012, an increase of 7.9 percentage points. In 2013, however, the costs of fuel oil and diesel both decreased from the previous year.

The decrease in diesel expenditures by HECO is due to the increased use of biodiesel. In 2013, HECO spent $18.0 million on biodiesel. The average cost of biodiesel consumed by HECO was $183.09/BBL, significantly higher than the average cost of diesel ($132.18/BBL).

The average unit cost of petroleum used in utility electricity generation increased rapidly in recent years with the growth rate being significantly higher than the growth rate of crude oil prices. As shown in Table 21, from 2005 to 2012, the average unit petroleum cost for the four electric utilities in Hawaii increased an average of 13.2 percent per year from $57.57 per BBL to $136.88 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 (excluding biodiesel) costs increased an average 8.9 percent per year from $77.36 per BBL to $140.52 per BBL. In comparison, the average crude oil price increased an average 7.6 percent per year over the same period. In 2013, the per unit fuel oil cost decreased 5.8 percent from the previous year; and the per unit diesel cost also decreased slightly. In 2013, the per unit fuel oil costs were highest at HECO, followed by HELCO and MECO. Diesel costs per unit were highest at HELCO, followed by MECO, KIUC, and HECO.

Table 21. Hawaii Utility Average Fuel Cost

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2012
Petroleum									
State Total	$/BBL	57.57	70.60	64.38	123.11	136.88	130.73	-4.5%	13.2%
HECO	$/BBL	52.61	64.13	60.90	121.99	137.86	130.05	-5.7%	14.8%
HELCO	$/BBL	57.44	70.24	68.28	118.09	129.27	125.81	-2.7%	12.3%
MECO	$/BBL	70.88	88.60	73.54	129.58	138.60	135.57	-2.2%	10.1%
KIUC	$/BBL	72.19	92.64	71.13	125.40	133.12	133.37	0.2%	9.1%
Fuel Oil									
State Total	$/BBL	51.22	63.27	60.24	120.15	135.72	127.85	-5.8%	14.9%
HECO	$/BBL	52.26	63.75	60.34	122.03	137.88	130.04	-5.7%	14.9%
HELCO	$/BBL	45.96	60.50	59.89	106.84	121.43	111.80	-7.9%	14.9%
MECO	$/BBL	42.93	59.63	59.24	105.17	117.39	108.67	-7.4%	15.5%
KIUC	$/BBL								
Diesel									
State Total	$/BBL	77.36	96.13	77.96	132.48	140.52	139.28	-0.9%	8.9%
HECO	$/BBL	76.07	95.67	89.82	112.16	128.37	132.18	3.0%	7.8%
HELCO	$/BBL	77.84	97.63	85.63	132.38	140.56	141.92	1.0%	8.8%
MECO	$/BBL	79.67	97.80	78.36	136.56	144.61	141.64	-2.1%	8.9%
KIUC	$/BBL	72.19	92.64	71.13	125.40	133.12	133.37	0.2%	9.1%

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 2013, total renewable electricity generated by the electric power industry (excluding customer generated electricity) increased 8.3 percent per year on average from 714 GWH to 1,352 GWH (Table 22). The share of renewable electricity in total electricity sales increased from 6.8 percent to 14.2 percent during this period.

In 2013, about 37.2 percent of Hawaii's renewable electricity was generated from wind, 30.7 percent from biomass, 20.8 percent from geothermal, 5.4 percent from hydro, 2.2 percent from biofuels, and 3.6 percent from PV and solar thermal.

Table 22. Renewable Electricity Generation in Hawaii

	Renewable Electricity Generation (GWH)						
Year	Total	Biomass	Biofuels	Geothermal	Hydro	Wind	PV&Solar
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
Growth 05-13	8.3%	0.4%	103.8%	3.1%	-1.4%	70.7%	
	% in Renewable Electricity Generation						
Year	Total	Biomass	Biofuels	Geothermal	Hydro	Wind	PV
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

Source: HECO and KIUC Renewable Portfolio Standard Status Report.

Table 23 shows renewable electricity generation by GWH units. From 2005 to 2013, Honolulu renewable electricity generation increased the most at 219 GWH or 6.5 percent per year. This was followed by Maui at 207 GWH or 18.0 percent per year, Hawaii County at 202 GWH or 7.3 percent per year, and Kauai at 10.0 GWH or 3.0 percent per year. In 2013, renewable electricity accounted for about 43.7 percent of electricity sales in Hawaii County. Hawaii County was followed by Maui at about 24.9 percent, Kauai at 11.0 percent, and Honolulu at 8.0 percent.

Table 23. Hawaii Renewable Electricity Generation by County

		2005	2006	2007	2008	2009	2010	2011	2012	2013
Renewable Generation State	GWH	714	861	938	963	930	897	1,096	1,134	1,352
Honolulu	GWH	333	395	326	359	364	316	431	405	552
Hawaii	GWH	268	293	389	399	368	372	436	479	470
Maui	GWH	75	136	196	170	161	175	189	210	283
Kauai	GWH	37	37	26	36	37	34	40	41	47
Biomass State	GWH	403	470	392	413	399	359	365	342	416
Honolulu	GWH	333	395	326	359	360	315	322	302	375
Hawaii	GWH	-	-	-	-	-	-	-	-	-
Maui	GWH	70	75	66	54	38	44	44	39	41
Kauai	GWH	-	-	-	-	-	-	-	-	-
Biofuels State	GWH	0	0	1	2	5	3	59	23	30
Honolulu	GWH	-	-	-	-	3	2	45	21	29
Hawaii	GWH	-	-	-	-	-	-	-	-	-
Maui	GWH	0	0	1	2	2	2	15	1	1
Kauai	GWH	-	-	-	-	-	-	-	-	-
Geothermal State	GWH	221	212	230	234	168	202	233	266	281
Honolulu	GWH	-	-	-	-	-	-	-	-	-
Hawaii	GWH	221	212	230	234	168	202	233	266	281
Maui	GWH	-	-	-	-	-	-	-	-	-
Kauai	GWH	-	-	-	-	-	-	-	-	-
Hydroelectricity State	GWH	82	97	72	78	107	70	90	104	73
Honolulu	GWH	-	-	-	-	-	-	-	-	-
Hawaii	GWH	40	56	42	36	60	29	45	58	35
Maui	GWH	5	4	3	6	10	7	6	7	5
Kauai	GWH	37	37	26	36	37	34	39	39	33
Wind State	GWH	7	82	242	237	250	261	344	388	504
Honolulu	GWH	-	-	-	-	-	0	64	75	122
Hawaii	GWH	7	25	116	128	141	141	157	155	152
Maui	GWH	-	57	126	109	110	120	123	158	230
Kauai	GWH	-	-	-	-	-	-	-	-	-
Photovoltaic and Solar State	GWH	-	-	-	-	1	2	4	12	48
Honolulu	GWH	-	-	-	-	-	-	0	6	27
Hawaii	GWH	-	-	-	-	-	0	0	0	2
Maui	GWH	-	-	-	-	1	2	2	3	5
Kauai	GWH	-	-	-	-	-	-	1	2	14
Electricity Sold State	GWH	10,539	10,568	10,585	10,390	10,126	10,013	9,962	9,639	9,501
Honolulu	GWH	7,721	7,701	7,675	7,556	7,378	7,277	7,242	6,976	6,859
Hawaii	GWH	1,116	1,149	1,163	1,141	1,120	1,110	1,104	1,085	1,076
Maui	GWH	1,252	1,266	1,280	1,239	1,192	1,192	1,181	1,145	1,135
Kauai	GWH	449	452	467	454	437	435	435	433	431
% of Renewable State	%	6.8	8.2	8.9	9.3	9.2	9.0	11.0	11.8	14.2
Honolulu	%	4.3	5.1	4.2	4.8	4.9	4.3	5.9	5.8	8.0
Hawaii	%	24.0	25.5	33.4	34.9	32.9	33.5	39.5	44.1	43.7
Maui	%	6.0	10.8	15.3	13.7	13.5	14.6	16.0	18.3	24.9
Kauai	%	8.4	8.2	5.7	7.8	8.5	7.9	9.3	9.4	11.0

Source: HECO and KIUC Renewable Portfolio Standard Status Report.

4. Factors Affecting Electricity Prices in Hawaii

In 2013, the 9,501 GWH of electricity sold in Hawaii generated a total revenue of about $3.2 billion. Total revenue or total cost to customers of electricity sold in Hawaii increased 6.3 percent per year on average from $1.9 billion in 2005 to $3.2 billion in 2013. Revenue from electricity sales increased every year from 2005 to 2008, decreased in 2009, and then increased every year from 2009 to 2012. In 2013, revenue from electricity sales decreased 3.9 percent due to both decreased GWH sales and decreased average price of electricity. Total GWH sold has been decreasing in recent years in Hawaii. From 2005 to 2007, total GWH sold in Hawaii increased only slightly. However, since 2007, total GWH sold has decreased each year.

The increased electricity cost to customers was due to the increased average price of electricity. As shown in Table 24, the average revenue per kWh sold in Hawaii increased from 18.3 cents in 2005 to 33.2 cents in 2013, an increase of 7.7 percent per year. In 2013, the average revenue from electricity sales decreased 2.5 percent from the previous year. The average electricity revenue in 2013 was the highest at KIUC at about 42.8 cents per kWh. This was followed by HELCO at 40.0 cents per kWh, MECO at 37.2 cents per kWh and HECO at 33.2 cents per kWh. From 2005 to 2013, the average cost of electricity increased the most at HECO at 8.9 percent per year; followed by MECO at 5.6 percent per year, HELCO at 5.4 percent per year, and KIUC at 4.9 percent per year.

Table 24. Hawaii Average Revenue of Electricity by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013	Avg. ann. Growth
Revenue from electricity sales												
State Total	$M	1,927	2,190	2,253	3,034	2,148	2,516	3,147	3,281	3,153	-3.9%	6.3%
HECO	$M	1,201	1,362	1,381	1,948	1,379	1,645	2,104	2,217	2,116	-4.5%	7.3%
HELCO	$M	294	339	361	445	343	372	443	439	430	-2.0%	4.9%
MECO	$M	302	344	349	451	296	344	417	437	422	-3.3%	4.3%
KIUC	$M	130	146	163	189	130	155	182	188	184	-2.0%	4.4%
Total electricity sold												
State Total	GWh	10,539	10,568	10,585	10,390	10,126	10,013	9,962	9,639	9,501	-1.4%	-1.3%
HECO	GWh	7,721	7,701	7,675	7,556	7,378	7,277	7,242	6,976	6,859	-1.7%	-1.5%
HELCO	GWh	1,116	1,149	1,163	1,141	1,120	1,110	1,104	1,085	1,076	-0.8%	-0.5%
MECO	GWh	1,252	1,266	1,280	1,239	1,192	1,192	1,181	1,145	1,135	-0.9%	-1.2%
KIUC	GWh	449	452	467	454	437	435	435	433	431	-0.4%	-0.5%
Average revenue/kWh sold												
State Total	$/kWh	0.183	0.207	0.213	0.292	0.212	0.251	0.316	0.340	0.332	-2.5%	7.7%
HECO	$/kWh	0.156	0.177	0.180	0.258	0.187	0.226	0.290	0.318	0.309	-2.9%	8.9%
HELCO	$/kWh	0.263	0.295	0.310	0.390	0.306	0.335	0.402	0.405	0.400	-1.2%	5.4%
MECO	$/kWh	0.241	0.272	0.273	0.364	0.249	0.288	0.353	0.382	0.372	-2.5%	5.6%
KIUC	$/kWh	0.291	0.323	0.349	0.417	0.297	0.357	0.420	0.435	0.428	-1.6%	4.9%

Source: Hawaii Electric Utility Monthly Financial Reports.

In 2013, the fuel and purchased power cost accounted for about 63.4 percent of the total electricity costs. The rapid growth of electricity costs in Hawaii was mainly due to increased fuel costs and an increase in the average cost of purchased power. The increase in the average cost of purchased power was heavily affected by petroleum generated electricity being a significant portion of purchased electricity in Hawaii. As shown in Table 25, from 2005 to 2013, the total fuel cost of the utilities and the cost of purchased electricity increased 7.1 percent per year from about $1.2 billion in 2005 to $2.0 billion in 2013. From 2005 to 2013, the utility fuel cost increased from $694 million to $1,277 million and the purchased power cost increased from $463 million to $720 million. The fuel and purchased power cost increased the most at HECO at 7.7 percent per year. HECO was followed by KIUC at 7.0 percent per year, MECO at 5.6 percent per year, and HELCO at 5.3 percent per year.

Table 25. Hawaii Average Cost of Fuel and Purchased Power by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013	Avg. ann. Growth
Fuel and purchased power cost												
State Total	$M	1,157	1,358	1,392	2,024	1,228	1,523	2,053	2,124	1,998	-5.9%	7.1%
HECO	$M	760	874	894	1,342	827	1,044	1,432	1,486	1,379	-7.2%	7.7%
HELCO	$M	168	208	210	286	187	207	259	262	254	-3.2%	5.3%
MECO	$M	170	207	207	291	158	199	264	273	263	-3.7%	5.6%
KIUC	$M	59	69	81	105	56	73	98	102	101	-0.8%	7.0%
Utility fuel cost												
State Total	$M	694	845	850	1,327	724	969	1,356	1,391	1,277	-8.2%	7.9%
HECO	$M	421	516	526	867	460	631	909	945	851	-9.9%	9.2%
HELCO	$M	65	85	75	110	74	93	122	117	126	7.4%	8.5%
MECO	$M	154	180	174	253	137	176	234	235	209	-11.3%	3.9%
KIUC	$M	54	64	76	98	52	69	91	94	92	-2.4%	6.9%
Purchased power cost												
State Total	$M	463	512	542	696	504	553	697	732	720	-1.7%	5.7%
HECO	$M	339	358	369	475	367	412	523	541	528	-2.4%	5.7%
HELCO	$M	103	122	135	176	113	113	137	145	128	-11.7%	2.8%
MECO	$M	16	26	33	38	20	23	30	38	54	43.2%	16.3%
KIUC	$M	5	6	5	7	4	4	8	8	10	17.8%	8.5%
Average fuel and purchased power cost												
State Total	$/kWh	0.110	0.128	0.132	0.195	0.121	0.152	0.206	0.220	0.210	-4.6%	8.5%
HECO	$/kWh	0.098	0.114	0.117	0.178	0.112	0.143	0.198	0.213	0.201	-5.6%	9.3%
HELCO	$/kWh	0.150	0.181	0.181	0.251	0.167	0.186	0.235	0.242	0.236	-2.4%	5.8%
MECO	$/kWh	0.136	0.163	0.162	0.235	0.132	0.167	0.223	0.239	0.232	-2.9%	6.9%
KIUC	$/kWh	0.131	0.153	0.173	0.231	0.128	0.169	0.226	0.236	0.235	-0.4%	7.5%
Share of fuel and purchased power cost												
State Total	%	60.0%	62.0%	61.8%	66.7%	57.1%	60.5%	65.2%	64.7%	63.4%	-2.1%	0.7%
HECO	%	63.2%	64.2%	64.8%	68.9%	60.0%	63.4%	68.0%	67.0%	65.2%	-2.8%	0.4%
HELCO	%	57.2%	61.3%	58.2%	64.2%	54.5%	55.6%	58.5%	59.7%	59.0%	-1.2%	0.4%
MECO	%	56.4%	60.1%	59.3%	64.5%	53.1%	58.0%	63.2%	62.6%	62.3%	-0.4%	1.3%
KIUC	%	45.2%	47.5%	49.7%	55.3%	43.1%	47.3%	53.9%	54.3%	54.9%	1.3%	2.5%

Source: Hawaii Electric Utility Monthly Financial Reports.

From 2005 to 2013, the average fuel and purchased electricity cost per kWh increased from 11.0 cents to 21.0 cents, an average increase of 8.5 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 63.4 percent in 2013. In 2013, the share of fuel and purchased power cost was the highest in HECO at 65.2 percent, followed by MECO at 62.3 percent, HELCO at 59.0 percent, and KIUC at 54.9 percent.

Table 26. Utility Fuel Cost and Purchased Power Cost Comparison by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013	Avg. ann. Growth
Average fuel cost of utility net generation												
State Total	$/kWh	0.100	0.120	0.123	0.198	0.111	0.150	0.211	0.231	0.222	-4.0%	10.4%
HECO	$/kWh	0.089	0.106	0.108	0.185	0.102	0.143	0.206	0.229	0.218	-5.0%	11.8%
HELCO	$/kWh	0.123	0.151	0.153	0.236	0.144	0.169	0.219	0.239	0.232	-2.8%	8.3%
MECO	$/kWh	0.125	0.151	0.153	0.227	0.127	0.164	0.221	0.237	0.231	-2.8%	8.0%
KIUC	$/kWh	0.124	0.144	0.165	0.220	0.122	0.162	0.217	0.227	0.228	0.2%	7.9%
Average cost of purchased electricity												
State Total	$/kWh	0.110	0.124	0.127	0.163	0.121	0.135	0.172	0.177	0.170	-4.3%	5.5%
HECO	$/kWh	0.100	0.110	0.114	0.145	0.112	0.128	0.164	0.170	0.161	-5.1%	6.1%
HELCO	$/kWh	0.149	0.178	0.175	0.226	0.168	0.176	0.218	0.213	0.207	-2.7%	4.2%
MECO	$/kWh	0.167	0.170	0.151	0.191	0.109	0.124	0.157	0.173	0.185	6.8%	1.3%
KIUC	$/kWh	0.144	0.161	0.175	0.226	0.113	0.162	0.209	0.215	0.196	-8.4%	4.0%
Ratio of purchased cost/fuel cost												
State Total	%	110%	104%	104%	82%	109%	90%	82%	77%	76%	-0.2%	-4.4%
HECO	%	113%	104%	105%	79%	110%	90%	79%	74%	74%	-0.1%	-5.1%
HELCO	%	121%	118%	115%	95%	117%	104%	99%	89%	89%	0.1%	-3.8%
MECO	%	134%	112%	99%	84%	86%	76%	71%	73%	80%	9.9%	-6.2%
KIUC	%	116%	111%	106%	103%	92%	100%	96%	94%	86%	-8.7%	-3.6%
Ratio of fuel cost in average revenue												
State Total	%	54.8%	57.8%	57.6%	67.8%	52.4%	59.5%	66.7%	68.0%	66.9%	-1.6%	2.5%
HECO	%	57%	60%	60%	72%	55%	63%	71%	72%	71%	-2.2%	2.7%
HELCO	%	47%	51%	49%	61%	47%	50%	55%	59%	58%	-1.6%	2.7%
MECO	%	52%	56%	56%	62%	51%	57%	62%	62%	62%	-0.3%	2.3%
KIUC	%	43%	45%	47%	53%	41%	45%	52%	52%	53%	1.9%	2.8%
Ratio of purchased power cost in average revenue												
State Total	%	60.3%	59.9%	59.8%	55.8%	57.2%	53.8%	54.6%	52.1%	51.1%	-1.8%	-2.0%
HECO	%	64%	62%	63%	56%	60%	56%	56%	53%	52%	-2.3%	-2.6%
HELCO	%	57%	60%	57%	58%	55%	53%	54%	53%	52%	-1.5%	-1.1%
MECO	%	69%	63%	55%	52%	44%	43%	44%	45%	50%	9.5%	-4.1%
KIUC	%	49%	50%	50%	54%	38%	45%	50%	49%	46%	-6.9%	-0.9%

Source: Hawaii Electric Utility Monthly Financial Reports.

While both the average fuel cost and average purchased power cost increased over time, the average cost of purchased power increased at a slower rate. As shown in Table 26, from 2005 to 2013, the average fuel cost to generate one kWh of net electricity (gross generation minus station usage) by the utilities increased 10.4 percent per year from 10.0 cents to 22.2 cents for the state. During the same period the average cost of purchased electricity increased only 5.5 percent per year from 11.0 cents to 17.0 cents. In 2005, the average cost of purchased electricity was above the average fuel cost of the utilities. In 2013, however, the average cost of purchased electricity was about 23.5 percent below the average fuel cost of the utilities in Hawaii. Since the purchased electricity cost also includes other costs in addition to the fuel cost, the average fuel cost of purchased electricity should even be lower.

Due to the slower growth of purchased electricity costs, the ratio of average purchased power cost to average utility fuel cost decreased from 110 percent in 2005 to 76 percent in 2013. In 2013, purchased electricity was cheapest at HECO (16.1 cents/kWh), followed by MECO (18.5 cents/kWh), KIUC (19.6 cents/kWh), and HELCO (20.7 cents/kWh).

In addition to fuel and purchased power costs, the cost of electricity is also affected by four other factors. As shown in Table 27, the operating income of the utilities accounted for about 6.1 percent, taxes accounted for about 11.5 percent, depreciation and amortization accounted for about 5.3 percent, and other utility operating expenses accounted for about 14.1 percent of the total electricity cost paid by consumers in 2013. Other utility operating expenses include other operation and maintenance expense, transmission and distribution expenses, customer accounts and service expenses, and administration and general expenses. The total of these other costs have increased from $777 million in 2005 to $1,166 million in 2013, an average increase of 5.2 percent per year.

This growth rate was lower than the 7.1 percent growth rate of fuel and purchased power cost, but higher than the 3.2 percent average inflation rate (Honolulu CPI-U) during the same period. Among the four components of other electricity costs, taxes increased the most at 6.4 percent per year (similar to the 6.3 percent growth of total electricity revenue), followed by other utility operating expenses at 5.6 percent per year, operating income at 4.9 percent per year, and depreciation and amortization at 2.4 percent per year.

Table 27. Other Major Costs of Electricity by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	2013	Growth 2013	Avg. ann. Growth
Operating income												
State Total	$M	131	135	121	148	129	135	173	191	192	0.7%	4.9%
HECO	$M	65	75	54	76	71	75	90	117	115	-1.6%	7.4%
HELCO	$M	22	17	25	26	24	27	38	31	31	-0.1%	4.6%
MECO	$M	27	25	21	27	19	18	27	24	30	25.4%	1.5%
KIUC	$M	17	18	21	18	14	15	18	19	16	-14.9%	-0.9%
Taxes												
State Total	$M	220	246	241	333	252	280	355	379	361	-4.7%	6.4%
HECO	$M	137	156	146	212	164	185	232	260	243	-6.3%	7.5%
HELCO	$M	33	35	43	52	42	45	58	53	50	-5.1%	5.4%
MECO	$M	39	43	39	52	35	38	50	51	52	3.0%	3.7%
KIUC	$M	11	12	14	16	11	13	15	16	16	-1.5%	4.6%
Depreciation and amortization												
State Total	$M	137	144	151	156	159	162	154	156	166	6.2%	2.4%
HECO	$M	70	74	78	81	81	85	88	90	99	9.8%	4.5%
HELCO	$M	27	29	30	31	32	36	32	33	34	2.4%	3.0%
MECO	$M	25	25	27	28	29	26	21	20	20	-1.3%	-2.6%
KIUC	$M	16	16	16	16	17	15	13	13	14	3.1%	-2.1%
Other utility operating expenses												
State Total	$M	290	313	356	383	389	423	420	440	446	1.3%	5.6%
HECO	$M	173	186	213	243	241	261	268	269	286	6.3%	6.5%
HELCO	$M	45	51	54	51	59	59	57	61	63	2.3%	4.2%
MECO	$M	43	46	56	54	57	64	58	72	59	-17.1%	4.2%
KIUC	$M	29	30	32	34	32	39	38	38	38	-0.7%	3.5%
All others												
State Total	$M	777	839	868	1,020	929	1,000	1,103	1,167	1,166	-0.1%	5.2%
HECO	$M	445	491	491	613	558	606	679	736	744	1.0%	6.6%
HELCO	$M	126	132	152	160	157	166	185	178	178	-0.3%	4.3%
MECO	$M	133	139	144	161	140	146	155	166	161	-2.9%	2.5%
KIUC	$M	73	77	82	85	74	82	84	86	83	-3.4%	1.6%
% of operating income												
State Total	%	6.8%	6.2%	5.4%	4.9%	6.0%	5.4%	5.5%	5.8%	6.1%		
HECO	%	5.4%	5.5%	3.9%	3.9%	5.2%	4.5%	4.3%	5.3%	5.4%		
HELCO	%	7.3%	5.0%	6.9%	5.9%	6.9%	7.1%	8.6%	7.0%	7.2%		
MECO	%	8.8%	7.3%	6.1%	6.0%	6.5%	5.4%	6.4%	5.5%	7.1%		
KIUC	%	13.2%	12.4%	12.6%	9.7%	10.9%	9.9%	9.8%	10.0%	8.7%		
% of taxes												
State Total	%	11.4%	11.2%	10.7%	11.0%	11.7%	11.1%	11.3%	11.6%	11.5%		
HECO	%	11.4%	11.5%	10.5%	10.9%	11.9%	11.2%	11.0%	11.7%	11.5%		
HELCO	%	11.3%	10.4%	11.8%	11.7%	12.3%	12.1%	13.0%	12.1%	11.7%		
MECO	%	13.0%	12.4%	11.1%	11.6%	11.7%	11.0%	12.0%	11.6%	12.4%		
KIUC	%	8.3%	8.5%	8.5%	8.5%	8.4%	8.4%	8.4%	8.4%	8.4%		
% of depreciation and amortization												
State Total	%	7.1%	6.6%	6.7%	5.1%	7.4%	6.4%	4.9%	4.8%	5.3%		
HECO	%	5.8%	5.4%	5.6%	4.1%	5.8%	5.2%	4.2%	4.1%	4.7%		
HELCO	%	9.1%	8.6%	8.2%	6.9%	9.4%	9.7%	7.3%	7.5%	7.8%		
MECO	%	8.1%	7.3%	7.9%	6.1%	9.8%	7.5%	4.9%	4.6%	4.7%		
KIUC	%	12.6%	10.9%	10.0%	8.7%	12.9%	9.4%	7.3%	7.1%	7.5%		
% of other utility operating expenses												
State Total	%	15.0%	14.3%	15.8%	12.6%	18.1%	16.8%	13.4%	13.4%	14.1%		
HECO	%	14.4%	13.7%	15.5%	12.5%	17.5%	15.9%	12.7%	12.2%	13.5%		
HELCO	%	15.3%	15.0%	15.1%	11.5%	17.1%	15.8%	12.8%	13.9%	14.5%		
MECO	%	14.1%	13.3%	16.1%	12.1%	19.3%	18.6%	13.9%	16.4%	14.0%		
KIUC	%	22.1%	20.9%	19.4%	17.9%	24.7%	25.1%	20.8%	20.3%	20.6%		

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.

Due to the rapid growth in electricity prices and the installation of customer-sited solar systems, total electricity sold by utilities decreased. Since residential customers tend to be more sensitive to price changes, and 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 28, from 2005 to 2013, total electricity sold decreased an average 1.3 percent per year in Hawaii, while electricity sold to the residential sector decreased an average 2.4 percent per year from 3,164 GWH to 2,609 GWH. In comparison, electricity sold to the commercial sector and the industrial sector only decreased an average 0.7 percent and 0.9 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 27.5 percent in 2013. In 2013, the decrease of residential sector electricity sales over the previous year was more significant at 4.8 percent.

At the county level, residential sales in the HECO system decreased the most. From 2005 to 2013, residential electricity sales of HECO decreased 3.1 percent per year; followed by MECO (decreased 1.6 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 27, from 2005 to 2013, total utility customers for the state increased an average 0.7 percent per year. The number of residential customers increased 0.8 percent per year from 398,332 customers to 423,281 customers, the number of commercial customers increased 0.1 percent per year from 64,072 to 64,498, and the number of industrial customers decreased 0.1 percent per year from 684 to 677.

At the county utility level, the number of customers increased slower at HECO compared with the other utilities. From 2005 to 2013, the share of HECO customers as a percentage of total statewide utility customers decreased 1.6 percentage points, from 63.0 percent to 61.4 percent.

During the same period, HECO's share of residential customers decreased slightly more than the overall total, with a 1.9 percentage point decrease from 64.7 percent to 62.8 percent.

Table 28. Electricity Consumption by Sector and by Utility

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2013
Total									
State Total	GWH	10,539	10,585	10,126	9,962	9,639	9,501	-1.4%	-1.3%
HECO	GWH	7,721	7,675	7,378	7,242	6,976	6,859	-1.7%	-1.5%
HELCO	GWH	1,116	1,163	1,120	1,104	1,085	1,076	-0.8%	-0.5%
MECO	GWH	1,252	1,280	1,192	1,181	1,145	1,135	-0.9%	-1.2%
KIUC	GWH	449	467	436	435	433	431	-0.4%	-0.5%
Residential									
State Total	GWH	3,164	3,201	3,055	2,929	2,739	2,609	-4.8%	-2.4%
HECO	GWH	2,143	2,135	2,025	1,925	1,777	1,667	-6.2%	-3.1%
HELCO	GWH	423	451	440	427	410	396	-3.4%	-0.8%
MECO	GWH	442	450	428	418	395	388	-1.9%	-1.6%
KIUC	GWH	156	165	162	159	157	158	0.4%	0.1%
Commercial									
State Total	GWH	3,465	3,521	3,389	3,368	3,238	3,269	1.0%	-0.7%
HECO	GWH	2,480	2,513	2,449	2,429	2,320	2,341	0.9%	-0.7%
HELCO	GWH	453	463	441	446	430	435	1.2%	-0.5%
MECO	GWH	406	417	382	379	374	379	1.4%	-0.8%
KIUC	GWH	125	129	117	114	114	113	-0.6%	-1.2%
Industrial									
State Total	GWH	3,909	3,863	3,681	3,665	3,662	3,623	-1.1%	-0.9%
HECO	GWH	3,098	3,028	2,904	2,888	2,879	2,850	-1.0%	-1.0%
HELCO	GWH	240	248	238	231	245	245	0.0%	0.3%
MECO	GWH	404	414	382	384	375	368	-2.1%	-1.2%
KIUC	GWH	167	173	157	161	162	160	-1.0%	-0.6%
% of Residential									
State Total	%	30.0%	30.2%	30.2%	29.4%	28.4%	27.5%		
HECO	%	27.7%	27.8%	27.5%	26.6%	25.5%	24.3%		
HELCO	%	37.9%	38.8%	39.3%	38.7%	37.8%	36.8%		
MECO	%	35.3%	35.1%	35.9%	35.4%	34.5%	34.2%		
KIUC	%	34.8%	35.4%	37.1%	36.6%	36.3%	36.6%		
% of Commercial									
State Total	%	32.9%	33.3%	33.5%	33.8%	33.6%	34.4%		
HECO	%	32.1%	32.7%	33.2%	33.5%	33.3%	34.1%		
HELCO	%	40.6%	39.8%	39.4%	40.4%	39.6%	40.4%		
MECO	%	32.4%	32.5%	32.0%	32.1%	32.7%	33.4%		
KIUC	%	27.9%	27.6%	26.9%	26.3%	26.4%	26.3%		
County % of Total									
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	73.3%	72.5%	72.9%	72.7%	72.4%	72.2%		
HELCO	%	10.6%	11.0%	11.1%	11.1%	11.3%	11.3%		
MECO	%	11.9%	12.1%	11.8%	11.9%	11.9%	11.9%		
KIUC	%	4.3%	4.4%	4.3%	4.4%	4.5%	4.5%		

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 29. Number of Retail Customers by Sector in Hawaii

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2013
Total									
State Total		463,088	475,104	478,590	482,498	484,716	488,456	0.8%	0.7%
HECO		291,580	294,591	295,282	296,800	297,529	299,528	0.7%	0.3%
HELCO		73,835	78,983	79,813	81,199	81,792	82,637	1.0%	1.4%
MECO		63,901	66,323	67,489	68,230	68,922	69,577	1.0%	1.1%
KIUC		33,772	35,207	36,006	36,269	36,473	36,714	0.7%	1.0%
Residential									
State Total		398,332	408,923	413,643	418,174	420,240	423,281	0.7%	0.8%
HECO		257,804	260,583	261,630	263,384	264,047	265,772	0.7%	0.4%
HELCO		60,699	65,305	66,825	68,423	69,099	69,719	0.9%	1.7%
MECO		54,135	56,076	57,431	58,326	58,879	59,419	0.9%	1.2%
KIUC		25,694	26,959	27,757	28,041	28,215	28,371	0.6%	1.2%
Commercial									
State Total		64,072	65,503	64,255	63,625	63,772	64,498	1.1%	0.1%
HECO		33,416	33,661	33,305	33,058	33,116	33,412	0.9%	0.0%
HELCO		13,071	13,608	12,919	12,702	12,617	12,839	1.8%	-0.2%
MECO		9,632	10,110	9,916	9,769	9,908	10,025	1.2%	0.5%
KIUC		7,953	8,124	8,115	8,096	8,131	8,222	1.1%	0.4%
Industrial									
State Total		684	678	692	699	704	677	-3.8%	-0.1%
HECO		360	347	347	358	366	344	-6.0%	-0.6%
HELCO		65	70	69	74	76	79	3.9%	2.5%
MECO		134	137	142	135	135	133	-1.5%	-0.1%
KIUC		125	124	134	132	127	121	-4.7%	-0.4%
% of Residential									
State Total	%	86.0%	86.1%	86.4%	86.7%	86.7%	86.7%		
HECO	%	88.4%	88.5%	88.6%	88.7%	88.7%	88.7%		
HELCO	%	82.2%	82.7%	83.7%	84.3%	84.5%	84.4%		
MECO	%	84.7%	84.5%	85.1%	85.5%	85.4%	85.4%		
KIUC	%	76.1%	76.6%	77.1%	77.3%	77.4%	77.3%		
% of Commercial									
State Total	%	13.8%	13.8%	13.4%	13.2%	13.2%	13.2%		
HECO	%	11.5%	11.4%	11.3%	11.1%	11.1%	11.2%		
HELCO	%	17.7%	17.2%	16.2%	15.6%	15.4%	15.5%		
MECO	%	15.1%	15.2%	14.7%	14.3%	14.4%	14.4%		
KIUC	%	23.5%	23.1%	22.5%	22.3%	22.3%	22.4%		
County % of Total									
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	63.0%	62.0%	61.7%	61.5%	61.4%	61.3%		
HELCO	%	15.9%	16.6%	16.7%	16.8%	16.9%	16.9%		
MECO	%	13.8%	14.0%	14.1%	14.1%	14.2%	14.2%		
KIUC	%	7.3%	7.4%	7.5%	7.5%	7.5%	7.5%		

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 30 shows that annual electricity consumption per customer for the state decreased an average 1.9 percent per year from 22,757 kWh in 2005 to 19,451 kWh in 2013. In looking at the types of customers, annual electricity consumption per residential customer decreased an average 3.1 percent per year from 7,943 kWh to 6,163 kWh, annual electricity consumption per commercial customer decreased an average 0.8 percent per year from 54,081 kWh to 50,689 kWh, and annual electricity consumption by industrial customers decreased 0.8 percent per year from 5,715,476 kWh to 5,351,326 kWh.

At the county level, MECO had the highest annual electricity consumption per residential customer in 2013 at 6,528 kWh. This was followed by HECO at 6,273 kWh, HELCO at 5,676 kWh, and KIUC at 5,564 kWh. However, the difference between 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 2013, residential consumption per customer decreased an average 3.5 percent per year at HECO, decreased 2.8 percent per year at MECO, decreased 2.5 percent per year at HELCO, and decreased 1.1 percent per year at KIUC.

Table 30. Annual Electricity Consumption per Customer by Sector

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2013
Total									
State Total	kWh/C	22,757	22,279	21,158	20,646	19,886	19,451	-2.2%	-1.9%
HECO	kWh/C	26,481	26,054	24,985	24,401	23,446	22,898	-2.3%	-1.8%
HELCO	kWh/C	15,121	14,721	14,031	13,591	13,267	13,022	-1.8%	-1.9%
MECO	kWh/C	19,595	19,301	17,666	17,309	16,611	16,311	-1.8%	-2.3%
KIUC	kWh/C	13,284	13,261	12,117	11,987	11,876	11,752	-1.0%	-1.5%
Residential									
State Total	kWh/C	7,943	7,827	7,386	7,004	6,518	6,163	-5.4%	-3.1%
HECO	kWh/C	8,311	8,191	7,741	7,309	6,729	6,273	-6.8%	-3.5%
HELCO	kWh/C	6,977	6,912	6,585	6,238	5,931	5,676	-4.3%	-2.5%
MECO	kWh/C	8,165	8,017	7,451	7,165	6,715	6,528	-2.8%	-2.8%
KIUC	kWh/C	6,072	6,127	5,834	5,673	5,574	5,564	-0.2%	-1.1%
Commercial									
State Total	kWh/C	54,081	53,761	52,746	52,939	50,780	50,689	-0.2%	-0.8%
HECO	kWh/C	74,227	74,652	73,519	73,475	70,053	70,072	0.0%	-0.7%
HELCO	kWh/C	34,685	34,027	34,165	35,089	34,095	33,892	-0.6%	-0.3%
MECO	kWh/C	42,163	41,202	38,525	38,811	37,758	37,851	0.2%	-1.3%
KIUC	kWh/C	15,749	15,881	14,452	14,139	14,046	13,804	-1.7%	-1.6%
Industrial									
State Total	kWh/C	5,715,476	5,697,455	5,320,073	5,242,739	5,201,000	5,351,326	2.9%	-0.8%
HECO	kWh/C	8,606,672	8,726,082	8,368,077	8,068,244	7,866,900	8,284,797	5.3%	-0.5%
HELCO	kWh/C	3,686,703	3,546,493	3,455,506	3,122,719	3,225,790	3,104,552	-3.8%	-2.1%
MECO	kWh/C	3,014,884	3,021,683	2,692,158	2,844,143	2,780,620	2,763,182	-0.6%	-1.1%
KIUC	kWh/C	1,338,824	1,392,734	1,172,027	1,221,235	1,273,029	1,323,260	3.9%	-0.1%

Source: Hawaii Electric Utility Monthly Financial Reports.

Due to the rapid growth of electricity prices, total revenue from retail electricity sales increased substantially from 2005 to 2012. This occurred in spite of a decrease in the kWh quantity of electricity in sold over the same period. As shown in Table 31, 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.

In 2013, however, total revenue from electricity sales decreased 3.9 percent from the previous year, revenue from residential sales decreased 5.9 percent, and revenue from commercial and industrial sales decreased 3.0 percent. Honolulu decreased the most in 2013.

Table 31. Revenue from Retail Electricity Sales by Sector in Hawaii

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2012
Total									
State Total	$M	1,927	2,253	2,148	3,147	3,281	3,153	-3.9%	7.9%
HECO	$M	1,201	1,381	1,379	2,104	2,217	2,116	-4.5%	9.1%
HELCO	$M	294	361	343	443	439	430	-2.0%	5.9%
MECO	$M	302	349	296	417	437	422	-3.3%	5.4%
KIUC	$M	130	163	130	182	188	184	-2.0%	5.4%
Residential									
State Total	$M	653	772	739	1,016	1,023	962	-5.9%	6.6%
HECO	$M	379	438	436	617	624	577	-7.4%	7.4%
HELCO	$M	118	148	144	179	174	167	-4.1%	5.7%
MECO	$M	110	127	111	151	154	148	-4.0%	4.9%
KIUC	$M	46	59	49	69	71	70	-1.3%	
Others									
State Total	$M	1,274	1,481	1,409	2,131	2,258	2,191	-3.0%	8.5%
HECO	$M	823	943	943	1,487	1,593	1,539	-3.4%	9.9%
HELCO	$M	176	213	199	264	265	263	-0.7%	6.1%
MECO	$M	192	222	186	266	282	274	-3.0%	5.7%
KIUC	$M	84	104	81	113	118	115	-2.5%	4.9%
% of Residential									
State Total	%	33.9%	34.3%	34.4%	32.3%	31.2%	30.5%		
HECO	%	31.5%	31.7%	31.6%	29.3%	28.1%	27.3%		
HELCO	%	40.2%	41.0%	41.9%	40.4%	39.6%	38.8%		
MECO	%	36.5%	36.5%	37.3%	36.2%	35.3%	35.1%		
KIUC	%	35.5%	36.1%	37.7%	37.8%	37.6%	37.9%		
County % of Total									
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%		
HECO	%	62.3%	61.3%	64.2%	66.9%	67.6%	67.1%		
HELCO	%	15.2%	16.0%	16.0%	14.1%	13.4%	13.6%		
MECO	%	15.7%	15.5%	13.8%	13.3%	13.3%	13.4%		
KIUC	%	6.8%	7.2%	6.0%	5.8%	5.7%	5.9%		

Source: Hawaii Electric Utility Monthly Financial Reports.

The higher growth in commercial and industrial electricity revenue over residential revenue is due to the higher growth in commercial and industrial electricity prices. Table 32 shows that from 2005 to 2012, the average electricity price increased an average 9.3 percent per year from 18.3 cents per kWh to 34.0 cents per kWh. 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.

In 2013, however, the average electricity price decreased over the previous year by 2.5 percent. The average residential electricity price decreased 1.2 percent and the average commercial and industrial electricity price decreased 2.9 percent.

Based on the percentage change in electricity consumption per customer and the percentage change in the average electricity price from 2005 to 2013, the price elasticity for the total customers in the state is negative 0.18, and the price elasticity for the state residential customers is negative 0.28. In other words, residential customers are more sensitive to increases or decreases in electricity prices. If electricity prices increase, residential customers will decrease their electricity consumption more than the overall total.

Table 32. Average Electricity Price by County in Hawaii

		2005	2007	2009	2011	2012	2013	Growth in 2013	Avg. ann. Growth 2005 - 2012
Total									
State Total	$/kWh	0.183	0.213	0.212	0.316	0.340	0.332	-2.5%	9.3%
HECO	$/kWh	0.156	0.180	0.187	0.290	0.318	0.309	-2.9%	10.7%
HELCO	$/kWh	0.263	0.310	0.306	0.402	0.405	0.400	-1.2%	6.3%
MECO	$/kWh	0.241	0.273	0.249	0.353	0.382	0.372	-2.5%	6.8%
KIUC	$/kWh	0.291	0.349	0.297	0.420	0.435	0.428	-1.6%	5.9%
Residential									
State Total	$/kWh	0.206	0.241	0.242	0.347	0.373	0.369	-1.2%	8.8%
HECO	$/kWh	0.177	0.205	0.215	0.320	0.351	0.346	-1.4%	10.3%
HELCO	$/kWh	0.279	0.328	0.327	0.419	0.425	0.422	-0.7%	6.2%
MECO	$/kWh	0.249	0.283	0.259	0.361	0.391	0.382	-2.1%	6.6%
KIUC	$/kWh	0.297	0.356	0.301	0.434	0.450	0.443	-1.7%	
Others									
State Total	$/kWh	0.173	0.201	0.199	0.303	0.327	0.318	-2.9%	9.6%
HECO	$/kWh	0.147	0.170	0.176	0.280	0.306	0.296	-3.2%	11.0%
HELCO	$/kWh	0.253	0.299	0.293	0.391	0.393	0.387	-1.4%	6.5%
MECO	$/kWh	0.236	0.267	0.243	0.349	0.377	0.367	-2.7%	6.9%
KIUC	$/kWh	0.287	0.345	0.294	0.411	0.426	0.419	-1.7%	5.8%

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 33 shows the statewide average electricity price by sector in Hawaii from EIA data. Separate prices for the commercial and industrial sector from 1990 to 2012 are provided.

Table 33. 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	-	14.47
2004	18.06	16.19	13.35	-	15.70
2005	20.70	19.04	15.79	-	18.33
2006	23.35	21.42	17.96	-	20.72
2007	24.12	21.91	18.38	-	21.29
2008	32.50	29.72	26.05	-	29.20
2009	24.20	21.86	18.14	-	21.21
2010	28.10	25.93	21.94	-	25.12
2011	34.68	32.37	28.40	-	31.59
2012	37.34	34.88	30.82	-	34.04

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 such as 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 are available. However, the station use of purchased electricity from non-utility producers is 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 up to 2013. In addition, the electricity saved from the SWH and DSM programs were also available up to 2013. 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.

As shown in Table 34, from 2005 to 2013, total electricity demand in Hawaii increased only an average 0.2 percent per year, from about 12,280 GWH to 12,447 GWH. 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 1.3 percent per year from 11,755 GWH to 10,598 GWH, electricity generated by user owned PV systems increased 86.6 percent per year from 2 GWH to 356 GWH; electricity replaced by SWH increased 9.5 percent per year from 84 GWH to 174 GWH; and electricity replaced by DSM programs increased 14.8 percent per year from 439 GWH to 1,320 GWH. The analysis estimates that the share of gross electricity generation produced by the electric power industry decreased from 95.7 percent in 2005 to 85.1 percent in 2013, a decrease of 10.6 percentage points.

Table 34. Total Electricity Demand in Hawaii

Electricity Generation and Conservation (Demand-Side-Management)

Units: GWH

Year	Gross 1/ Generation	By Users PV	SWH	DSM	Sub-Total	Gross 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
Growth 05-13	-1.3%	86.6%	9.5%	14.8%	17.0%	0.2%

Electricity Generation and Conservation (Demand-Side-Management)

Units: % in Gross Total

Year	Gross 1/ Generation	By Users PV	SWH	DSM	Sub-Total	Gross 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

1/ Including station use of non-utility producers. 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 has decreased significantly. From 1990 to 2012, the share of utility generated electricity decreased 25.0 percentage points, from 82.4 percent to 57.4 percent. A large part of this decrease can be attributed to an increase in electricity purchased by the utility, which has replaced electricity generated by the utility. Since the average cost of electricity purchased by the utility is below the average fuel cost of utility generated electricity, the increased share of purchased electricity has helped reduce the cost of electricity sold by the utility.

Not all the electricity generated by the electric power industry is sold to the utility customers. In 2013, about 5.7 percent of the gross electricity generated by the utilities in Hawaii was consumed by the utility owned power stations. In addition, about 5.0 percent of utility net generation (gross generation minus station use) and purchased power was lost during electricity transmission and distribution. Therefore, less than 90 percent of the electricity generated was sold to utility customers.

From 2005 to 2013, the average fuel cost per kWh of electricity generated by the utilities in Hawaii increased an average of 10.4 percent per year from 10.0 cents/kWh to 22.2 cents/kWh. The fuel cost increase was significantly higher than the 5.5 percent average cost increase for purchased electricity, which increased from 11.0 cents/kWh to 17.0 cents/kWh during the same period. In 2013, the average cost of purchased electricity was 23.5 percent below the average fuel cost of utility generated electricity.

The average cost of purchased electricity in 2013 was the lowest at HECO at about 16.1 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 in 2013, significantly lower than the average cost of purchased power by HECO.

The relatively slower growth in purchased power prices in recent years was due to a high and increasing share of electricity being generated from non-petroleum sources including coal and renewable energy by non-utility producers. According to the most recent data available, in 2012 about 95.6 percent of utility generated electricity was from petroleum, while only 39.0 percent of non-utility generated electricity was from petroleum.

From 2005 to 2012, the average unit petroleum cost for the four electric utilities in Hawaii increased an average of 13.2 percent per year from $57.57 per BBL to $136.88 per BBL. Fuel oil costs increased the most at an average 14.9 percent per year from $51.22 per BBL to $135.72 per BBL. This was followed by diesel oil (excluding biodiesel) costs increasing an average 8.9 percent per year from $77.36 per BBL to $140.52 per BBL. It is important to note that the average crude oil price only increased an average 7.6 percent per year over the same period. While outside the scope of this paper, future research should explore why the average petroleum cost for the utilities increased much faster than the crude oil price, especially the average fuel oil cost.

From 2005 to 2013, the average revenue from electricity sold in Hawaii increased 7.7 percent per year from 18.3 cents/kWh to 33.2 cents/kWh. Due to the rapid growth in the average petroleum cost, the share of utility fuel cost as a percentage of the average revenue of electricity sold increased 12.1 percentage points, from 54.8 percent to 66.9 percent. On the other hand, the average purchased power cost as a percentage of the average revenue of electricity sold decreased 9.1 percentage points, from 60.3 percent to 51.1 percent.

In addition to the fuel and purchased power cost, the cost of electricity is also affected by four other factors. The operating income of the utilities accounted for about 6.1 percent, taxes accounted for about 11.5 percent, depreciation and amortization accounted for about 5.3 percent, and other utility operating expenses accounted for about 14.1 percent of total electricity prices paid by consumers in 2013. Other utility operating expenses include other operation and maintenance expenses, transmission and distribution expenses, customer accounts and service expenses, and administration and general expenses.

From 2005 to 2013, the four components of electricity cost increased 5.2 percent per year on average. This growth rate was lower than the 7.1 percent growth rate of fuel and purchased power costs, but higher than the 3.2 percent average inflation rate during the same period. Among the four components of other electricity costs, taxes increased the most at 6.4 percent per year, followed by other utility operating expenses at 5.6 percent per year, operating income at 4.9 percent per year, and depreciation and amortization at 2.4 percent per year.

Total electricity sold by utilities decreased over the period analyzed. A large part of this decrease was due to reduced consumption caused by electricity price increases and the installation of customer-sited solar systems. From 2005 to 2013, total electricity sold decreased an average 1.3 percent per year in Hawaii. The largest decrease during this period was for residential

customers, which decreased an average 2.4 percent per year from 3,164 GWH to 2,609 GWH. In contrast, electricity sold to the commercial sector and the industrial sector only decreased an average 0.7 percent and 0.9 percent per year, respectively. As a result, the residential sector share of total electricity sold decreased from 30.0 percent in 2005 to 27.5 percent in 2012. In 2013, the decrease in residential sector electricity sales over the previous year was more significant at 4.8 percent.

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 2013, total utility customers for the state increased 0.7 percent per year. Residential customers increased the most at 0.8 percent per year. This was followed by commercial customers with an increase of 0.1 percent per year and industrial customers which increased 0.1 percent per year.

This analysis also looked at the price elasticity for electricity prices and found that residential customers are more price sensitive than customers overall. The price elasticity for total customers was a negative 0.18 and the price elasticity for residential customers was a negative 0.28. In other words, if electricity prices increase, residential customers will reduce their consumption more than the total of all customers.

Electricity demand can be met by both electricity generated by 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 user generated electricity (such as user installed PV systems). From 2005 to 2013, the total share of electricity generated by the electric power industry as a percentage of total electricity demand in Hawaii decreased 10.6 percentage points, from 95.7 percent to 85.1 percent. Without the electricity generated and conserved by users, total electricity expenditure in Hawaii would be even higher.