State of Hawaii
Electric Power Industry
Current Status and Trends

November 2013

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State of Hawaii Electric Power Industry Current Status and Trends

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 increase of 7.9 percent per year on average, an amount much higher than the 3.4% CPI growth during the same period. Total electricity expenditures in Hawaii accounted for about 4.5 percent of Hawaii's total Gross Domestic Product (GDP) in 2012.

This report provides basic information to help readers understand the current status and recent changes in Hawaii's electric power industry. Based on the most recent data available this report answers questions such as:

- 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). The EIA provides annual electricity related data from 1990 to 2011 at the state level. Detailed annual data by type of producers and by type of fuels are available from 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. In addition to these sources, the report also uses data from the U.S. Bureau of Economic Analysis (BEA), the U.S. Census Bureau, and the State of Hawaii Data Book.

2. Electricity Generation in Hawaii

Electricity consumed in Hawaii is mainly sold by the four electric utility companies engaged in the production, purchase, transmission, distribution, and sale of electric energy in Hawaii: 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	% 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

Source: Energy Information Administration, State Energy Data System

Electricity consumed in Hawaii is generated mainly by the four electric utilities and non-utility electricity produces. 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 59.5 percent of the 10,723 GWH of electricity generation by the electric power industry in 2011, the four types of non-utility producers accounted for about 40.5 percent of total generation. From 1990 to 2011, the share of the electric utilities in total generation decreased from 82.4 percent to 59.5 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. (It is, however, a relatively small amount by comparison).

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 (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 usage. Since the usage data of non-utility producers is not available, total generation by the non-utility producers is also not available. In 2011, total utility generation (including station usage) and purchased electricity in Hawaii was 10,864 GWH based on the utility MFR, slightly higher than the total electricity generation from the EIA data. It appears that the station usage of non-utility producers is not included in the total electricity generation data provided by EIA.

As shown in Table 2, the four electric utilities in Hawaii generated (including station usage) 6,377 GWH of electricity in 2012. Station usage accounted for about 6.0 percent of utility net generation for the state. Total utility net generation was 6,016 GWH in 2012. From 2005 to 2012, utility net generation decreased about 2.0 percent per year on average. The share of station usage was highest at HECO, followed by HELCO, MECO, and KIUC. From 2005 to 2012, the share of station usage increased from 5.6 percent to 6.0 percent for the state.

Table 2. Hawaii Net Electricity Generation by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	Avg. ann. Growth
Total utility generation										
State Total	GWh	7,309	7,441	7,328	7,083	6,889	6,861	6,818	6,377	-1.9%
HECO	GWh	5,021	5,159	5,153	4,975	4,779	4,720	4,699	4,399	-1.9%
HELCO	GWh	561	596	516	490	546	584	586	518	-1.1%
MECO	GWh	1,279	1,233	1,184	1,159	1,126	1,119	1,104	1,034	-3.0%
KIUC	GWh	448	453	475	459	438	438	429	426	-0.7%
Utility station use										
State Total	GWh	389	389	388	375	371	382	379	362	-1.0%
HECO	GWh	300	304	302	291	284	293	293	278	-1.1%
HELCO	GWh	31	30	27	26	30	31	31	29	-0.9%
MECO	GWh	45	43	45	45	45	45	43	43	-0.8%
KIUC	GWh	13	12	13	13	12	13	13	12	-1.3%
Utility net generation										
State Total	GWh	6,920	7,052	6,941	6,708	6,518	6,479	6,439	6,016	-2.0%
HECO	GWh	4,721	4,855	4,851	4,684	4,495	4,426	4,406	4,121	-1.9%
HELCO	GWh	530	566	490	464	516	553	555	489	-1.1%
MECO	GWh	1,234	1,190	1,138	1,114	1,081	1,074	1,060	992	-3.1%
KIUC	GWh	435	441	462	446	426	425	417	414	-0.7%
Utility share in net generation										
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	0.0%
HECO	%	68.2%	68.8%	69.9%	69.8%	69.0%	68.3%	68.4%	68.5%	0.1%
HELCO	%	7.7%	8.0%	7.1%	6.9%	7.9%	8.5%	8.6%	8.1%	0.9%
MECO	%	17.8%	16.9%	16.4%	16.6%	16.6%	16.6%	16.5%	16.5%	-1.1%
KIUC	%	6.3%	6.3%	6.7%	6.7%	6.5%	6.6%	6.5%	6.9%	1.3%
% of station use in net generation										
State Total	%	5.6%	5.5%	5.6%	5.6%	5.7%	5.9%	5.9%	6.0%	1.0%
HECO	%	6.4%	6.3%	6.2%	6.2%	6.3%	6.6%	6.6%	6.8%	0.9%
HELCO	%	5.8%	5.4%	5.4%	5.6%	5.8%	5.6%	5.5%	5.9%	0.2%
MECO	%	3.6%	3.6%	4.0%	4.0%	4.1%	4.2%	4.1%	4.3%	2.3%
KIUC	%	3.0%	2.6%	2.8%	2.8%	2.7%	3.0%	3.0%	2.9%	-0.6%

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 3 shows that electricity purchased by the utilities (net non-utility generation) decreased from 4,202 GWH in 2005 to 4,131 GWH in 2012, a 0.2 percent decrease per year, much lower than the decrease in net utility generation over the same period. As a result, the share of purchased electricity in total net generation increased from 37.8 percent in 2005 to 40.7 percent in 2012. Total net generation decreased about 1.3 percent per year on average from 11,122 GWH in 2005 to 10,147 GWH in 2012.

Table 3. Hawaii Electricity Sales by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	Avg. ann. Growth
Electricity purchased										
State Total	GWh	4,202	4,129	4,255	4,277	4,154	4,090	4,046	4,131	-0.2%
HECO	GWh	3,383	3,250	3,238	3,266	3,267	3,231	3,187	3,190	-0.8%
HELCO	GWh	688	689	769	781	669	641	631	681	-0.1%
MECO	GWh	97	156	221	201	185	191	191	222	12.5%
KIUC	GWh	35	34	27	29	34	27	37	38	1.2%
Electricity net to system										
State Total	GWh	11,122	11,181	11,195	10,985	10,672	10,569	10,485	10,147	-1.3%
HECO	GWh	8,104	8,105	8,089	7,951	7,762	7,657	7,594	7,311	-1.5%
HELCO	GWh	1,217	1,255	1,259	1,245	1,184	1,194	1,187	1,170	-0.6%
MECO	GWh	1,331	1,346	1,359	1,315	1,266	1,265	1,252	1,214	-1.3%
KIUC	GWh	470	476	489	475	460	453	453	452	-0.5%
Total electricity sold										
State Total	GWh	10,539	10,568	10,585	10,390	10,126	10,013	9,962	9,639	-1.3%
HECO	GWh	7,721	7,701	7,675	7,556	7,378	7,277	7,242	6,976	-1.4%
HELCO	GWh	1,116	1,149	1,163	1,141	1,120	1,110	1,104	1,085	-0.4%
MECO	GWh	1,252	1,266	1,280	1,239	1,192	1,192	1,181	1,145	-1.3%
KIUC	GWh	449	452	467	454	437	435	435	433	-0.5%
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%	1.1%
HECO	%	41.7%	40.1%	40.0%	41.1%	42.1%	42.2%	42.0%	43.6%	0.6%
HELCO	%	56.5%	54.9%	61.1%	62.7%	56.5%	53.7%	53.2%	58.2%	0.4%
MECO	%	7.3%	11.6%	16.2%	15.3%	14.6%	15.1%	15.3%	18.3%	14.0%
KIUC	%	7.4%	7.2%	5.5%	6.1%	7.5%	6.1%	8.1%	8.4%	1.8%
Share of lose in net to system										
State Total	%	5.2%	5.5%	5.5%	5.4%	5.1%	5.3%	5.0%	5.0%	-0.7%
HECO	%	4.7%	5.0%	5.1%	5.0%	4.9%	5.0%	4.6%	4.6%	-0.4%
HELCO	%	8.3%	8.4%	7.6%	8.3%	5.4%	7.1%	7.0%	7.3%	-1.8%
MECO	%	5.9%	5.9%	5.8%	5.7%	5.8%	5.8%	5.6%	5.7%	-0.7%
KIUC	%	4.5%	5.0%	4.5%	4.5%	5.2%	4.0%	4.1%	4.1%	-1.1%

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 percent of the electricity sent to the system was lost. The percent of loss is highest in the HELCO system, followed MECO, HECO, and KIUC. Total electricity sold is electricity net to system minus electricity lost. From 2005 to 2012, total electricity sold decreased 1.3 percent per year on average from 10,539 GWH to 9,639 GWH. The shares of system loss in net generation were rather stable at about 5 percent for the state over this period.

Table 4 shows that utility station usage and loss decreased from 972 GWH in 2005 to 869 GWH in 2012, a decrease of 1.6 percent per year on average. The share of utility station usage

and loss in total utility generation and purchased electricity decreased slightly from 8.4 percent in 2005 to 8.3 percent in 2012.

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

		2005	2006	2007	2008	2009	2010	2011	2012	Avg. ann. Growth
Total generation and purchased										
State Total	GWh	11,511	11,570	11,583	11,360	11,043	10,951	10,864	10,508	-1.3%
HECO	GWh	8,404	8,409	8,392	8,242	8,046	7,950	7,886	7,589	-1.4%
HELCO	GWh	1,248	1,285	1,285	1,271	1,214	1,225	1,217	1,199	-0.6%
MECO	GWh	1,376	1,389	1,404	1,360	1,311	1,310	1,295	1,256	-1.3%
KIUC	GWh	482	487	502	488	472	465	466	464	-0.6%
Station use and lose										
State Total	GWh	972	1,002	998	970	916	938	903	869	-1.6%
HECO	GWh	683	708	716	686	668	673	644	613	-1.5%
HELCO	GWh	132	136	123	130	94	115	114	114	-2.0%
MECO	GWh	124	122	124	120	118	119	114	111	-1.5%
KIUC	GWh	34	35	35	34	35	31	31	31	-1.5%
% of station use and lose										
State Total	%	8.4%	8.7%	8.6%	8.5%	8.3%	8.6%	8.3%	8.3%	
HECO	%	8.1%	8.4%	8.5%	8.3%	8.3%	8.5%	8.2%	8.1%	
HELCO	%	10.5%	10.6%	9.5%	10.2%	7.8%	9.4%	9.3%	9.5%	
MECO	%	9.0%	8.8%	8.8%	8.8%	9.0%	9.1%	8.8%	8.9%	
KIUC	%	7.0%	7.2%	7.0%	7.0%	7.5%	6.6%	6.7%	6.6%	

Source: Hawaii Electric Utility Monthly Financial Reports.

Since the station usage of non-utility producers is not available, the percentage of station usage and loss calculated above underestimates the true share of station usage and loss in the whole electric system of Hawaii. If we assume that the share of station usage of the non-utility producers in purchased electricity is similar to that of the share of utility station usage in net generation as shown in Table 5, the share of total station usage and loss in gross generation would be about 10.5 percent.

Hawaii's gross electricity generation in 2012 was estimated to be about 10,774 GWH. In 2012, 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 2012, 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	Avg. ann. Growth
Station use of non-utility										
State Total	GWh	259	247	253	256	254	258	255	266	0.4%
HECO	GWh	215	204	202	203	207	214	212	216	0.0%
HELCO	GWh	40	37	42	44	39	36	35	40	0.1%
MECO	GWh	4	6	9	8	8	8	8	10	15.2%
KIUC	GWh	1	1	1	1	1	1	1	1	0.7%
Total gross generation										
State Total	GWh	11,770	11,817	11,836	11,616	11,297	11,209	11,120	10,774	-1.3%
HECO	GWh	8,619	8,613	8,594	8,444	8,253	8,164	8,098	7,805	-1.4%
HELCO	GWh	1,288	1,322	1,327	1,315	1,253	1,260	1,252	1,239	-0.5%
MECO	GWh	1,380	1,394	1,413	1,368	1,318	1,318	1,303	1,266	-1.2%
KIUC	GWh	484	488	503	489	473	466	467	465	-0.6%
Share in gross generation										
State Total	%	100%	100%	100%	100%	100%	100%	100%	100%	
HECO	%	73%	73%	73%	73%	73%	73%	73%	72%	
HELCO	%	11%	11%	11%	11%	11%	11%	11%	12%	
MECO	%	12%	12%	12%	12%	12%	12%	12%	12%	
KIUC	%	4%	4%	4%	4%	4%	4%	4%	4%	
Total station use and lose										
State Total	GWh	1,232	1,249	1,251	1,226	1,171	1,196	1,158	1,135	-1.2%
HECO	GWh	898	912	918	889	875	887	856	829	-1.1%
HELCO	GWh	171	173	164	174	133	151	149	154	-1.5%
MECO	GWh	127	128	133	128	126	127	122	121	-0.8%
KIUC	GWh	35	36	36	35	36	32	32	32	-1.4%
% of station use and lose										
State Total	%	10.5%	10.6%	10.6%	10.6%	10.4%	10.7%	10.4%	10.5%	
HECO	%	10.4%	10.6%	10.7%	10.5%	10.6%	10.9%	10.6%	10.6%	
HELCO	%	13.3%	13.1%	12.4%	13.2%	10.6%	12.0%	11.9%	12.4%	
MECO	%	9.2%	9.2%	9.4%	9.4%	9.6%	9.6%	9.3%	9.5%	
KIUC	%	7.2%	7.4%	7.1%	7.2%	7.7%	6.8%	6.9%	6.8%	

Source: Hawaii Electric Utility Monthly Financial Reports.

3. The Cost of Electricity in Hawaii

In 2012, the 9,639 GWH of electricity sold in Hawaii generated a total revenue of about $3.3 billion. Total revenue or total cost to customers of electricity sold in Hawaii increased 7.9 percent per year on average from $1.9 billion in 2005 to $3.3 billion in 2012. As shown in Table 6, the average revenue per kWh sold in Hawaii went from 18.3 cents in 2005 to 34.0 cents in 2012. Average electricity revenue in 2012 was the highest at KIUC at about 43.5 cents per kWh; followed by HELCO at 40.5 cents per kWh, MECO at 38.2 cents per kWh, and HECO at 31.8 cents per kWh. From 2005 to 2012, the average electricity cost increased 9.3 percent per year for the state as a whole. The average cost of electricity increased the most at HECO at 10.7 percent per year; followed by MECO at 6.8 percent per year, HELCO at 6.3 percent per year, and KIUC at 5.9 percent per year.

Table 6. Hawaii Average Revenue of Electricity by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	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	7.9%
HECO	$M	1,201	1,362	1,381	1,948	1,379	1,645	2,104	2,217	9.1%
HELCO	$M	294	339	361	445	343	372	443	439	5.9%
MECO	$M	302	344	349	451	296	344	417	437	5.4%
KIUC	$M	130	146	163	189	130	155	182	188	5.4%
Total electricity sold										
State Total	GWh	10,539	10,568	10,585	10,390	10,126	10,013	9,962	9,639	-1.3%
HECO	GWh	7,721	7,701	7,675	7,556	7,378	7,277	7,242	6,976	-1.4%
HELCO	GWh	1,116	1,149	1,163	1,141	1,120	1,110	1,104	1,085	-0.4%
MECO	GWh	1,252	1,266	1,280	1,239	1,192	1,192	1,181	1,145	-1.3%
KIUC	GWh	449	452	467	454	437	435	435	433	-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	9.3%
HECO	$/kWh	0.156	0.177	0.180	0.258	0.187	0.226	0.290	0.318	10.7%
HELCO	$/kWh	0.263	0.295	0.310	0.390	0.306	0.335	0.402	0.405	6.3%
MECO	$/kWh	0.241	0.272	0.273	0.364	0.249	0.288	0.353	0.382	6.8%
KIUC	$/kWh	0.291	0.323	0.349	0.417	0.297	0.357	0.420	0.435	5.9%

Source: Hawaii Electric Utility Monthly Financial Reports.

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, which was also heavily affected by fuel costs as a significant portion of purchased electricity in Hawaii is generated using petroleum. As shown in Table 7, from 2005 to 2012, the total fuel cost of the utilities and the cost of purchased electricity increased 9.1 percent per year from $1.2 billion in 2005 to $2.1 billion in 2012. The fuel and

purchased power cost increased the most at HECO at 10.1 percent per year; followed by KIUC at 8.2 percent per year, MECO at 7.0 percent per year, and HELCO at 6.6 percent per year. From 2005 to 2012, the average fuel and purchased electricity cost per kWh increased from 11.0 cents to 22.0 cents; and the share of fuel and purchased power cost in the total cost of electricity sold increased from 60.0 percent in 2005 to 64.7 percent in 2012. In 2012, the share of fuel and purchased power cost was the highest in HECO, followed by MECO, HELCO, and KIUC.

Table 7. Hawaii Average Cost of Fuel and Purchased Power by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	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	9.1%
HECO	$M	760	874	894	1,342	827	1,044	1,432	1,486	10.1%
HELCO	$M	168	208	210	286	187	207	259	262	6.6%
MECO	$M	170	207	207	291	158	199	264	273	7.0%
KIUC	$M	59	69	81	105	56	73	98	102	8.2%
Utility fuel cost										
State Total	$M	694	845	850	1,327	724	969	1,356	1,391	10.5%
HECO	$M	421	516	526	867	460	631	909	945	12.3%
HELCO	$M	65	85	75	110	74	93	122	117	8.7%
MECO	$M	154	180	174	253	137	176	234	235	6.3%
KIUC	$M	54	64	76	98	52	69	91	94	8.3%
Purchased power cost										
State Total	$M	463	512	542	696	504	553	697	732	6.8%
HECO	$M	339	358	369	475	367	412	523	541	6.9%
HELCO	$M	103	122	135	176	113	113	137	145	5.1%
MECO	$M	16	26	33	38	20	23	30	38	12.9%
KIUC	$M	5	6	5	7	4	4	8	8	7.2%
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	10.5%
HECO	$/kWh	0.098	0.114	0.117	0.178	0.112	0.143	0.198	0.213	11.7%
HELCO	$/kWh	0.150	0.181	0.181	0.251	0.167	0.186	0.235	0.242	7.0%
MECO	$/kWh	0.136	0.163	0.162	0.235	0.132	0.167	0.223	0.239	8.4%
KIUC	$/kWh	0.131	0.153	0.173	0.231	0.128	0.169	0.226	0.236	8.7%
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%	1.1%
HECO	%	63.2%	64.2%	64.8%	68.9%	60.0%	63.4%	68.0%	67.0%	0.8%
HELCO	%	57.2%	61.3%	58.2%	64.2%	54.5%	55.6%	58.5%	59.7%	0.6%
MECO	%	56.4%	60.1%	59.3%	64.5%	53.1%	58.0%	63.2%	62.6%	1.5%
KIUC	%	45.2%	47.5%	49.7%	55.3%	43.1%	47.3%	53.9%	54.3%	2.6%

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 in Hawaii. As shown in Table 8,

from 2005 to 2012, the average fuel cost to generate one kWh net electricity (gross generation minus station usage) by the utilities increased 12.7 percent per year from 10.0 cents to 23.1 cents for the state. During the same period the average cost of purchased electricity increased only 7.0 percent per year from 11.0 cents to 17.7 cents. 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 77 percent in 2012. In 2012, one kWh of electricity purchased cost 23 percent less than the fuel cost of one kWh generated by the utilities on average. Purchased electricity was cheapest at HECO, followed by MECO, HELCO, and KIUC.

Table 8. Utility Fuel Cost and Purchased Power Cost Comparison by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	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	12.7%
HECO	$/kWh	0.089	0.106	0.108	0.185	0.102	0.143	0.206	0.229	14.5%
HELCO	$/kWh	0.123	0.151	0.153	0.236	0.144	0.169	0.219	0.239	9.9%
MECO	$/kWh	0.125	0.151	0.153	0.227	0.127	0.164	0.221	0.237	9.6%
KIUC	$/kWh	0.124	0.144	0.165	0.220	0.122	0.162	0.217	0.227	9.0%
Average cost of purchased electricity										
State Total	$/kWh	0.110	0.124	0.127	0.163	0.121	0.135	0.172	0.177	7.0%
HECO	$/kWh	0.100	0.110	0.114	0.145	0.112	0.128	0.164	0.170	7.8%
HELCO	$/kWh	0.149	0.178	0.175	0.226	0.168	0.176	0.218	0.213	5.2%
MECO	$/kWh	0.167	0.170	0.151	0.191	0.109	0.124	0.157	0.173	0.5%
KIUC	$/kWh	0.144	0.161	0.175	0.226	0.113	0.162	0.209	0.215	5.9%
Ratio of purchased cost/fuel cost										
State Total	%	110%	104%	104%	82%	109%	90%	82%	77%	-5.0%
HECO	%	113%	104%	105%	79%	110%	90%	79%	74%	-5.8%
HELCO	%	121%	118%	115%	95%	117%	104%	99%	89%	-4.3%
MECO	%	134%	112%	99%	84%	86%	76%	71%	73%	-8.3%
KIUC	%	116%	111%	106%	103%	92%	100%	96%	94%	-2.9%
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%	3.1%
HECO	%	57%	60%	60%	72%	55%	63%	71%	72%	3.4%
HELCO	%	47%	51%	49%	61%	47%	50%	55%	59%	3.4%
MECO	%	52%	56%	56%	62%	51%	57%	62%	62%	2.7%
KIUC	%	43%	45%	47%	53%	41%	45%	52%	52%	2.9%
Ratio of perchased power cost in average revenue										
State Total	%	60.3%	59.9%	59.8%	55.8%	57.2%	53.8%	54.6%	52.1%	-2.1%
HECO	%	64%	62%	63%	56%	60%	56%	56%	53%	-2.7%
HELCO	%	57%	60%	57%	58%	55%	53%	54%	53%	-1.1%
MECO	%	69%	63%	55%	52%	44%	43%	44%	45%	-5.9%
KIUC	%	49%	50%	50%	54%	38%	45%	50%	49%	0.0%

Source: Hawaii Electric Utility Monthly Financial Reports.

In addition to fuel and purchased power costs, the cost of electricity is also affected by four other factors. As shown in Table 9, the operating income of the utilities accounted for about 5.8 percent, taxes accounted for about 11.6 percent, depreciation and amortization accounted for about 4.8 percent, and other utility operating expenses accounted for about 13.4 percent of total electricity cost paid by consumers in 2012. 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 $1,167 million in 2012, an average increase of 6 percent per year.

Table 9. Other Major Cost of Electricity by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	Avg. ann. Growth
Operating income										
State Total	$M	131	135	121	148	129	135	173	191	5.5%
HECO	$M	65	75	54	76	71	75	90	117	8.7%
HELCO	$M	22	17	25	26	24	27	38	31	5.3%
MECO	$M	27	25	21	27	19	18	27	24	-1.5%
KIUC	$M	17	18	21	18	14	15	18	19	1.3%
Taxes										
State Total	$M	220	246	241	333	252	280	355	379	8.1%
HECO	$M	137	156	146	212	164	185	232	260	9.6%
HELCO	$M	33	35	43	52	42	45	58	53	6.9%
MECO	$M	39	43	39	52	35	38	50	51	3.8%
KIUC	$M	11	12	14	16	11	13	15	16	5.5%
Depreciation and amortization										
State Total	$M	137	144	151	156	159	162	154	156	1.9%
HECO	$M	70	74	78	81	81	85	88	90	3.7%
HELCO	$M	27	29	30	31	32	36	32	33	3.0%
MECO	$M	25	25	27	28	29	26	21	20	-2.8%
KIUC	$M	16	16	16	16	17	15	13	13	-2.8%
Other utility operating expenses										
State Total	$M	290	313	356	383	389	423	420	440	6.2%
HECO	$M	173	186	213	243	241	261	268	269	6.5%
HELCO	$M	45	51	54	51	59	59	57	61	4.5%
MECO	$M	43	46	56	54	57	64	58	72	7.7%
KIUC	$M	29	30	32	34	32	39	38	38	4.1%
All others										
State Total	$M	777	839	868	1,020	929	1,000	1,103	1,167	6.0%
HECO	$M	445	491	491	613	558	606	679	736	7.5%
HELCO	$M	126	132	152	160	157	166	185	178	5.0%
MECO	$M	133	139	144	161	140	146	155	166	3.3%
KIUC	$M	73	77	82	85	74	82	84	86	2.3%

Source: Hawaii Electric Utility Monthly Financial Reports.

This growth rate was lower than the 9.1 percent growth rate of fuel and purchased power cost, but higher than the 3.4 percent average inflation rate (Honolulu CPI-U) during the same period. Among the four components of other electricity costs, taxes increased the most at 8.1 percent per year (similar to the 7.8 percent growth of total electricity revenue), followed by other utility operating expenses at 6.2 percent per year, operating income at 5.5 percent per year, and depreciation and amortization at 1.9 percent per year.

4. Generation by Fuel and Fuel Cost in Hawaii

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 10. Electricity Generation by Fuel: Total Electric Power Industry

	Total Electricity Generation	% in Total Electricity Generation								
Year	GWH	Petroleum	Coal	Other Gases 1/	Biomass	Geothermal	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	0.0	1.4
2009	11,011	75.3	13.6	0.2	2.6	1.5	1.0	2.3	0.0	3.5
2010	10,836	74.6	14.3	0.2	2.6	1.9	0.6	2.4	0.0	3.4
2011	10,723	73.9	13.3	0.3	2.9	2.1	0.9	3.2	0.0	3.4

Source: Energy Information Administration, State Energy Data System

As shown in Table 10, from 1990 to 2011, the share of petroleum generated electricity in Hawaii (including both utility and non-utility producers) decreased from 90.0 percent to 73.9 percent; the share of coal generated electricity increased from 0.0 percent to 13.3 percent; the share of wind generated electricity increased from 0.3 percent to 3.2 percent; the share of geothermal generated electricity increased from 0.0 to 2.1 percent; and the share of biomass decreased from 8.7 percent to 2.9 percent. In 2011, total renewable electricity accounted for about 9.1 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 11, almost all electricity generated from the utilities was from petroleum. From 1990 to 2011, the share of petroleum generated electricity as a percentage of total utility generated electricity decreased from 99.6 percent to 95.8 percent; the share of utility petroleum generated electricity in total petroleum generated electricity decreased from 91.2 percent to 77.1 percent.

Table 11. Electricity Generation by Utilities

	Total Electricity Generation	% in Total Electricity Generation								
Year	GWH	Petroleum	Coal	Other Gases 1/	Biomass	Geothermal	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	0.0	-	-
1999	6,452	99.6	-	-	-	-	0.3	0.1	-	-
2000	6,535	99.7	-	-	-	-	0.2	0.0	-	-
2001	6,383	99.7	-	-	-	-	0.3	0.0	-	-
2002	7,513	99.9	-	-	-	-	0.1	0.0	-	-
2003	6,493	99.9	-	-	-	-	0.0	0.0	-	-
2004	6,982	99.8	-	-	-	-	0.1	0.0	-	-
2005	6,915	99.8	-	-	-	-	0.1	0.0	-	-
2006	7,040	99.7	-	-	-	-	0.3	0.0	-	-
2007	6,928	99.8	-	-	-	-	0.2	0.0	-	-
2008	6,701	99.7	-	-	-	-	0.3	0.0	-	-
2009	6,510	96.2	-	-	0.1	-	0.4	0.0	-	3.3
2010	6,416	96.3	-	-	0.0	-	0.3	-	-	3.4
2011	6,376	95.8	-	-	0.6	-	0.3	-	-	3.3

Source: Energy Information Administration, State Energy Data System

As shown in Table 12, from 1990 to 2011, the share of petroleum generated electricity in non-utility generated electricity decreased from 45.0 percent to 41.8 percent; the share of coal generated electricity increased from 0.1 percent to 32.8 percent; the share of wind generated electricity increased from 1.7 percent to 7.8 percent; the share of geothermal electricity increased from 0.0 to 2.1 percent; and the share of biomass decreased from 8.7 percent to 2.9 percent.

The increased share of non-petroleum generated electricity, especially coal-fired 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, compared with the average price of HECO electricity at about 32 cents per kWh, the average fuel cost of HECO generated electricity was about 23 cents per kWh, and the average cost of HECO purchased power was 17 cents per kWh.

Table 12. Electricity Generation by Fuel: IPP & CHP

	Total Electricity Generation	% in Total Electricity Generation								
Year	GWH	Petroleum	Coal	Other Gases 1/	Biomass	Geothermal	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	0.0	3.4
2009	4,501	45.0	33.3	0.5	6.2	3.7	1.9	5.6	0.0	3.7
2010	4,420	43.2	35.0	0.5	6.4	4.5	1.2	5.9	0.0	3.3
2011	4,347	41.8	32.8	0.8	6.3	5.2	1.7	7.8	0.1	3.6

Source: Energy Information Administration, State Energy Data System

Table 13 shows that the generating capacity for Hawaii's total electric power industry increased from 1,976 MW in 1990 to 2,810 MW in 2011, an increase of 1.7 percent per year on average. Coal-fired capacity increased from 24 MW to 203 MW or 10.7 percent over the period; wind capacity increased from 23 MW to 92 MW or 6.8 percent per year on average; petroleum generation capacity increased from 1,692 MW to 2,214 MW or an average of 1.3 percent over the period; and biomass capacity increased from 211 MW to 227 MW or a 0.4 percent average per year.

Table 13. Power Generating Capacity by Type: Total Electric Power Industry

	Power Generating Capacity Units: MW								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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

Source: Energy Information Administration, State Energy Data System

Table 14 shows that the generating capacity of the utilities increased from 1,542 MW in 1990 to 1,945 MW in 2011, an increase of 1.1 percent per year on average. The generating capacity added by the utilities from 1990 to 2011 was mainly petroleum- and biomass-fired (consume biodiesel) capacity. In 2012, the average cost of biodiesel for HECO was about 89 cents per kWh, much higher than the HECO average cost of diesel at about 42 cents per kWh.

Table 14. Power Generating Capacity: Electric Utility

	Power Generating Capacity Units: MW								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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

Source: Energy Information Administration, State Energy Data System

Table 15 shows that the generating capacity of the non-utility producers in Hawaii increased from 435 MW in 1990 to 865 MW in 2011, an increase of 3.3 percent per year on average. The growth rate of coal-fired capacity was the highest during this period at 10.7 percent on average per year; followed by wind capacity at 6.8 percent per year; and petroleum capacity at 4.5 percent per year. Geothermal capacity increased from zero to 35 MW, but the biomass capacity decreased from 211 MW to 114 MW over the period.

Table 15. Power Generating Capacity: IPP and CHP

	Power Generating Capacity Units: MW								
Year	Petroleum	Coal	Other Gases	Biomass	Geothermal	Hydro	Wind	Solar	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

Source: Energy Information Administration, State Energy Data System

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.

As shown in Table 16, for the whole electric power industry in 2011, coal-fired generating units have the highest average operating hours at more than 7,000 hours per year, followed by geothermal units at almost 6,400 hours per year. The coal and geothermal units serve base load needs. Wind, hydro, and petroleum all have average operating hours of around 3,500-3,800 hours per year, similar to the average operating hours of all units at 3,817 hours per year. Biomass units have the lowest 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 16. 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

Source: Energy Information Administration, State Energy Data System

Table 17 and Table 18 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 3,279 hours per year in 2011, a decrease of 2.2 percent per year on average; while the average operating hours of non-utility units increased from 3,925 hours per year in 1990 to 5,025 hours per year in 2011 an increase of 1.2 percent per year on average.

For petroleum generating capacity, the average operating hours of utility-based units decreased from 5,180 hours per year in 1990 to 3,342 hours per year in 2011, an average decrease

of 2.1 percent per year; while the average operating hours of non-utility units decreased from 5,000 hours per year in 1990 to 4,703 hours per year in 2011, an average decrease of 0.3 percent per year.

Table 17. Average Operating Hours: Electric Utility

	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

Source: Energy Information Administration, State Energy Data System

Table 18. 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

Source: Energy Information Administration, State Energy Data System

Fossil fuels used to generate electricity in Hawaii consists mainly of petroleum and coal. As shown in Table 19, for the whole electric power industry, total petroleum used in electricity generation decreased from 16.0 million barrels (BBLs) in 1990 to 12.1 million BBLs in 2011, an average decrease of 1.3 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 2011, total electricity generated by petroleum decreased an average of 0.5 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 1.53 BBL per MWH in 2011.

Coal used in electricity generation in Hawaii was very limited before 1993. From 1993 to 2011, total coal used in electricity generation increased from 603,669 short tons (STs) to 709,440 STs, an average increase of 0.9 percent per year. During this period, total coal generated electricity decreased 0.2 percent per year, but coal consumption per MWH produced increased 1.1 percent per year on average from 0.41 ST per MWH to 0.50 ST per MWH.

Table 19. Fuel Consumption by All Electricity Producers

	Fuel Consumption			Fuel Consumption Per MWH		
Year	Petroleum BBL	Coal ST	Other Gases Billion BTU	Petroleum BBL	Coal ST	Other Gases Billion BTU
1990	16,033,262	2,013	211	1.84	0.85	0.01
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

Source: Energy Information Administration, State Energy Data System

The utilities account for most of the petroleum used to generate electricity in Hawaii. From 1990 to 2011, the utilities' share of petroleum consumption remained very stable at above 85 percent. As shown in Table 20, petroleum consumption per MWH was very stable for utility units. From 1990 to 2011, petroleum consumption per MWH decreased only slightly from 1.73 BBL per MWH to 1.71 BBL per MWH.

Table 20. 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		

Source: Energy Information Administration, State Energy Data System

For non-utility producers, petroleum consumption per MWH produced decreased significantly over time. From 1990 to 2011, petroleum consumption per MWH decreased an average of 5.5 percent per year from 2.95 BBL to 0.89 BBL. If we exclude the two years (1990-1991) with very high unit consumption, petroleum consumption per MWH decreased 2.7 percent

per year on average. In 2011, the per unit petroleum consumption for non-utility producers was only about 52 percent of the unit consumption by utility producers.

Table 21. 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

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 is available up to 2012. . The fuel cost of non-utility producers, however, is not available in the utility MFR.

As shown in Table 22, from 2005 to 2012, total petroleum consumption by the four electric utilities in Hawaii decreased an average 2.6 percent per year from about 12.0 million BBLs to about 10.0 million BBLs; fuel oil consumption decreased an average 2.5 percent per year from 9.1

million BBLs to 7.6 million BBLs; diesel oil (excluding biodiesel) consumption decreased an average 2.7 percent per year from 2.9 million BBLs to 2.4 million BBLs.

For the state, the share of fuel oil in total petroleum consumption for electricity production was very stable at about 76 percent. 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 22 percent of total petroleum consumption at MECO, and all petroleum consumed at KIUC was diesel.

Table 22. Hawaii Utility Fuel Consumption

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Petroleum										
State Total	BBL	12,046,758	12,237,022	12,045,419	11,517,449	11,244,809	10,991,537	10,873,734	10,027,770	-2.6%
HECO	BBL	7,993,010	8,151,077	8,195,607	7,817,000	7,555,082	7,374,920	7,312,962	6,719,585	-2.4%
HELCO	BBL	1,136,268	1,213,931	1,067,210	1,006,708	1,089,738	1,046,406	1,031,711	904,034	-3.2%
MECO	BBL	2,170,554	2,109,359	1,959,432	1,911,184	1,869,575	1,846,995	1,806,667	1,697,767	-3.4%
KIUC	BBL	746,926	762,655	823,170	782,557	730,414	723,216	722,394	706,384	-0.8%
Fuel Oil										
State Total	BBL	9,120,687	9,442,103	9,358,136	8,970,985	8,617,627	8,357,750	8,263,907	7,612,236	-2.5%
HECO	BBL	7,874,530	8,076,729	8,098,475	7,747,069	7,411,899	7,307,478	7,285,178	6,703,981	-2.3%
HELCO	BBL	726,866	844,427	787,051	758,212	734,535	612,502	577,107	533,394	-4.3%
MECO	BBL	519,291	520,947	472,610	465,704	471,193	437,770	401,622	374,861	-4.5%
KIUC	BBL	-	-	-	-	-	-	-	-	
Diesel										
State Total	BBL	2,926,071	2,794,919	2,687,283	2,546,464	2,627,182	2,633,787	2,609,827	2,415,534	-2.7%
HECO	BBL	118,480	74,348	97,132	69,931	143,183	67,442	27,784	15,604	-25.1%
HELCO	BBL	409,402	369,504	280,159	248,496	355,203	433,904	454,604	370,640	-1.4%
MECO	BBL	1,651,263	1,588,412	1,486,822	1,445,480	1,398,382	1,409,225	1,405,045	1,322,906	-3.1%
KIUC	BBL	746,926	762,655	823,170	782,557	730,414	723,216	722,394	706,384	-0.8%
% of Fuel Oil										
State Total	%	75.7%	77.2%	77.7%	77.9%	76.6%	76.0%	76.0%	75.9%	
HECO	%	98.5%	99.1%	98.8%	99.1%	98.1%	99.1%	99.6%	99.8%	
HELCO	%	64.0%	69.6%	73.7%	75.3%	67.4%	58.5%	55.9%	59.0%	
MECO	%	23.9%	24.7%	24.1%	24.4%	25.2%	23.7%	22.2%	22.1%	
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
County % of Fuel Oil										
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
HECO	%	86.3%	85.5%	86.5%	86.4%	86.0%	87.4%	88.2%	88.1%	
HELCO	%	8.0%	8.9%	8.4%	8.5%	8.5%	7.3%	7.0%	7.0%	
MECO	%	5.7%	5.5%	5.1%	5.2%	5.5%	5.2%	4.9%	4.9%	
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
County % of Diesel										
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
HECO	%	4.0%	2.7%	3.6%	2.7%	5.5%	2.6%	1.1%	0.6%	
HELCO	%	14.0%	13.2%	10.4%	9.8%	13.5%	16.5%	17.4%	15.3%	
MECO	%	56.4%	56.8%	55.3%	56.8%	53.2%	53.5%	53.8%	54.8%	
KIUC	%	25.5%	27.3%	30.6%	30.7%	27.8%	27.5%	27.7%	29.2%	

Source: Hawaii Electric Utility Monthly Financial Reports.

Over the past 7 years, 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. As shown in Table 23, from 2005 to 2012, total petroleum costs by the four electric 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. The decrease in diesel expenditures by HECO is due to the increased use of biodiesel. In 2012, HECO spent $18.9 million on biodiesel. The average cost of biodiesel consumed by HECO was $254.94/BBL, significantly higher than the average cost of diesel.

Table 23. Hawaii Utility Fuel Cost

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Petroleum										
State Total	$M	694	845	850	1,327	724	965	1,339	1,373	10.2%
HECO	$M	421	516	526	867	460	627	892	926	11.9%
HELCO	$M	65	85	75	110	74	93	122	117	8.7%
MECO	$M	154	180	174	253	137	176	234	235	6.3%
KIUC	$M	54	64	76	98	52	69	91	94	8.3%
Fuel Oil										
State Total	$M	467	588	592	979	519	708	993	1,033	12.0%
HECO	$M	412	509	516	858	447	623	889	924	12.3%
HELCO	$M	33	49	48	76	44	50	62	65	9.9%
MECO	$M	22	30	28	45	28	35	42	44	10.2%
KIUC	$M	-	-	-	-	-	-	-	-	
Diesel										
State Total	$M	226	258	258	348	205	257	346	339	6.0%
HECO	$M	9	7	9	9	13	4	3	2	-19.3%
HELCO	$M	32	36	27	34	30	43	60	52	7.3%
MECO	$M	132	151	145	207	110	141	192	191	5.5%
KIUC	$M	54	64	76	98	52	69	91	94	8.3%
% of Fuel Oil										
State Total	%	67.4%	69.5%	69.6%	73.8%	71.7%	73.4%	74.2%	75.3%	
HECO	%	97.9%	98.6%	98.2%	99.0%	97.2%	99.4%	99.7%	99.8%	
HELCO	%	51.2%	57.8%	63.5%	69.0%	59.1%	53.8%	50.6%	55.4%	
MECO	%	14.5%	16.4%	16.2%	17.9%	20.3%	19.7%	18.0%	18.7%	
KIUC	%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	

Source: Hawaii Electric Utility Monthly Financial Reports.

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 24, 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; 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 2012, fuel oil costs were highest at HECO, followed by HELCO and MECO; per unit diesel costs were highest at MECO, followed by HELCO, KIUC, and HECO.

Table 24. Hawaii Utility Average Fuel Cost

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Petroleum										
State Total	$/BBL	57.57	69.09	70.60	115.25	64.38	87.78	123.11	136.88	13.2%
HECO	$/BBL	52.61	63.33	64.13	110.89	60.90	84.97	121.99	137.86	14.8%
HELCO	$/BBL	57.44	70.21	70.24	108.89	68.28	89.33	118.09	129.27	12.3%
MECO	$/BBL	70.88	85.46	88.60	132.25	73.54	95.17	129.58	138.60	10.1%
KIUC	$/BBL	72.19	83.59	92.64	125.42	71.13	95.27	125.40	133.12	9.1%
Fuel Oil										
State Total	$/BBL	51.22	62.27	63.27	109.15	60.24	84.71	120.15	135.72	14.9%
HECO	$/BBL	52.26	63.04	63.75	110.79	60.34	85.27	122.03	137.88	14.9%
HELCO	$/BBL	45.96	58.36	60.50	99.74	59.89	82.05	106.84	121.43	14.9%
MECO	$/BBL	42.93	56.71	59.63	97.35	59.24	79.14	105.17	117.39	15.5%
KIUC	$/BBL									
Diesel										
State Total	$/BBL	77.36	92.13	96.13	136.70	77.96	97.51	132.48	140.52	8.9%
HECO	$/BBL	76.07	95.22	95.67	122.45	89.82	53.04	112.16	128.37	7.8%
HELCO	$/BBL	77.84	97.28	97.63	136.78	85.63	99.61	132.38	140.56	8.8%
MECO	$/BBL	79.67	94.89	97.80	143.49	78.36	100.14	136.56	144.61	8.9%
KIUC	$/BBL	72.19	83.59	92.64	125.42	71.13	95.27	125.40	133.12	9.1%

Source: Hawaii Electric Utility Monthly Financial Reports.

5. Electricity Consumption by Sector in Hawaii

Based on data from the utility MFR, electricity sold by the utilities can be classified into three sectors. The residential sector includes all residential customers and utility employees' accounts; the industrial sector includes large power customers; and the commercial sector includes all other customers. This section discusses the electricity consumption behavior of each of these sectors in Hawaii.

Due to the rapid growth in electricity prices in recent years, total electricity sold by the utilities decreased. Since residential customers tend to be more sensitive to electricity price changes, electricity sold to residential customers decreased by a higher percentage than that of other sectors. As shown in Table 25, from 2005 to 2012, total electricity sold decreased an average 1.3 percent per year in Hawaii, while electricity sold to the residential sector decreased an average 2.0 percent per year from 3,164 GWH to 2,739 GWH. In comparison, electricity sold to the commercial sector and the industrial sector only decreased an average 1.0 percent and 0.9 percent per year, respectively, over the same period. As a result, the share of the residential sector in total electricity sold decreased from 30.0 percent in 2005 to 28.4 percent in 2012.

At the county utility level, residential customers in the HECO system appear most sensitive to price changes. From 2005 to 2012, the percentage share that HECO represents in total electricity sold decreased 0.9 of a percentage point from 73.3 percent to 72.4 percent, while the percentage share HECO accounts for in residential sales decreased 2.9 percentage points from 67.7 percent to 64.9 percent.

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 25, from 2005 to 2012, 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 420,240 customers; the number of commercial customers decreased 0.1 percent per year from 64,072 to 63,772; and the number of industrial customers increased 0.4 percent per year from 648 to 704.

At the county utility level, the number of customers increased slower at HECO compared with the other utilities. From 2005 to 2012, the share of HECO customers in total statewide utility customers decreased 1.6 percentage points from 63.0 percent to 61.4 percent, and the share of

HECO customers in residential customers decreased 1.9 percentage points from 64.7 percent to 62.8 percent.

Table 25. Electricity Consumption by Sector and by Utility

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Total										
State Total	GWH	10,539	10,568	10,585	10,390	10,126	10,013	9,962	9,639	-1.3%
HECO	GWH	7,721	7,701	7,675	7,556	7,378	7,277	7,242	6,976	-1.4%
HELCO	GWH	1,116	1,149	1,163	1,141	1,120	1,110	1,104	1,085	-0.4%
MECO	GWH	1,252	1,266	1,280	1,239	1,192	1,192	1,181	1,145	-1.3%
KIUC	GWH	449	452	467	454	436	435	435	433	-0.5%
Residential										
State Total	GWH	3,164	3,182	3,201	3,085	3,055	2,989	2,929	2,739	-2.0%
HECO	GWH	2,143	2,134	2,135	2,049	2,025	1,976	1,925	1,777	-2.6%
HELCO	GWH	423	442	451	441	440	431	427	410	-0.5%
MECO	GWH	442	445	450	435	428	423	418	395	-1.6%
KIUC	GWH	156	160	165	160	162	159	159	157	0.1%
Commercial										
State Total	GWH	3,465	3,491	3,521	3,502	3,389	3,351	3,368	3,238	-1.0%
HECO	GWH	2,480	2,491	2,513	2,515	2,449	2,415	2,429	2,320	-1.0%
HELCO	GWH	453	458	463	458	441	443	446	430	-0.7%
MECO	GWH	406	415	417	406	382	378	379	374	-1.2%
KIUC	GWH	125	126	129	123	117	116	114	114	-1.3%
Industrial										
State Total	GWH	3,909	3,895	3,863	3,803	3,681	3,672	3,665	3,662	-0.9%
HECO	GWH	3,098	3,075	3,028	2,992	2,904	2,887	2,888	2,879	-1.0%
HELCO	GWH	240	248	248	242	238	236	231	245	0.3%
MECO	GWH	404	406	414	399	382	390	384	375	-1.0%
KIUC	GWH	167	166	173	170	157	160	161	162	-0.5%
% of Residential										
State Total	%	30.0%	30.1%	30.2%	29.7%	30.2%	29.9%	29.4%	28.4%	
HECO	%	27.7%	27.7%	27.8%	27.1%	27.5%	27.1%	26.6%	25.5%	
HELCO	%	37.9%	38.5%	38.8%	38.7%	39.3%	38.8%	38.7%	37.8%	
MECO	%	35.3%	35.2%	35.1%	35.1%	35.9%	35.5%	35.4%	34.5%	
KIUC	%	34.8%	35.5%	35.4%	35.4%	37.1%	36.7%	36.6%	36.3%	
% of Commercial										
State Total	%	32.9%	33.0%	33.3%	33.7%	33.5%	33.5%	33.8%	33.6%	
HECO	%	32.1%	32.4%	32.7%	33.3%	33.2%	33.2%	33.5%	33.3%	
HELCO	%	40.6%	39.9%	39.8%	40.1%	39.4%	39.9%	40.4%	39.6%	
MECO	%	32.4%	32.8%	32.5%	32.7%	32.0%	31.7%	32.1%	32.7%	
KIUC	%	27.9%	27.8%	27.6%	27.1%	26.9%	26.6%	26.3%	26.4%	
County % of Total										
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
HECO	%	73.3%	72.9%	72.5%	72.7%	72.9%	72.7%	72.7%	72.4%	
HELCO	%	10.6%	10.9%	11.0%	11.0%	11.1%	11.1%	11.1%	11.3%	
MECO	%	11.9%	12.0%	12.1%	11.9%	11.8%	11.9%	11.9%	11.9%	
KIUC	%	4.3%	4.3%	4.4%	4.4%	4.3%	4.3%	4.4%	4.5%	

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 26. Number of Retail Customers by Sector in Hawaii

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Total										
State Total		463,088	469,013	475,104	476,124	478,590	480,918	482,498	484,716	0.7%
HECO		291,580	292,988	294,591	293,740	295,282	296,422	296,800	297,529	0.3%
HELCO		73,835	76,417	78,983	79,606	79,813	80,695	81,199	81,792	1.5%
MECO		63,901	64,937	66,323	67,065	67,489	67,739	68,230	68,922	1.1%
KIUC		33,772	34,671	35,207	35,713	36,006	36,062	36,269	36,473	1.1%
Residential										
State Total		398,332	403,278	408,923	410,477	413,643	416,141	418,174	420,240	0.8%
HECO		257,804	259,098	260,583	259,929	261,630	262,635	263,384	264,047	0.3%
HELCO		60,699	62,851	65,305	66,188	66,825	67,837	68,423	69,099	1.9%
MECO		54,135	54,834	56,076	56,925	57,431	57,835	58,326	58,879	1.2%
KIUC		25,694	26,495	26,959	27,435	27,757	27,834	28,041	28,215	1.3%
Commercial										
State Total		64,072	65,044	65,503	64,977	64,255	64,105	63,625	63,772	-0.1%
HECO		33,416	33,530	33,661	33,474	33,305	33,444	33,058	33,116	-0.1%
HELCO		13,071	13,500	13,608	13,348	12,919	12,792	12,702	12,617	-0.5%
MECO		9,632	9,962	10,110	10,004	9,916	9,765	9,769	9,908	0.4%
KIUC		7,953	8,052	8,124	8,151	8,115	8,104	8,096	8,131	0.3%
Industrial										
State Total		684	691	678	670	692	672	699	704	0.4%
HECO		360	360	347	337	347	343	358	366	0.2%
HELCO		65	66	70	70	69	66	74	76	2.3%
MECO		134	141	137	136	142	139	135	135	0.1%
KIUC		125	124	124	127	134	124	132	127	0.2%
% of Residential										
State Total	%	86.0%	86.0%	86.1%	86.2%	86.4%	86.5%	86.7%	86.7%	
HECO	%	88.4%	88.4%	88.5%	88.5%	88.6%	88.6%	88.7%	88.7%	
HELCO	%	82.2%	82.2%	82.7%	83.1%	83.7%	84.1%	84.3%	84.5%	
MECO	%	84.7%	84.4%	84.5%	84.9%	85.1%	85.4%	85.5%	85.4%	
KIUC	%	76.1%	76.4%	76.6%	76.8%	77.1%	77.2%	77.3%	77.4%	
% of Commercial										
State Total	%	13.8%	13.9%	13.8%	13.6%	13.4%	13.3%	13.2%	13.2%	
HECO	%	11.5%	11.4%	11.4%	11.4%	11.3%	11.3%	11.1%	11.1%	
HELCO	%	17.7%	17.7%	17.2%	16.8%	16.2%	15.9%	15.6%	15.4%	
MECO	%	15.1%	15.3%	15.2%	14.9%	14.7%	14.4%	14.3%	14.4%	
KIUC	%	23.5%	23.2%	23.1%	22.8%	22.5%	22.5%	22.3%	22.3%	
County % of Total										
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
HECO	%	63.0%	62.5%	62.0%	61.7%	61.7%	61.6%	61.5%	61.4%	
HELCO	%	15.9%	16.3%	16.6%	16.7%	16.7%	16.8%	16.8%	16.9%	
MECO	%	13.8%	13.8%	14.0%	14.1%	14.1%	14.1%	14.1%	14.2%	
KIUC	%	7.3%	7.4%	7.4%	7.5%	7.5%	7.5%	7.5%	7.5%	

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 27 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 19,886 kWh in 2012; annual electricity consumption per residential customer decreased an average 2.8 percent per year from 7,943 kWh to 6,518 kWh; annual electricity consumption per commercial customer decreased an average 0.9 percent per year from 54,081 kWh to 50,780 kWh; annual electricity consumption by industrial customers decreased 1.3 percent per year from 5,715,476 kWh to 5,201,000 kWh.

At the county utility level, HECO had the highest annual electricity consumption per residential customer in 2012 at 6,729 kWh; followed by MECO at 6,715 kWh, HELCO at 5,931 kWh, and KIUC at 5,574 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 2012, residential consumption per customer decreased an average 3.0 percent per year at HECO; decreased 2.8 percent per year at MECO, decreased 2.3 percent per year at HELCO, and decreased 1.2 percent per year at KIUC.

Table 27. Annual Electricity Consumption per Customer by Sector

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Total										
State Total	kWh/C	22,757	22,532	22,279	21,822	21,158	20,821	20,646	19,886	-1.9%
HECO	kWh/C	26,481	26,283	26,054	25,723	24,985	24,550	24,401	23,446	-1.7%
HELCO	kWh/C	15,121	15,033	14,721	14,333	14,031	13,753	13,591	13,267	-1.9%
MECO	kWh/C	19,595	19,503	19,301	18,478	17,666	17,590	17,309	16,611	-2.3%
KIUC	kWh/C	13,284	13,039	13,261	12,707	12,117	12,050	11,987	11,876	-1.6%
Residential										
State Total	kWh/C	7,943	7,891	7,827	7,516	7,386	7,184	7,004	6,518	-2.8%
HECO	kWh/C	8,311	8,238	8,191	7,882	7,741	7,523	7,309	6,729	-3.0%
HELCO	kWh/C	6,977	7,037	6,912	6,669	6,585	6,353	6,238	5,931	-2.3%
MECO	kWh/C	8,165	8,123	8,017	7,634	7,451	7,320	7,165	6,715	-2.8%
KIUC	kWh/C	6,072	6,049	6,127	5,849	5,834	5,728	5,673	5,574	-1.2%
Commercial										
State Total	kWh/C	54,081	53,666	53,761	53,892	52,746	52,279	52,939	50,780	-0.9%
HECO	kWh/C	74,227	74,301	74,652	75,138	73,519	72,199	73,475	70,053	-0.8%
HELCO	kWh/C	34,685	33,945	34,027	34,294	34,165	34,636	35,089	34,095	-0.2%
MECO	kWh/C	42,163	41,689	41,202	40,550	38,525	38,716	38,811	37,758	-1.6%
KIUC	kWh/C	15,749	15,616	15,881	15,108	14,452	14,264	14,139	14,046	-1.6%
Industrial										
State Total	kWh/C	5,715,476	5,636,553	5,697,455	5,676,276	5,320,073	5,464,790	5,242,739	5,201,000	-1.3%
HECO	kWh/C	8,606,672	8,541,250	8,726,082	8,878,567	8,368,077	8,416,539	8,068,244	7,866,900	-1.3%
HELCO	kWh/C	3,686,703	3,760,826	3,546,493	3,455,125	3,455,506	3,572,454	3,122,719	3,225,790	-1.9%
MECO	kWh/C	3,014,884	2,877,511	3,021,683	2,933,850	2,692,158	2,806,990	2,844,143	2,780,620	-1.1%
KIUC	kWh/C	1,338,824	1,339,232	1,392,734	1,339,887	1,172,027	1,286,392	1,221,235	1,273,029	-0.7%

Source: Hawaii Electric Utility Monthly Financial Reports.

Due to the rapid growth of electricity prices, total revenue from retail electricity sales increased substantially in recent years even though the kWh sold decreased over time. As shown in Table 28, 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; revenue from commercial and industrial sales (separate revenues from the commercial sector and the industrial sector are not available in the MFR) increased an average 8.5 percent per year from $1,274 million to $2,258 million.

Table 28. Revenue from Retail Electricity Sales by Sector in Hawaii

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Total										
State Total	$M	1,927	2,190	2,253	3,034	2,148	2,516	3,147	3,281	7.9%
HECO	$M	1,201	1,362	1,381	1,948	1,379	1,645	2,104	2,217	9.1%
HELCO	$M	294	339	361	445	343	372	443	439	5.9%
MECO	$M	302	344	349	451	296	344	417	437	5.4%
KIUC	$M	130	146	163	189	130	155	182	188	5.4%
Residential										
State Total	$M	653	743	772	1,003	739	840	1,016	1,023	6.6%
HECO	$M	379	428	438	592	436	503	617	624	7.4%
HELCO	$M	118	137	148	180	144	152	179	174	5.7%
MECO	$M	110	125	127	163	111	126	151	154	4.9%
KIUC	$M	46	53	59	68	49	59	69	71	6.3%
Others										
State Total	$M	1,274	1,447	1,481	2,031	1,409	1,676	2,131	2,258	8.5%
HECO	$M	823	933	943	1,356	943	1,142	1,487	1,593	9.9%
HELCO	$M	176	202	213	265	199	220	264	265	6.1%
MECO	$M	192	219	222	288	186	218	266	282	5.7%
KIUC	$M	84	93	104	122	81	96	113	118	4.9%
% of Residential										
State Total	%	33.9%	33.9%	34.3%	33.0%	34.4%	33.4%	32.3%	31.2%	
HECO	%	31.5%	31.5%	31.7%	30.4%	31.6%	30.6%	29.3%	28.1%	
HELCO	%	40.2%	40.5%	41.0%	40.5%	41.9%	40.9%	40.4%	39.6%	
MECO	%	36.5%	36.3%	36.5%	36.1%	37.3%	36.7%	36.2%	35.3%	
KIUC	%	35.5%	36.0%	36.1%	35.6%	37.7%	37.8%	37.8%	37.6%	
County % of Total										
State Total	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	
HECO	%	62.3%	62.2%	61.3%	64.2%	64.2%	65.4%	66.9%	67.6%	
HELCO	%	15.2%	15.5%	16.0%	14.7%	16.0%	14.8%	14.1%	13.4%	
MECO	%	15.7%	15.7%	15.5%	14.9%	13.8%	13.7%	13.3%	13.3%	
KIUC	%	6.8%	6.7%	7.2%	6.2%	6.0%	6.2%	5.8%	5.7%	

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 29 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; 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.

Based on the percentage change in electricity consumption per customer and the percentage change in the average electricity price from 2005 to 2012, the price elasticity for the total customers in the state is negative 0.15, and the price elasticity for the state residential customers is negative 0.22.

Table 29. Average Electricity Price by Sector in Hawaii

		2005	2006	2007	2008	2009	2010	2011	2012	Growth
Total										
State Total	$/kWh	0.183	0.207	0.213	0.292	0.212	0.251	0.316	0.340	9.3%
HECO	$/kWh	0.156	0.177	0.180	0.258	0.187	0.226	0.290	0.318	10.7%
HELCO	$/kWh	0.263	0.295	0.310	0.390	0.306	0.335	0.402	0.405	6.3%
MECO	$/kWh	0.241	0.272	0.273	0.364	0.249	0.288	0.353	0.382	6.8%
KIUC	$/kWh	0.291	0.323	0.349	0.417	0.297	0.357	0.420	0.435	5.9%
Residential										
State Total	$/kWh	0.206	0.233	0.241	0.325	0.242	0.281	0.347	0.373	8.8%
HECO	$/kWh	0.177	0.201	0.205	0.289	0.215	0.255	0.320	0.351	10.3%
HELCO	$/kWh	0.279	0.310	0.328	0.409	0.327	0.353	0.419	0.425	6.2%
MECO	$/kWh	0.249	0.280	0.283	0.374	0.259	0.298	0.361	0.391	6.6%
KIUC	$/kWh	0.297	0.328	0.356	0.421	0.301	0.368	0.434	0.450	6.1%
Others										
State Total	$/kWh	0.173	0.196	0.201	0.278	0.199	0.239	0.303	0.327	9.6%
HECO	$/kWh	0.147	0.168	0.170	0.246	0.176	0.215	0.280	0.306	11.0%
HELCO	$/kWh	0.253	0.285	0.299	0.378	0.293	0.323	0.391	0.393	6.5%
MECO	$/kWh	0.236	0.267	0.267	0.358	0.243	0.283	0.349	0.377	6.9%
KIUC	$/kWh	0.287	0.320	0.345	0.416	0.294	0.351	0.411	0.426	5.8%

Source: Hawaii Electric Utility Monthly Financial Reports.

Table 30 shows the statewide average electricity price by sector in Hawaii from EIA data. Separate prices for the commercial and industrial sector from 1990 to 2011 are provided.

Table 30. 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

Source: Energy Information Administration, State Energy Data System

The overall demand for electricity can be met through several alternative channels. Electricity users can purchase electricity from the utilities, generate electricity themselves, and 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. For the data on electricity generated and consumed by the final users, only the electricity generated from PV systems was available. In this study we defined total electricity demand as the sum of total generation by the electric power industry, electricity generated from PV systems, and the electricity replaced by SWH and DSM projects.

As shown in Table 31, from 2005 to 2011, total electricity demand increased an average 0.2 percent per year from about 12,303 GWH to 12,420 GWH. Electricity generation by the electric power industry decreased 0.9 percent per year from 11,770 GWH to 11,120 GWH, electricity generated by user owned PV systems increased 83.9 percent per year from 2.4 GWH to 92.9 GWH; electricity replaced by SWH increased 11.9 percent per year from 91.7 GWH to 180.2 GWH; and electricity replaced DSM increased 15.2 percent per year from 438.9 GWH to 1,027.3 GWH. The share of electricity generation produced by the electric power industry decreased from 95.67 percent in 2005 to 89.53 percent in 2011, a decrease of 6.14 percentage points.

Table 31. Total Electricity Demand in Hawaii

Electricity Generation and Concervation (Demand-Side-Management)

Units: MWH

Year	Gross 1/ Generation	By Users PV	By Users SWH	By Users DSM	By Users Sub-Total	Gross Total
2005	11,770,286	2,400	91,700	438,900	533,000	12,303,286
2006	11,816,718	3,600	102,800	497,300	603,700	12,420,418
2007	11,836,287	7,900	116,900	619,400	744,200	12,580,487
2008	11,615,774	14,600	125,800	750,100	890,500	12,506,274
2009	11,296,840	35,000	139,000	808,800	982,800	12,279,640
2010	11,209,235	54,339	172,056	916,420	1,142,815	12,352,050
2011	11,119,606	92,930	180,173	1,027,328	1,300,431	12,420,037
Growth	-0.9%	83.9%	11.9%	15.2%	16.0%	0.2%

Electricity Generation and Concervation (Demand-Side-Management)

Units: % in Gross Total

Year	Gross 1/ Generation	By Users PV	By Users SWH	By Users DSM	By Users Sub-Total	Gross Total
2005	95.67	0.02	0.75	3.57	4.33	100.00
2006	95.14	0.03	0.83	4.00	4.86	100.00
2007	94.08	0.06	0.93	4.92	5.92	100.00
2008	92.88	0.12	1.01	6.00	7.12	100.00
2009	92.00	0.29	1.13	6.59	8.00	100.00
2010	90.75	0.44	1.39	7.42	9.25	100.00
2011	89.53	0.75	1.45	8.27	10.47	100.00

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

1/ Estimated by DBEDT

6. Conclusions

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). According to the most recent data available, from 2005 to 2011, the total share of electricity generated by the electric power industry as a percentage of total electricity demand in Hawaii decreased 6.2 percentage points from 95.7 percent to 89.5 percent. Without the electricity generated and conserved by users, total electricity expenditure in Hawaii would be even higher.

In recent years the share of total electricity generation of the electric power industry generated by utility producers decreased significantly. According to the most recent EIA data available, from 1990 to 2011, the share of utility generated electricity decreased 22.9 percentage points from 82.4 percent to 59.5 percent. Since the average expenditure of purchased electricity is below the average fuel cost of utility generated electricity, the increased share of purchased electricity helped to reduce the average cost of electricity sold by the utility.

Not all the electricity generated by the electric power industry is sold to the utility customers. In Hawaii, about 5.7 percent of the gross electricity generated by the utilities in 2012 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 2012, the percentage share of gross generation electricity sold was rather stable in Hawaii.

From 2005 to 2012, the average fuel cost per kWh of electricity generated by the utilities in Hawaii increased 12.7 percent per year from 10.0 cents/kWh to 23.1 cents/kWh; while the average cost of purchased electricity increased only 7.0 percent per year from 11.0 cents/kWh to 17.7 cents/kWh. In 2012, the average cost of purchased electricity was 23.4 percent below the average fuel cost of utility generated electricity.

The average cost of purchased electricity in 2012 was the lowest at HECO at about 17.0 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 about 10 cents/kWh in 2012, significantly lower than the average

cost of purchased power by HECO. This suggests that adding more coal-fired capacity may help Hawaii reduce the average cost of electricity in the future.

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 2011 about 95.8 percent of utility generated electricity was from petroleum, while only 41.8 percent of non-utility generated electricity was from petroleum.

From 2005 to 2012, the average petroleum price for the four electric utilities in Hawaii increased an average 13.2 percent per year from $57.57/BBL to $136.88/BBL; the average fuel oil cost increased 14.9 percent per year from $51.22/BBL to $135.72/BBL; and the average diesel cost increased 8.9 percent per year from $77.36/BBL to $140.52/BBL. In comparison, the average crude oil price only increased 7.6 percent per year over the same period. Future research may be necessary to identify the precise reasons why the average petroleum cost, especially the average fuel oil cost, of the utilities increased much faster than the crude oil price.

From 2005 to 2012, the average revenue from electricity sold in Hawaii increased 9.3 percent per year from 18.3 cents/kWh to 34.0 cents/kWh. Due to the rapid growth in the average petroleum cost, the share of utility fuel cost as part of the average revenue of electricity sold increased 13.1 percentage points from 54.8 percent to 68.0 percent. On the other hand, the share of average purchased power cost as part of the average revenue of electricity sold decreased 8.2 percentage points from 60.3 percent to 52.1 percent. In combination, the share of fuel and purchased power cost as part of the average revenue of electricity sold increased 4.7 percentage points from 60.0 percent to 64.7 percent during the same period.

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 5.8 percent, taxes accounted for about 11.6 percent, depreciation and amortization accounted for about 4.8 percent, and other utility operating expenses accounted for about 13.4 percent of total electricity prices paid by consumers in 2012. 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 2012, the four components of electricity cost increased 6.0 percent per year on average. This growth rate was lower than the 9.1 percent growth rate of fuel and purchased power costs, but higher than the 3.4 percent average inflation rate during

the same period. Among the four components of other electricity costs, taxes increased the most at 8.1 percent per year, followed by other utility operating expenses at 6.2 percent per year, operating income at 5.5 percent per year, and depreciation and amortization at 1.9 percent per year.

Due to the rapid growth in electricity prices in recent years, total electricity sold by the utilities decreased. Since residential customers are more sensitive to electricity price changes, electricity sold to residential customers decreased more than that of other sectors. From 2005 to 2012, total electricity sold decreased 1.3 percent per year in Hawaii, while electricity sold to the residential sector decreased 2.0 percent from 3,164 GWH to 2,739 GWH. In comparison, the electricity sold to the commercial sector and the industrial sector decreased only 1.0 percent and 0.9 percent per year, respectively, over the same period.

Decreased electricity consumption in recent years has been due to a decrease in consumption per customer rather than a decrease in the number of customers. From 2005 to 2012, total utility customers for the state increased 0.7 percent per year; residential customers increased 0.8 percent per year; commercial customers decreased 0.1 percent per year; and industrial customers increased 0.4 percent per year.

Based on the percentage change in electricity consumption per customer and the percentage change in the average electricity price from 2005 to 2012, the price elasticity for the total customers in the state is negative 0.15, and the price elasticity for the state's residential customers is negative 0.22.