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Renewable Energy in Hawaii

June 2011

Abstract

For electricity generation, currently there are two sets of renewable energy goals: (1) the Renewable Portfolio Standards (RPS) established initially by Act 272, SLH 2001, and expanded by Act 155, SLH 2009, requires 40% of the net electricity sales by December 31, 2030; and (2) The Hawaii Clean Energy Initiative (HCEI) in 2008 established an overall goal for the electricity sector to meet 40% of the electricity demand by 2030.

The primary difference between the two in the electricity sector is on the denominator. The RPS measurement is based on electricity sales while HCEI is based on electricity demand. Electricity demand is defined as the sum of electricity sales and efficiency savings.

In terms of RPS, Hawaii's renewable energy and efficiency savings together accounted for 18.9% of total electricity sales in 2009, which exceeded the 2015 RPS requirement of 15%, while based on HCEI, the above accounted for 8.4% of the total electricity demand.

Based on a forecast by Hawaiian Electric Company, Inc, we estimate that total electricity demand by 2030 will be 14,360 GWh, a 1.23% annual growth from the 11,109 GWh in 2009. Currently, electricity generated from renewable sources totaled 1,243.7 GWh, accounted for 8.7% of total electricity demand. As of March 2011, there are 68 renewable energy projects under construction or in the planning stage with a total estimated generation of 3,793 GWh. The combined existing and proposed renewable energy projects are estimated to be able to generate a total of 5,000 GWh, representing about 35% of the total electricity demand. Additional 750 GWh of renewable would be needed to reach the HCEI goal. However, the existing and proposed renewable energy projects would generate 50% of the electricity sales; a measure that exceeds the RPS goal.

The existing and proposed renewable energy projects suggested that 46% of the electricity-generating renewable sources would be from wind, 23% from solar, 12% from biomass, and rest are from biofuel, hydro and geothermal.

This report also describes the status of major renewable energy projects in the State and presents the energy policy timelines since the 1970s.

Introduction

Hawaii is unique among the 50 states for its lopsided dependence on petroleum. In 2008, petroleum provided nearly 85 percent of total energy consumed in Hawaii, much higher than the national average of 37.5 percent. This makes Hawaii the most vulnerable state in the nation to the disruptions in the world oil markets. Whenever the oil price has fluctuated, Hawaii's economy has been significantly affected.

Energy costs are about 10 percent of Hawaii's gross state product. Most of the energy costs are spending on petroleum and roughly 90 percent of the spending on petroleum not only leaves the state, but goes to countries outside the U.S. A region's economic vitality is reduced by a multiplied effect for every dollar that leaves the region as a result of taking cash out of circulation in the economy through import payments.

Clearly, it is in the state's best economic interests to reduce Hawaii's dependence on imported oil. High oil price volatility makes it crucial to any rational economic planning. Limited oil reserves around the world make it increasingly critical.

Clean, locally developed, renewable energy will, in the long run, boost Hawaii's economy. The land, the sea, the wind, and the sun are all capable of providing virtually limitless amounts of indigenous energy. Hawaii's abundant renewable energy resources and energy efficiency technologies will make it possible within a relatively short period of time.

In order to provide a framework to help realize this vision, the Hawaii Clean Energy Initiative (HCEI) was launched in 2008. It was an unprecedented collaboration by the State of Hawaii and the U.S. Department of Energy to transform the energy foundation of Hawaii to clean energy, using Hawaii's own renewable and indigenous energy resources, within a single generation.

The goal declared in the HCEI is to transform Hawaii to a 70 percent clean energy economy by 2030, and reaping all the attendant economic and environmental benefits of such transformation including, increasing Hawaii's energy and economic security, fostering and demonstrating Hawaii's innovation, building the work force for the future, and servings a clean energy model for the U.S. and the world.

The plan recognized that the transformation to a clean energy economy includes many complex challenges and issues. The HCEI strategy is based on a deployment process that supports each energy sector separately, as well as an integrated framework that coordinates the processes in a holistic fashion.

The HCEI has identified four key sectors of energy economy. Each has a clear overall goal:

Electricity

The overall goal for the Electricity sector is to meet 40 percent of the State's electricity demand with renewable energy by 2030. In order to deliver "clean" electricity to Hawaii's residents, HCEI will (1) align government regulations and policies with clean energy goals, (2) increase certainty in the process for developing new renewable energy, (3) deploy renewable generation and grid infrastructure, and (4) explore next generation technologies and new applications of existing technologies.

End Use Efficiency

The overall goal of the End-Use Efficiency sector is to meet the State's Energy Efficiency Portfolio Standard of 30 percent by reducing electricity demand by 4300 gigawatt hours by 2030. In order to reduce the use of electricity by end users – including homes, businesses, industrial and military sectors – HCEI will (1) align the efficiency regulatory policy and framework with clean energy goals, (2) support the retrofitting of residential and commercial existing buildings, (3) strengthen new construction policies and building codes, and (4) identify non-building related energy efficiency measures.

Transportation

The overall goal for the Transportation sector is to reduce the consumption of petroleum in ground transportation by 70 percent or approximately 385 million gallons per year (MGY) by 2030. Unlike the more heavily regulated Electricity and Efficiency sectors, Transportation does not have goals mandated by statute so its strategies to reduce the use of petroleum fuel for ground transportation in Hawaii rely heavily on influencing personal behavior. Primary areas of concern will be (1) improve the standard vehicle efficiency of the fleet, (2) reduce the overall number of vehicle miles traveled (VMT), (3) expand the use of renewable fuels in the transportation sector, and (4) accelerate the deployment of electric and hydrogen vehicles and related infrastructure

Alternative Fuels

Alternative fuels (including biofuels and hydrogen) play a critical role in Hawaii's successful attainment of 70 percent clean energy. Those that are direct substitutes for petroleum products (i.e., drop-in replacement biofuels) will be particularly important for areas where investment in additional transportation infrastructure is unlikely (e.g. aviation). Additionally, certain fuel technologies already in place in the state (e.g. biodiesel production) will need to be expanded upon to meet the renewable fuel targets set by HCEI. The shift to renewable fuels will also pave the way for the state to preserve traditional agricultural land and jobs. HCEI's fuel strategy includes (1) evaluating local agricultural potential and supporting its development, (2) investing in key logistical infrastructure, (3) evaluating and developing renewable fuel processing infrastructure, and (4) matching potential fuel supply to sources of demand.

This report examines current status of renewable energy developments and how far we are from the goals we set based on currently available data and information. It provides history and a policy framework for Hawaii's energy industry including:

- The state of energy production in Hawaii,
- Renewable energy development needed by 2030 to meet the state's stated goal,
- The status of renewable energy development as of May 2011, and
- An energy policy timeline for Hawaii.

Renewable Energy Trend in Hawaii

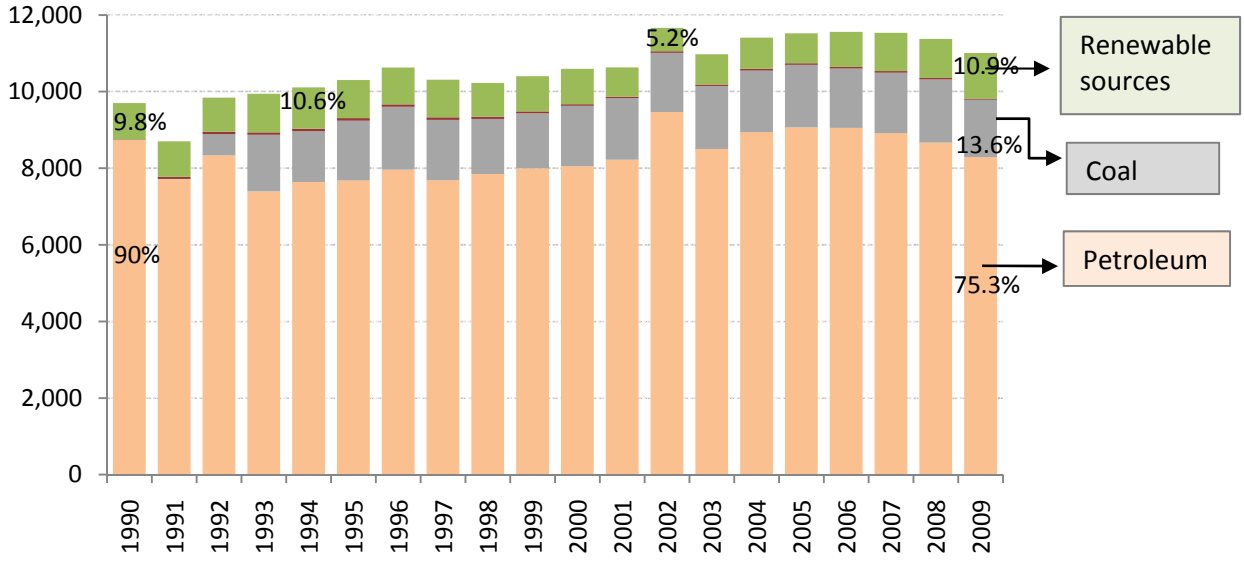
Before 1980, Hawaii's energy consumption was almost entirely dependent on imported oil. Then, some of islands' energy needs began to be met by bagasses, byproducts of Hawaii's sugar cane industry. With an increase in the overall capacity and efficiency of energy production from bagasse in 1970s, the use of bagasse for electric power generation had increased throughout the 1980s. At its peak, the industry was providing as much as 431 gigawatt hours (GWh), 5 percent of total electricity generated in 1991.[1]

In the early 1990s, more sources of renewable energy became open to Hawaii. Puna Geothermal Venture in the Big Island started the operation in 1993 with 25-30 MW capacity, increasing renewables share of total electricity generated to 10.6 percent in 1994. However, with the downfall of the sugar cane industry throughout the 1990s, the role of renewable sources had continued to shrink until new statewide efforts for a clean energy future launched in the early 2000s.

Most of the renewable projects are still in planning and discussion stage. Nevertheless, as a result of enforceable laws and concerted efforts of stakeholders, there were some achievements in developing new sources of renewable energies in the past several years.

With the new and added capacity of the wind farms on Maui and Big Island in 2006 and 2007, electricity generated from renewable sources in Hawaii rose again to 10.9 percent of total electricity generated in 2009.

Figure1. Net Electricity Generation in Hawaii by Source (1990-2009)



Source: U.S. Energy Information Administration (EIA)

[1] Sugar cane history table, Hawaiian Sugar Planters' Association

Renewable Portfolio Standard Laws in Hawaii

Renewable Portfolio Standards (RPS) is a regulation system that establishes numeric targets for renewable energy supply and applies those targets to retail electricity suppliers. Along with Federal tax incentives, RPSs at the state level in the United States became prevalent since the late 1990s.

Hawaii established a renewable portfolio goal by Act 272, Session Laws of Hawaii (SLH), 2001. Under this act, each electric utility was required to establish goals to increase net renewable energy sales to 9 percent by the end of 2010. Then, the goal was replaced with an enforceable RPS by Act 95, SLH, 2004. Not only replaced the voluntary compliance with an enforceable law, but the act also increased the goal to 20 percent of electricity be generated from renewable resources by the end of 2020.

After the launch of Hawaii Clean Energy Initiative (HCEI) in 2008, the Hawaii RPS was significantly expanded again by Act 155, SLH, 2009 as follows, formalizing many of the goals established by the HCEI.

- 10 percent of its net electricity sales by December 31, 2010;
- 15 percent of its net electricity sales by December 31, 2015;
- 25 percent of its net electricity sales by December 31, 2020; and
- 40 percent of its net electricity sales by December 31, 2030.

Besides the requirement for electricity from renewable sources, Act 155, SLH, 2009 also created a separate Energy Efficiency Portfolio Standards (EEPS), which set a goal of 4,300 gigawatt-hour reduction in electricity use by 2030.

Energy Efficiency

Energy efficiency in Hawaii comes from two major sources: (1) the electric energy savings using renewable displacement technologies such as the photovoltaic systems and the solar water heating systems, and (2) the electricity savings by the efficiency technology programs.

Though no percentage goals for efficiency saving were established in Act 155, SLH, 2009, a Memorandum of Understanding (MOU) signed by the U.S. Department of Energy and the State of Hawaii in 2008 has established an overall goal of 70 percent "clean energy" by 2030 with energy efficiency savings of 30 percent of the state's total energy consumption.

The MOU did not specify how the 30% energy efficiency should be calculated. In general, it is not necessary to make a clear distinction between sales and demand (or consumption), although the two are not exactly the same concepts. In our context, however, a distinction of sales from demand is necessary because actual electricity sales would be much less than total electricity demand with the ambitious efficiency saving goal. Using electricity sale as a base to calculate the percentage would lead to a double counting of the benefit of efficiency saving because the electricity sale would be reduced by the savings.

Here, we defined electricity demand as the sum of electricity sale and electricity savings from the efficiency programs. Energy efficiency programs include diverse efforts to reduce electricity consumption. Some of the electricity savings might not be suitable to be counted as demand, but for simplicity's sake we included all efficiency savings reported in the utilities' RPS reports in the calculation of electricity demand.

Table 1 shows electricity saved by energy efficiency programs and its share of electricity demand from 2003 to 2009. Electricity saving by energy efficiency technologies has increased significantly during the period of 2003 and 2009. As a result, contribution to the total electricity demand of energy savings from all energy efficiency programs increased from 1.7 percent in 2003 to 8.8 percent in 2009.

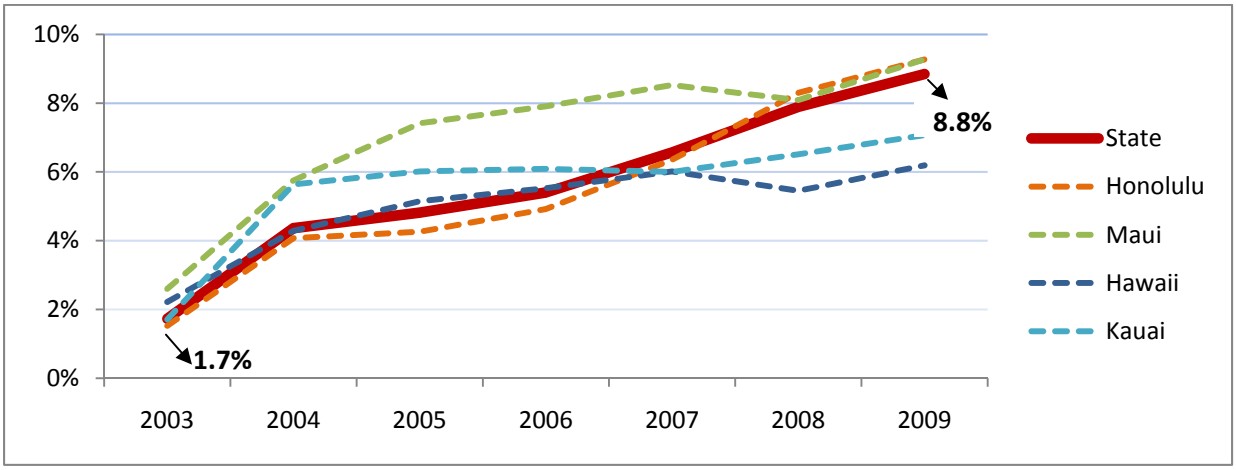
Table 1. Energy Efficiency Saving from 2003 to 2009 (GWh)

	2003[1]	2004	2005	2006	2007	2008	2009
Efficiency Saving (A)	179.6	479.8	533.0	603.7	744.2	890.5	982.8
- Renewable Displacement Technology	172.3	84.8	94.1	106.4	124.8	140.4	174.0
- Energy Efficiency Technology	7.3	395.0	438.9	497.3	619.4	750.1	808.8
Electricity Sale (B)	10,206	10,511	10,538	10,568	10,585	10,390	10,126
Total Electricity Demand (C=A+B)	10,386	10,991	11,071	11,172	11,329	11,281	11,109
Efficiency Saving/Electricity Demand (%)	1.7%	4.4%	4.8%	5.4%	6.6%	7.9%	8.8%

[1] Definition of Renewable Displacement Technology and Energy Efficiency Technology differs from other years.
Source: Hawaiian Electric Company, Inc. and Kauai Island Utility Cooperative, *Renewable Portfolio Standard Status Report*, various years.

Energy efficiency contributed the most on Oahu and Maui at 9.3 percent in 2009. Kauai and Big Island were a bit behind in accomplishing efficiency saving goals. In Kauai, 7.1 percent of the electricity demand was saved by energy efficiency programs, and 6.2 percent of the Big Island's electricity demand was saved through efficiency programs in 2009.

Figure 2. Efficiency Saving as Percentage of Total Electricity Demand



Source: Hawaiian Electric Company, Inc. and Kauai Island Utility Cooperative, *Renewable Portfolio Standard Status Report*, various years.

Electricity Generated from Renewable Sources

The current Hawaii RPS law requires that the share of electricity from renewable sources of total electricity sale has to be at least 10 percent by 2010 and 15 percent by 2015.

Act 162, 2006, allowed electrical energy savings displacement and electrical energy savings generated by certain energy efficiency technologies to count towards the RPS. Under the standard required by Act 162, the state of Hawaii already reached the 2010 goals in 2009. The combined share of the efficacy saving and the electricity from renewable sources of total electricity sale was 18.9 percent in 2009.

However, Act 155 in 2009 stated that starting from January 1, 2015, energy savings brought about by the use of energy efficiency technologies or renewables to displace or off-set electricity demand will no longer count towards compliance with the RPS. RPS must be entirely met by electricity generated from renewable energy sources.

Generating 929 gigawatt hours from renewable energy sources, the share of renewables was only 9.2 percent in 2009 under this new standard. Assuming a moderate increase in the electricity sale for the next 5 years, about 600 additional gigawatt hours needs to be generated from new renewable sources by 2015 to meet the new RPS requirement, which could be challenging given various uncertainties with the currently proposed renewable projects.

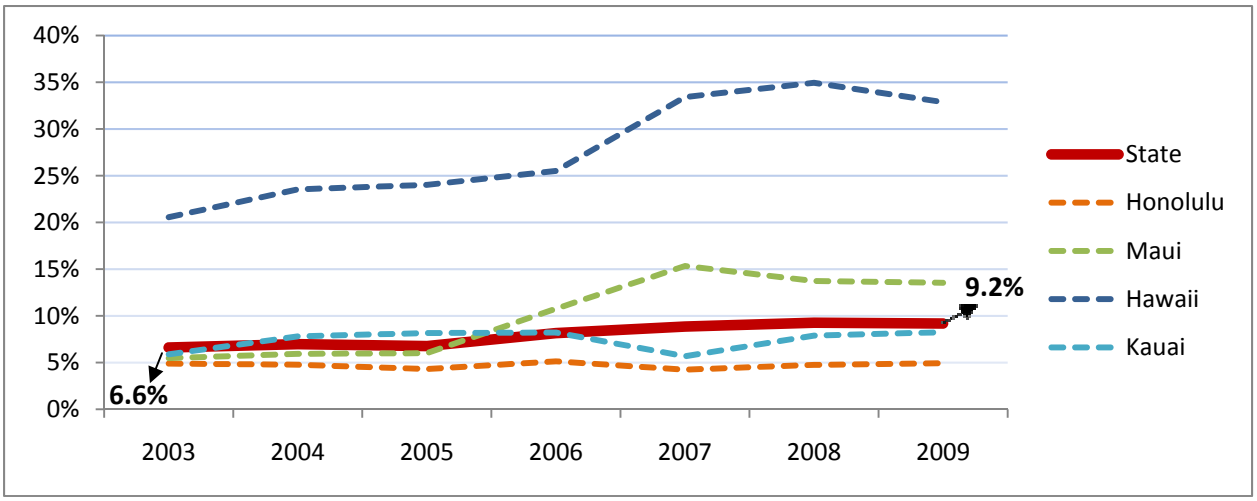
Table 2. Electricity from Renewable Energy Sources (GWh, %)

	2003	2004	2005	2006	2007	2008	2009
RPS (A+B)							
-Electricity from Renewable Sources (A)	674.4	732.9	712.7	861.3	937.6	963.5	929.0
-Efficiency Saving (B)	179.6	479.8	533.0	603.7	744.2	890.5	982.8
Electricity Sale (C)	10,206	10,511	10,538	10,568	10,585	10,390	10,126
A /C	6.6%	7.0%	6.8%	8.1%	8.9%	9.3%	9.2%
(A+B) / C	8.4%	11.5%	11.8%	13.9%	15.9%	17.8%	18.9%

Source: Hawaiian Electric Company, Inc. and Kauai Island Utility Cooperative, *Renewable Portfolio Standard Status Report*, various years.

While each island has been similarly performing in efficiency saving, the performance in generating electricity from renewable sources varies significantly by island depending on the availability of renewable sources. With abundant sources of renewable energy, the Big Island is way ahead of other islands in using renewable sources to generate electricity. Since 2007, it has been generating over 30 percent of its electricity sale from renewable sources such as wind, geothermal, and hydro.

Figure 3. Electricity Generated by Renewable as Percentage of Total Electricity Sale

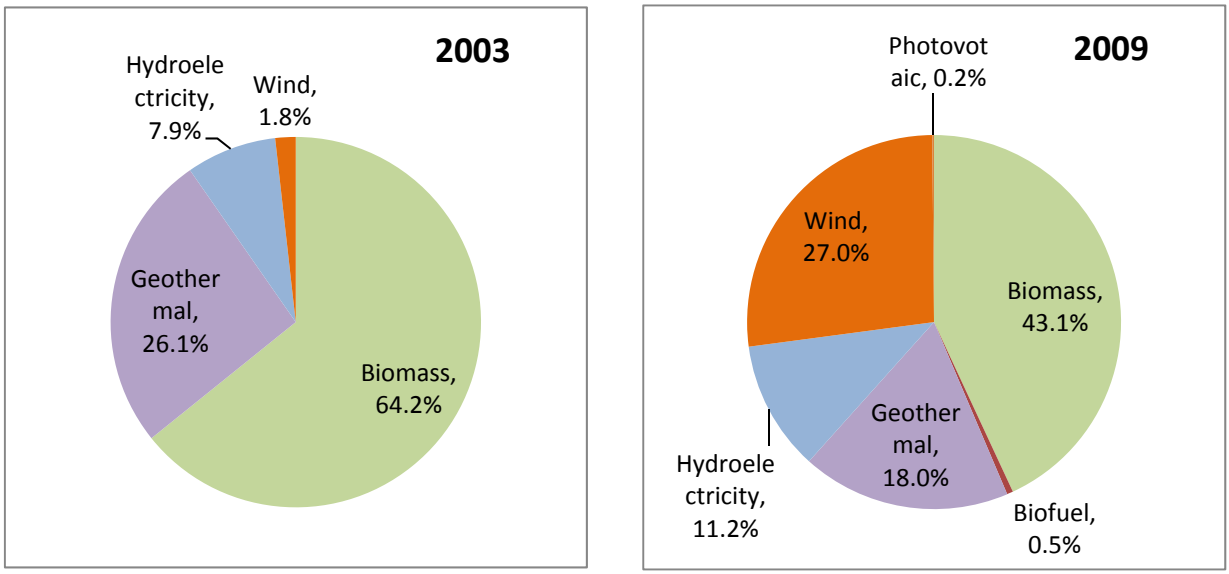


Source: Hawaiian Electric Company, Inc. and Kauai Island Utility Cooperative, *Renewable Portfolio Standard Status Report*, various years.

Renewable Energy by Sources

In 2003, biomass was the main source of renewable and accounted for 64.4 percent of Hawaii's renewable electrical energy sources. Due to the rapid growth in geothermal and wind energy, the share of biomass in renewable sources declined to 43.1 percent in 2009. Electricity generated from geothermal increased 33.3 percent between 2003 and 2008, but decreased sharply by 28.5 percent between 2008 and 2009. Electricity generated by wind was only 12 gigawatt hours in 2003 but jumped to 250.4 gigawatt hours in 2009.

Figure 4. Electricity Generated by Renewable Energies by Source (State total)



Source: Hawaiian Electric Company, Inc. and Kauai Island Utility Cooperative, *Renewable Portfolio Standard Status Report*, various years.

The only renewable sources on Oahu are biomass and biofuels, which generated 360.3 and 3.3 gigawatt hours of electricity, respectively, in 2009. Over the 2003 and 2009 period, biomass usage on Oahu has been flat.

Wind and biomass are two major sources of renewable energy for Maui County. In 2009, 38.4 gigawatt hours of electricity was generated by burning bagasse from a local sugar mill. It was a scale that was significantly downsized from 64 gigawatt hours in 2003.

A wind farm that was developed in 2006 on Maui helped the county to take a big step toward a clean energy future. Wind energy produced 110 gigawatt hours of electricity in 2009, representing 68 percent of total electricity from renewables and 9.2 percent of total electricity sales in Maui County.

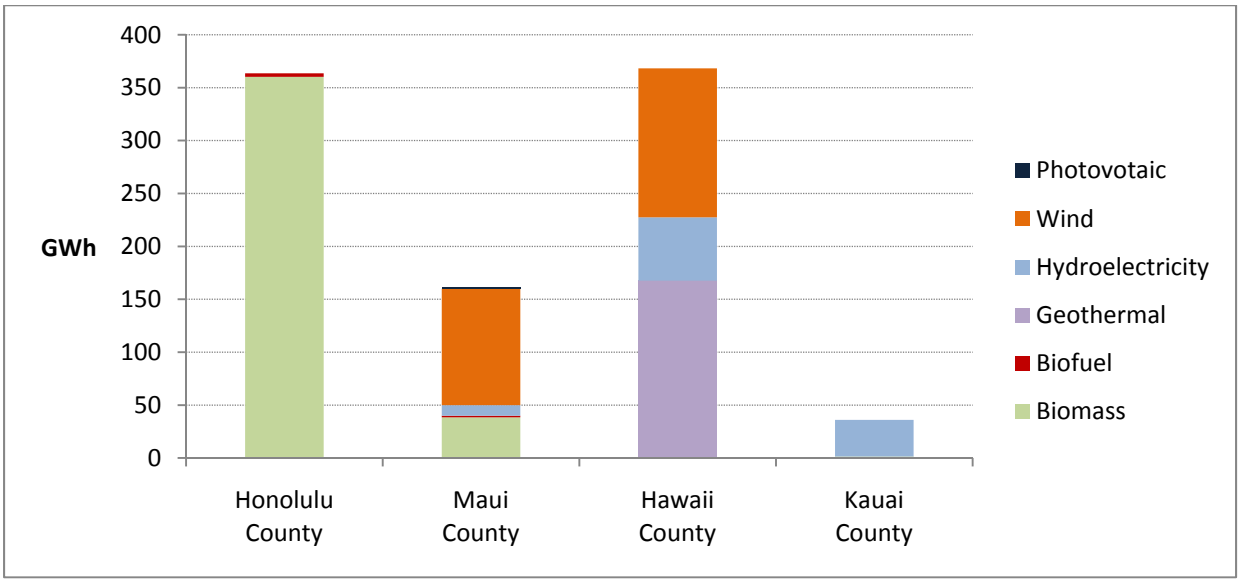
Generating 10 gigawatt hours in 2009, the role of hydroelectricity was relatively small in Maui County compared to other two sources.

In Hawaii County, the geothermal resource has been playing an important role in electricity generation. In 2009, 15% of the Big Island's electricity was generated by geothermal.

Wind energy that jumped in 2007, generating 116.4 gigawatt hours of electricity for that year, is the second largest renewable source in Hawaii County. The amount of electricity generated by wind increased to 140.7 gigawatt hours in 2009, accounting for 12.6% of the total electricity sales on the Big Island.

Hydroelectricity has been the main renewable source for Kauai, accounting for 7.9% of the total electricity sales in 2009. The hydroelectricity production has been flat in the past few years. Biomass was another source of renewable energy, but it generated only 1.4 gigawatt hours of electricity in 2009, 0.3% of the total electricity sales for that year.

Figure 5. Electricity Generated by Renewable Energy Sources by County (2009)



Source: Hawaiian Electric Company, Inc. and Kauai Island Utility Cooperative, *Renewable Portfolio Standard Status Report*, various years.

Renewable Energy Needed by 2030

If Hawaii is to achieve 70 percent clean energy by 2030 with 30 percent from efficiency measures and 40 percent coming from renewable sources, then how much renewable energy capacities would be needed to meet the goal?

Hawaiian Electric Company's Integrated Resource Plan in 2008 provides a long-term forecast of electricity sales on Oahu based on historical sales, economic conditions and known large projects. It forecasts a high growth in electricity demand until 2020 with the construction and operation of the Honolulu mass transit system, but a slower rate of growth through 2030, with an average of 1.23 percent annual growth over the forecast period from 2007 to 2030.

The 1.23 percent growth rate is higher than the 0.8 percent DBEDT forecast for average population growth, and lower than the 1.6 percent DBEDT forecast of the average real personal income growth for the period.

Forecasting the actual demand for electricity by 2030 is an exercise which exceeds the scope of this report. Therefore, for the purposes of this report, we accepted the 1.23 percent demand growth scenario to illustrate the relationship between the expected capacity and the state's goal.

It should be noted that the HECO forecast did not consider the potential change in the electricity demand due to changes in consumers' behavior. For instance, the increased use of electric cars may result in a quite bit of increase in electricity demand. Besides, the forecast was formulated before the recent global recession and needs to be adjusted to a post-recession year. The forecast was also elevated due to Honolulu mass transit system that is not applicable to other neighbor islands.

Despite these shortcomings, by using the 1.23 percent growth scenario the electricity demand in 2030 implied by Act 155 remains similar to the 2030 demand calculated here.

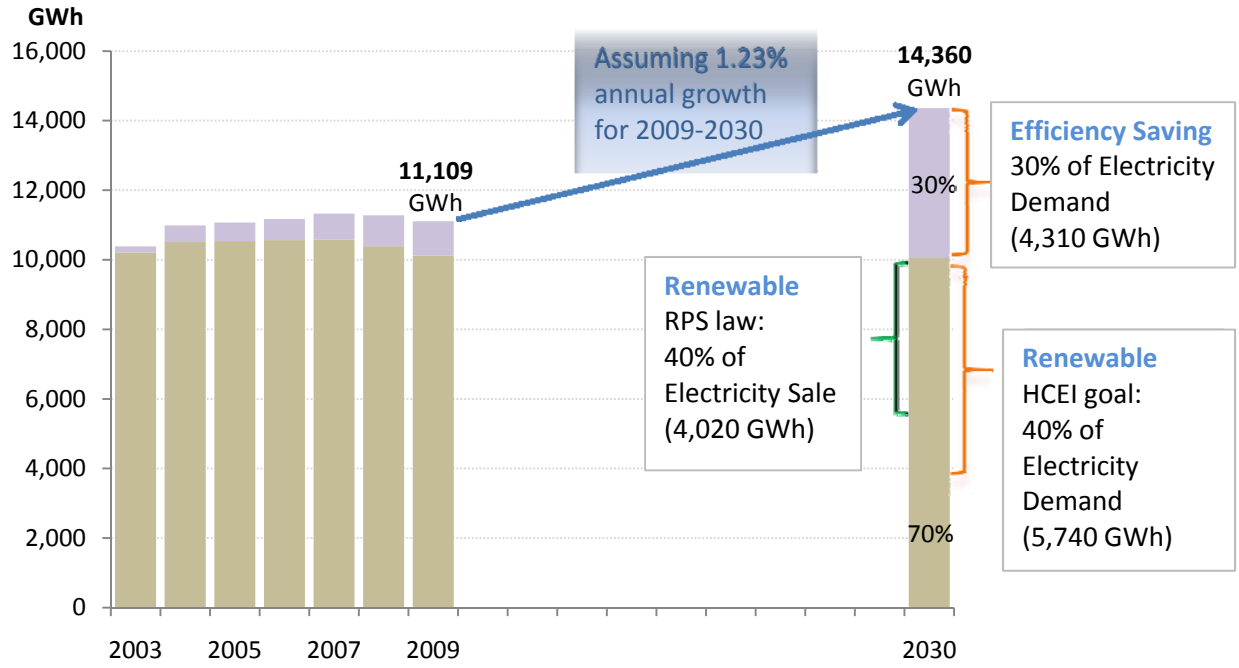
When defined as the sum of electricity sale and efficiency savings, total electricity demand of the state of Hawaii was 11,109 gigawatt hours in 2009 (see p6-7 for more discussion on the definition of electricity demand). Applying 1.23 percent annual growth to the period of 2009 and 2030, the electricity demand is forecast to reach about 14,360 gigawatt hours in 2030. This is similar to what legislators had in mind when they set a goal to reduce electricity demand by 4,300 gigawatt hours in Act 155, SLH, 2009.

HCEI set a goal to achieve 40 percent of electricity ***demand*** from renewable sources by 2030. However, Act 155, SLH, 2009 requires that 40 percent of electricity ***sales*** to be from renewable sources. The requirements by the two schemes are quite different because electricity demand will be much larger than electricity sales with efficiency savings.

If Hawaii can successfully reduce electricity demand by 4,300 gigawatt hours (30 percent of total demand) the sales of electricity in 2030 will be about 10,000 gigawatt hours. To achieve the goal set by HCEI, total electricity sales from renewable energy sources needs to be about 5,740 gigawatt hours by 2030, but 4,020 gigawatt hours from renewable sources will be enough to comply the current RPS law.

Figure 6. Projection of the Future Electricity Demand and Renewable Energy Needed

Source



Source: Hawaiian Electric Company, Inc. and DBEDT calculations.

Looking at the existing and currently proposed renewable projects in Hawaii, the state currently has 321 MW existing renewable generating capacity and about 1,127 MW proposed renewable generating capacity (detailed information will be provided in the next section). [2]

Although there are a number of uncertainties in the actual viability of each renewable project, in order to provide a brief summary of how Hawaii is doing so far in terms of capacity, this report estimate the amount of electricity generated from renewable sources assuming all current and proposed renewable projects will be in operation.

Calculating electricity generation requires two sets of information: capacity and annual operating hours by type of renewable energy sources. We estimated the future annual operating hours for each renewable source based on historical data (see Table 3 for historical annual operating hours by sources).

[2] It excludes the pumped storage hydropower and biofuel production

The projected 2030 annual operating hours for biomass, geothermal, and hydro are based on the average annual operating hours from 2004 to 2008. The projected 2030 annual operating hours for wind is assumed to be the same as the 2008 annual operating hours. For solar, and others, the annual operating hours is assumed to be 3,000 hours per year. The operating capacity for solar energy tends to be low due to limited availability of sun light in a day.

Table 3. Average Annual Operating Hours by Energy Source (Hours/Year)

	Fossil Fuel			Renewable energy sources					Total
	Petroleum	Coal	Other Gases	Biomass	Geo-thermal	Hydro	Wind	Solar	
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

Source: Calculated by DBEDT from EIA data.

Table 4 shows the estimated electricity generation from renewable energy sources when all current and proposed renewable projects are in full operation.

If all the proposed renewable projects listed in Table 5 are built by 2030, total electricity generated from renewable energy will be roughly 5,000 gigawatt hours, about 750 gigawatt hours less than the amount required by HCEI, but about 1,000 gigawatt hours more than the amount required by the current RPS law.

If Hawaii's renewable energy future is developed as proposed now, it is estimated that almost 70 percent of total electricity generation from renewables will be from wind or solar energy: 46 percent from wind and 23% from solar energy sources.

Table 4. Estimated Electricity Generated by Renewable Energy Sources

Type of Energy	Capacity of renewable energies			Estimated average annual operating hours[1]	Estimated electricity generated by renewables	
	Existing (MW)	Proposed (MW)	Total (MW)	(Hours)	(GWh)	(%)
Biomass	56	165	221	2,723	602	11.9%
Electricity from biofuel	110	0	110	3,898	429	8.5%
Geo-thermal	30	8	38	6,351	241	4.8%
Hydro	30.5	39.4[2]	69.9	3,960	277	5.5%
Solar	3.15	388.2	391.4	3,000	1,174	23.3%
Wind	91.1	526.2	617.3	3,750	2,315	46.0%
Total	320.7	1,126.8	1,447.5		**5,037**	100%

1. Estimated by DBEDT based on historical data from EIA.
2. The hydropower pumped storage with 300MW capacity is excluded because it is not new generation of electricity.
Source: DBEDT SID/READ.

Status of Hawaii Renewable Energy Development

Renewable energy is not new to Hawaii. Dating back as far as 1881, King David Kalakaua and Thomas Edison discussed whether it was feasible to generate geothermal electricity and transport that electricity to Oahu through an undersea cable.[3]

Despite the interest, available technologies and abundant resources, renewable energy as an industry did not take off for long time in Hawaii. Although there sometimes were oil price crisis threatening economies, petroleum was much more cost effective for most of the time. The inflation-adjusted price of oil remained under $25 per barrel since the mid-1980s until early 2000s, compared to over $100 per barrel in 2008 and 2011.

Now, Hawaii has made a commitment to 70% of Hawaii's energy consumption to come from clean energy sources by 2030 and it continues to make progress towards reaching its goal.

The Energy Office at DBEDT compiled information on current and proposed renewable projects in Hawaii from various sources. This section introduces the current status of Hawaii's renewable energy based on the information as of March 2011. Both publicly available and confidential information collected were used in the calculation of the aggregated total. However, any reference to a specific project in this section is based only on publicly available information.

Table 5 summarizes 32 existing and 68 proposed renewable energy projects by island and by source. The proposed projects are in various stages of the process. Some are close to completion while some are just proposed with many uncertainties until its realization.

Although the information on the proposed projects are subject to change in the course of Hawaii's journey to a clean energy future, putting all currently available information together in one place would help us to assess Hawaii's current progress toward its goals.

Solar

Hawaii is leading the nation in solar water heating systems. Hawaii is the first state to require solar water heater systems and is ranked first in the nation in solar water heater installed capacity, with 25% of single family homes having solar water heaters in 2010.[4]

As for commercial projects, currently only 4 projects with a combined capacity of 3.2 MW are in operation. However, solar power is an emerging source of renewable energy with 14 proposed projects, promising a combined capacity of 388 MW. Eleven of them are planned to be built on Oahu. The majority of these projects are photovoltaic systems (PV), which use solar cells to directly convert energy from the sun into electricity.

[3] DBEDT. Available: http://hawaii.gov/dbedt/info/energy/renewable/geothermal
[4] U.S. Solar Market Insight (October 2010).

Table 5. Renewable Energy Projects in Hawaii: Existing and Proposed (as of March, 2011)

Type of Energy	Capacity Unit	Existing Projects						Proposed Projects						
		State Total	Hawaii	Oahu	Maui	Kauai	Lanai	State Total	Hawaii	Oahu	Maui	Kauai	Molokai	Lanai
Battery storage	MW	0	0	0	0	0	0	1.5	NA	0	NA	1.5	0	0
		(0)[1]	(0)	(0)	(0)	(0)	(0)	(4)	(1)	(0)	(1)	(1)	(1)	(0)
Bio-digestion	MW	0	0	0	0	0	0	4.5	0	0	0	4.5	0	0
		(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(0)	(1)	(0)	(0)
Biofuel plantation	Acres	300	300	0	0	0	0	0	0	0	0	0	0	0
		(1)	(1)	(0)	(0)	(0)	(0)	(2)	(2)	(0)	(0)	(0)	(0)	(0)
Biofuel	MGY	1.755	0	1	0.75	0.005	0	89.9	58.7	NA	1.3	30	0	0
		(3)	(0)	(1)	(1)	(1)	(0)	(12)	(4)	(4)	(2)	(2)	(0)	(0)
Biomass	MW	56	0	46	10	0	0	165	106	37	0	22	0	0
		(2)	(0)	(1)	(1)	(0)	(0)	(11)	(5)	(3)	(1)	(2)	(0)	(0)
Electricity from biofuel	MW	110	0	110	0	0	0	0	0	0	0	0	0	0
		(1)	(0)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)	(0)
Geo-thermal	MW	30	30	0	0	0	0	8	8	0	NA	0	0	0
		(1)	(1)	(0)	(0)	(0)	(0)	(2)	(1)	(0)	(1)	(0)	(0)	(0)
Hydro	MW	30.5	14.7	0	6.3	9.5	0	339	0	0	NA	39	0	300
		(16)	(3)	(0)	(4)	(9)	(0)	(9)	(0)	(0)	(1)	(7)	(0)	(1)
Ocean thermal	MW	0	0	0	0	0	0	0	0	NA	0	0	0	0
		(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(1)	(0)	(0)	(0)	(0)
Sea Water AC	Tons	0	0	0	0	0	0		0	NA	0	0	0	0
		(0)	(0)	(0)	(0)	(0)	(0)	(2)	(0)	(2)	(0)	(0)	(0)	(0)
Solar	MW	3.2	0.5	0	0	1.5	1.2	388	0	369	0	20	0	0
		(4)	(1)	(0)	(0)	(2)	(1)	(14)	(0)	(11)	(0)	(3)	(0)	(0)
Synthetic natural gas		0	0	0	0	0	0		0	NA	0	0	0	0
		(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(1)	(0)	(0)	(0)	(0)
Wave	MW	0	0	0	0	0	0	0.5	0	0	0.5	0	0	0
		(0)	(0)	(0)	(0)	(0)	(0)	(1)	(0)	(0)	(1)	(0)	(0)	(0)
Wind	MW	91.1	31.1	30	30	0	0	526	10	70	42	0	204	200
		(4)	(2)	(1)	(1)	(0)	(0)	(8)	(2)	(1)	(2)	(0)	(2)	(1)
Total[2]		(32)	(8)	(4)	(7)	(12)	(1)	(68)	(15)	(23)	(9)	(16)	(3)	(2)

Source: DBEDT, SID/READ

1. In the parentheses are the number of projects.
2. Overall totals are not included because the units vary by type of energy.

A concentrated solar power (CSP) is another available technology to generate electricity using solar energy. Current capacity using CSP technology is very small at 5KW and a few projects for 5-10 MW capacity have been proposed on the island of Oahu and Kauai.

Wind

Wind is heavily influenced by factors such as terrain and weather. As a wind turbine turns, the blades of the turbine power an electric generator, creating electricity. According to the U.S. Department of Energy, Hawaii has good wind resources that are suitable for utility-scale production on each of the islands.

Wind power currently has the largest existing capacity, 91.1 MW. First Wind operates a 30 MW wind farm on the north shore of Oahu as well as a 30 MW wind farm on Maui. Kaheawa Wind Power facility on Maui began operation in 2006, while the 12 wind turbines in Kahuku began operating March 2011. A second phase of the Kaheawa facility is expected to be in operation by the end of 2011, adding an additional 21 MW of capacity.

Tawhiri Power and Hawi Renewable Development run 20.5 MW and 10.6 MW wind farms, respectively on the Big Island. Tawhiri Power runs the Pakini Nui Wind Farm, which has fourteen 1.5 MW turbines. First Wind is planning a second project on the North Shore of Oahu, named Kawailoa Wind, which can provide up to 70 MW of additional capacity.

Wind also provides the greatest potential capacity for the future. The combined capacity of 8 proposed projects in five islands amounts to 526 MW. As part of the interisland wind project, the biggest wind energy effort in the works, Pattern Energy Group, Molokai Properties' Molokai project and Castle & Cooke's Lanai project can provide up to 200 MW.

Hydroelectricity

Hydroelectricity depends on rainfall and the ability to capture water as it flows downstream. It has advantages of not generating emissions or polluting the water, but has the disadvantage of requiring high initial investment costs to construct dams and reservoirs.

Hawaii currently has 16 projects located on the islands of Hawaii, Maui and Kauai with combined capacity of 30.45 MW. The Wailuku River Hydroelectric Power Company, that began operating in May 1993, runs the largest hydroelectric plant in the state, providing 11 MW capacity.

A large proposed project on Lanai (300 MW) is in its infancy stage of planning. Lanai Hydro, LLC filed an application for a preliminary permit on June 10, 2010 to study the feasibility of the project, according to the Federal Register. This project is proposed as support to renewable energy. The idea is to store energy during times of high production and to release energy during times of high demand. Newly available wind power is presumed be used to pump water uphill.

Biofuel and Biomass

Current Hawaii law requires that 85 percent of gasoline sold in Hawaii must contain 10 percent ethanol. To date, there are no ethanol production facilities in operation in Hawaii. Existing bioenergy projects are all producing biodiesel.

Biomass energy is derived from organic matter such as wood, plants, residues from agriculture and forestry, and municipal and industrial wastes. In Hawaii, sugar mills have provided local utilities with electricity power for decades by burning bagasse. Currently, the Hawaiian Commercial and Sugar (HC&S) plantation on Maui, the last remaining sugar plantation in the islands, produces electricity for its operations, with 10-12 MW sold to Maui Electric Company.[5]

On Oahu, municipal trash has been burned to provide electricity. In operation since May 1990, the Honolulu Project of Waste Energy Recovery (H-Power) has been converting waste to energy with a capacity of 46 MW. H-Power now accounts for approximately 8% of Oahu's electricity.[6]

For the future, 11 biomass projects with combined capacity of 165 MW have been proposed on the islands of Hawaii, Oahu, Maui and Kauai.

Non-Commercial Projects

Included in Table 5 are companies that generate or store energy as a primary business function. Besides them, there also are a number of renewable projects that generate or store energy for personal use. Those non-commercial renewable projects are summarized in Table 6.

The existing non-commercial renewable projects are mostly small scale solar powered electricity generating stations with 2.7 MW combined capacity. At present, 12 more solar projects with 3.6 MW combined capacity are proposed on the islands of Oahu, Hawaii and Kauai. Besides, 1 biofuel and 1 hydro project are proposed to be built on the islands of Kauai and Hawaii, but both are at a very small scale.

[5] HECO, Hawaii's Energy Future, available at http://www.hawaiisenergyfuture.com/articles/Biomass.html
[6] Hawaii Clean Energy Initiative. available at: http://stage-hcei.ehawaii.gov/land/

Table 6. Non-Commercial Renewable Projects in Hawaii (as of March 2011)

Type of Energy	Capacity Unit	Existing Projects				Proposed Projects			
		State Total	Hawaii	Oahu	Kauai	State Total	Hawaii	Oahu	Kauai
Biofuel	MGY	0	0	0	0	3	0	0	3
		(0)[1]	(0)	(0)	(0)	(1)	(0)	(0)	(1)
Hydro	MW	0	0	0	0	0.07	0.07	0	0
		(0)	(0)	(0)	(0)	(1)	(1)	(0)	(0)
Solar	MW	2.7	0.7	2.0	0.01	3.6	0.3	2	1.3
		(10)	(1)	(8)	(1)	(12)	(2)	(2)	(8)
Wave	MW	0.04	0	0.04	0	0	0	0	0
		(1)	(0)	(1)	(0)	(0)	(0)	(0)	(0)
Total									
		(11)	(1)	(9)	(1)	(14)	(3)	(2)	(9)

[1] The number of projects is in the parentheses.
Source: DBEDT, SID/READ.

Conclusion

During the past decade, we have witnessed the increasing worldwide recognition of the potential role of renewable energy. By early 2010, at least 85 countries set policy targets and at least 83 countries had policies to promote renewable power generation. In the United States, 29 states have enacted renewable portfolio standard policies. Renewable electric power capacity accounted for about 25 percent of the world's total electric power capacity and renewable sources contributed 10.6 percent of total electricity generated in the U.S. in 2009.[7]

Hawaii began to give serious attention to renewable portfolio standards at the beginning of the 2000s. The first RPS goal was established in 2001 and was replaced by an enforceable law in 2004. The law has been expanded a few times in scope and ambition.

The targets in the current Hawaii RPS law are aggressive. The goals declared in the Hawaii Clean Energy Initiative are even more aggressive.

If all of the goals of HCEI are realized by the review period of 2030, the State will have achieved a remarkable feat that will be an enduring legacy for future generations: cleaner environment and secure and sustainable energy for economy. In the due course, it will also create vast economic development opportunities in all islands.

At this time, the potential resources and technologies to meet the state's energy initiative exist. However, developing new renewable projects involves many challenging issues relating to permitting, financial and technological risks, opposition by residents, and environmental issues.

With all these challenges, development of renewable projects does not appear to be proceeding at a pace that will achieve the stated goal. Unless the state is willing to expedite the development process, can secure political community consensus on development, and find adequate capital resources, the HCEI goals may prove challenging.

Solving our energy challenges will require joint community collaboration and a strong commitment to success. Nevertheless, given committed leadership and Hawaii's history of innovation and community cooperation, we believe that the renewable energy sector can grow and thrive.

[7] REN21 (2010). Renewables 2010 Global Status Report
http://www.ren21.net/Portals/97/documents/GSR/REN21_GSR_2010_full_revised%20Sept2010.pdf.
Energy Information Administration (April 2011). Electric Power Annual 2009.

APPENDIX

Hawaii's Energy Policy Timeline

Hawaii began proactively addressing energy issues in response to the 1973 energy crisis through a series of public and private actions. The State Legislature created the Energy Resources Coordinator in 1974, and in 1978 the Hawaii State Plan became law with goals to support Hawaii's energy needs through increased energy self-sufficiency. The State adopted numerous laws and policies to encourage development of Hawaii's renewable energy resources, and subsequent wind, geothermal and solar energy projects were undertaken and began to contribute electricity to Hawaii's electric utilities.

The drastic reduction in oil prices in the mid-1980s, and perception that past energy crises would not recur, considerably slowed energy self-sufficiency initiatives. Nonetheless in 1990, the State formulated the Hawaii Integrated Energy Policy Development Program and subsequently issued detailed Hawaii Energy Strategies in 1995, 2000 and 2007.

Subsequent hikes of oil prices and continuing price volatility brought renewed focus to Hawaii's energy dependency and vulnerability and heightened the need for concerted and sustainable action.

1974

- The legislature created the energy program and the position of Energy Resources Coordinator (Director of Hawaii's Department of Planning and Economic Development (DPED) per Act 73, 1974). HRS 196, relating to energy resources, and HRS 201-12, relating to a state program for energy planning and conservation, provide the legal basis. These statutory provisions were enacted as Act 237, 1974, and Act 240, 1974, respectively.
- The Hawaii Natural Energy Institute (HNEI) was formed by legislative action (Act 235, 1974). For several years, funding was channeled through DPED.
- The Natural Energy Laboratory of Hawaii (NELH) established by the Legislature at Keahole Point (Act 236, 1974). A 1971 study had proposed the site for OTEC research.

1975

- State begins pressing for a "component share" of the national Strategic Petroleum Reserve as insurance against disruptions in world oil supplies.
- State issues report, "Alternate Energy Sources for Hawaii."

1976

- State Energy Office established.
- First state law offering state tax credit for renewable energy.
- HGP-A demonstration geothermal well completed. At the time, it was known as the hottest in the world.

1977

- HGP-A demonstration geothermal generator receives U.S. Department of Energy (USDOE) funding. The well underwent a series of flow tests to determine its potential.

- University of Hawaii (UH) receives funding for Solar Meteorological Center and Training Site, which will provide statewide solar and wind resource data.
- A public opinion survey, conducted as part of DPED's Hawaii State Plan project, showed public support for development of indigenous energy resources.
- Hawaii State Plan was developed and submitted to 1978 Legislature. Objectives include increasing energy self-sufficiency, promoting the prudent use of power through conservation and efficiency, and maintaining dependable, efficient and economical statewide energy systems capable of supporting the needs of the people.
- Legislature passed, and Governor signed: Act 102, exempting non-fossil-fuel electricity sources (such as sugar plantations burning bagasse) from PUC regulation; and Act 195, imposing taxes on motor vehicles and for distributing liquid fuels, including diesel.
- Governor's 1978-1979 Executive Supplemental Budget contains $5 million in GO Bonds to increase research into natural energy, including over $1 million for essential facilities at the Natural Energy Laboratory of Hawaii.
- Publication of "Energy Use in Hawaii," a 52-page compilation of energy statistics essential for policy formulation.
- Energy audits conducted at UH, Honolulu International Airport, and other facilities.
- Completed design of Hawaii State Energy Conservation Program to allow federal funding support of Hawaii's energy efforts. Federal grant support for the year exceeded $500,000.
- Workshops were held to achieve consensus among building code and County Council officials regarding thermal and lighting standards.
- Grant awards totaling $1.3 million were received from the federal government to finance 10 solar demonstration projects.
- DPED's energy functions are handled by 2 offices: The State Energy Office (energy management and conservation) and the Center for Science Policy and Technology Assessment (alternate energy development.)

1978

- Legislature passed specific energy objectives for HRS Section 196 regarding a state energy program and a state energy resources coordinator. Exempts non-fossil fuel energy sources from PUC regulation. PUC begins to regulate relationship between utilities and IPP's.
- ERC reports more than 6,000 solar water heaters in Hawaii.
- Three major OTEC projects, involving more than $50 million, are underway.
- Legislature appropriated $10.5 million for energy research and development, CIP, and energy agency operating costs.
- Act 136, 1978, transferred ERC functions from Governor's Office to DPED.
- The Hawaii State Plan was enacted by the Legislature as Act 100, 1978. Development of the State Energy Functional Plan begins.
- Governor's Advisory Committee on Alternate Energy Development and the Hawaii Energy Conservation Council provide advice.
- Pertinent legislation includes: Act 19, providing tax credit for water heater insulation; Act 36, allowing counties to participate in joint ventures; Act 131, appropriating $3.8 million for alternative energy; Act 132, provides for establishment of rates to be paid by a utility to a producer of geothermal steam; Act 133,

requiring energy efficiency building standards developed by ASHRAE to be incorporated in county building codes; Act 134, requiring life-cycle costing in state and county procurement practices; Act 137, prohibiting sale or installation of gas appliances with pilot lights; Act 243, the supplemental appropriations act of 1978, provides $5.6 million for alternate energy R&D and redirects $280,620 from a 1977 appropriation to HNEI; Act 244, general improvement act of 1978, provides appropriations of $763,000 for various specific energy projects.

1981

- Hawaii Integrated Energy Assessment with U.S. Department of Energy looked at Hawaii's future and concluded that renewable resources would have to play a part.

1984

- Energy Functional Plan adopted – 43 actions were mandated including energy planning, conservation, land use planning, and management of the energy supply.
- Legislature took actions to further promote existing geothermal development by designating geothermal subzones.

1986

- Law enacted to allow state agencies to engage in performance contracting to achieve energy efficiency improvements.

1987

- DBEDT develops a plan for "import substitution" (sustainability) including energy. Legislature appropriates $3M for geothermal development exploration program.
- The state is involved in ocean surveys for a deep-water cable to bring geothermal power from the Big Island to Oahu.
- DBEDT sponsors 18 Ocean Thermal Energy Conversion (OTEC) demonstration projects at Natural Energy Laboratory of Hawaii Authority (NELHA).

1990

- Honolulu begins commercial conversion of garbage to electricity via incineration (H-Power).
- Legislation passed mandating that the counties adopt building codes based on ASHRAE 90.1-1989 standards.

1991

- State adopts the Hawaii Integrated Energy Policy – Recommendations on energy production and use, consideration of the environment, resource planning, energy development, energy emergency planning.
- Collaborative for Integrated Resource Planning (IRP) convenes to discuss establishing IRP, which includes Demand-side Management for conservation and efficiency programs for electric and gas utilities.

1992

- Implementation of first state performance contract by the University of Hawaii at Hilo, which resulted in about $10M savings over the life of the 10 year contract.

1993

- Commercial scale geothermal operations begin on the Big Island with Puna Geothermal Venture 30 MW plant.

1994

- State initiates study on commercial scale ethanol production in Hawaii. State initiates study on photovoltaic energy production in Hawaii. State initiates study on potential for large-scale wind energy production.

- Honolulu, Hawaii and Kauai counties adopt building energy codes.

1995

- Public Utilities Commission issued a Decision and Order directing utilities to develop IRP and DSM programs.

1996

- A comprehensive transportation-energy study concludes that renewable energy resources are not yet competitive for large-scale transition away from petroleum-based fuels. Recommendations include conservation and improved infrastructure.

- A PUC report warns against trying to create a renewable energy sector based on tax credits, rebates, low-interest loans and other incentives. At the same time, the PUC notes that "fossil fuels have received and continue to receive far more direct and indirect subsidies than do renewable energy resources."

1997

- The Hawaii Energy Strategy program (HES) produced a comprehensive set of recommendations to increase the diversification of Hawaii's energy supplies, energy efficiency and conservation, and use of renewable energy resources. In addition, a transportation energy strategy provided a phased plan for reducing oil consumption in the transportation sector.

- Act 257 of the Hawaii Revised Statutes required oil producers, refiners, marketers, oil transporters, and oil storers to report data to DBEDT. The new law (Act 257) also called for the establishment of a voluntary Petroleum Advisory Council consisting of eleven members representing retail service stations, independent dealers, petroleum jobbers and refiners, as well as staff from DBEDT, the Attorney General's Office, and the Dept. of Commerce and Consumer Affairs.

- Established the Rebuild Hawaii Program with federal funding.

- The Hawaii Electric Vehicle Demonstration Project continued throughout 1997, with 35 sedans and light trucks, three buses, one trolley, and one electric boat in use.

- Enabling legislation for performance contracting was amended to increase the allowable term of contracts from 10 to 15 years.

- Hawaii received a $255,000 grant from the U.S. Department of Energy to develop guidelines for energy efficient residential buildings. The guidelines promoted cost effective, energy-saving materials, equipment, and practices for locally built homes.

1998

- The State Plan, enacted into law as Chapter 226 of the Hawaii Revised Statutes, called for:
    - Dependable, efficient, and economical statewide energy systems capable of supporting the people's needs;
    - An increased proportion of indigenous energy use to improve self-sufficiency; and greater energy security.

- By law, the state's energy policy also requires that the total costs and benefits of all energy resource options, including efficiency, be compared.

1999

- On the Big Island, approximately 30 percent of electricity is generated from non fossil fuel sources. This is a higher percentage than any other island in the State, and is also higher than California. The facilities

include HELCO-owned hydroelectric plants on the Wailuku River north of Hilo and its wind facility at Lalamilo

- President Clinton issued Executive Order 13123, entitled, "Greening the Government through Efficient Energy Management." It set the following goals for government agencies:
  - Reduce greenhouse gas emissions by 30% by 2010 compared to 1990;
  - Reduce energy use per gross square foot by 30% by 2005, and 35% by 2010, relative to 1985;
  - Increase use of renewable energy;
  - Reduce use of petroleum and switch to less greenhouse gas intensive energy sources;
  - Reduce total greenhouse gas emissions; and
  - Conserve water.

2000

- Hawaii Energy Strategy 2000 – Reinforced need for renewable energy development but acknowledged non-competitive pricing.
- Slightly over $2.4 million in State and federal funds were budgeted for Hawaii energy programs in fiscal year 2000-01.

2001

- Act 272, Relating to Renewable Energy Resources mandated that Hawaii create “renewable portfolio standards” (RPS). The law set the following goals for utilities’ use of renewable energy:
  - 7% by 2003;
  - 8% by 2005; and
  - 9% by 2010.
- The counties of Honolulu and Kauai require updated building energy code based on ASHRAE 90.1-1999 standards and R-19 insulation—or equivalent technologies—in all new residences, and in renovations and additions over 100 square feet. This is the first time such measures are being applied to non-air conditioned homes on Oahu.
- Act 143, relating to Energy Content of Fuels, is another legislative measure which will encourage the use of renewable energy. The law adjusted the State fuel tax to reflect the energy content of alternative fuels, and reduced the fuel tax on alternative fuels for several years.
- The net metering law, Act 272, limited individual systems to no more than 10 kilowatts of capacity. It also provided that utilities do not need to accept additional net-metered generators once those on the system reach a total of 0.5% of the utility’s peak electricity demand. Net metering allows the owners and operators of small, renewable energy facilities to sell surplus electricity to the utilities at the same retail rate they pay to the utilities for purchased electricity.

2002

- Act 77 (SLH 2002) took effect on May 31, 2002, required that State buildings significantly reduce their energy consumption in the coming decade.
- Act 77 also prohibited regular unleaded gasoline sales by petroleum manufacturers, wholesalers or jobbers to either dealer-operated or independent retail service stations, as well as to another jobber or wholesaler, for more than the maximum pre-tax wholesale price. Retailers may not sell self-service regular unleaded gasoline to the public for more than the established maximum pre-tax retail price. The maximum pre-tax price margin would be the same for retailers statewide.
- In 2002, DBEDT in partnership with the Department of Health and the Chamber of Commerce of Hawaii initiated the Hawaii Green Business Program. The program provides recognition to hotels and resorts that go beyond environmental compliance, to achieve high levels of energy and resource efficiency. The program has expanded to include offices, retail and restaurant and food service entities as well as instituted the Hawaii Green Government Challenge.

- In 2002, DBEDT was awarded special funding for five new energy efficiency and renewable energy projects totaling $450,000.

- Federal funding for energy projects in 2002 included:
  - $450,000 for Phase 1 of the Hawaii Hydrogen Power Park,
  - $106,244 for Rebuild Hawaii,
  - $100,000 for Managing High Saturations of Distributed Energy Resources as a Microgrid on the Big Island,
  - $70,000 for evaluating Bulk Energy Storage to Relieve Transmission Congestion on the Big Island,
  - $30,000 for promulgation of Hawaii Residential Model Energy Codes,
  - $1.5 million Department of Defense appropriation for a hydrogen fuel cell research facility.

2003

- Nearly $3 million in Federal and State funds were dedicated to a wide variety of energy initiatives:
  - Utility projects supported by Federal contracts, totaling $1.3 million, included administrative rulemaking, energy emergency preparedness, an initiative for international technology exports, state energy policy planning, research into renewable energy resources, energy storage, distributed energy resources, and a hydrogen power park.
  - $834,844 was allocated to the buildings sector, which encompasses building guidelines, the Model Energy Code, the Rebuild Hawaii consortium, technical assistance to State and County agencies, and innovative energy systems.
  - $218,863 in Federal grants, includes projects in resource efficiency, technology innovation, and the Hawaii Environmentally Preferable Purchasing Program.
  - Alternative fuels in the Transportation sector received $145,305 in Federal support.

- Governor issued new administrative rules implementing a 10-year-old law mandating that ethanol be added to gasoline sold in Hawaii.

- New law reduces total state fuel taxes by 50 percent for ethanol, methanol, biodiesel and other alternative fuels, excepting liquefied petroleum gas, starting in calendar year 2004.

- Kauai County passed an ordinance providing a 100% County fuel tax exemption for alternate fuels. While all Counties provide alternative fuel tax incentives, only Maui and Kauai provide 100 percent exemptions for biodiesel.

2004

- Act 95, Session Laws of Hawaii 2004, replaced Hawaii's original renewable portfolio standard (RPS) goal was replaced with an enforceable standard. Under the new standard, 20 percent of Hawaii's electricity is to be generated from renewable resources by the end of 2020. Each electric utility is required to achieve the following percentages of net electricity sales from renewables:
  - 7% by Dec. 31, 2003;
  - 8% by Dec. 31, 2005;
  - 10% by Dec. 31, 2010;
  - 15% by Dec. 31, 2015; and
  - 20% by Dec. 31, 2020.

- Governor suspends gasoline pricing controls under Act 77.

2005

- The Maui County energy efficient Building Code took effect in early 2005, joining the other three Counties which had already adopted versions of the Model Energy Code.

2006

- Act 96 passed and included the following provisions:

- Funding for at least four public school photovoltaic systems on different islands;
- Updating policies to promote efficiency in state buildings and vehicles; and
- Hiring staff at DBEDT and the Dept. of Education to coordinate energy efficiency projects.

- Act 162 passed which allowed electrical energy savings displacement and electrical energy savings generated by certain energy efficiency technologies to count towards the RPS. Act 162 also directed the Public Utilities Commission to:
  - Consider establishing a public benefits fund to promote efficiency and renewables;
  - Share the risk of escalating fossil fuel costs between the utility and its customers; and
  - Penalize utilities which do not achieve the goals of the Renewable Portfolio Standards law, while modifying definitions for renewable energy.

- Act 240 emphasized energy self sufficiency by:
  - Increasing the dollar caps on tax credits for solar thermal, photovoltaic and wind installations that had been in place since the 1970's; Making these tax credits permanent;
  - Establishing a pilot project to fund residential solar water heaters with savings from utility bills;
  - Creating a statewide alternative fuel standard, to reach 20 percent by 2020 and including a biodiesel purchasing preference for state vehicles;
  - Providing venture capital and other support to manage the state's transition to a renewable hydrogen economy; and
  - Funding biofuels projects including a statewide production assessment.

- Governor directs state agencies to outline their activities which comply with the new energy legislation as well as previous Administrative Directives. Emphasizing the importance for the state to "lead by example," agencies expand their efforts to construct buildings which meet LEED standards, purchase energy-efficient vehicles and Energy Star office equipment, and streamline permits for renewable energy projects, among other activities.

- Established the Lead by Example program for state agencies to increase energy efficiency and use of renewable energy technologies which authorized two positions and $500,000 in program support. Energy savings for 2010 resulted in $20M reduction in state electricity cost from electricity costs for 2009.

- In the spring of 2006, Hawaii's gasoline dealers, obeying a legislative mandate, began statewide marketing of E10-Unleaded, a fuel blend containing 90% unleaded gasoline and 10% ethanol.

2007

- The State Legislature requires that the state and counties adopt building energy codes based on the International Energy Conservation Code.

2008

- Hawaii Clean Energy Initiative, a comprehensive agreement to decisively move the state away from its dependence on fossil fuels for electricity and ground transportation was announced in October 2008. This effort, between the state and U.S. Department of Energy, seeks to move Hawai‘i toward having 70 percent of its energy use come from clean energy sources by 2030. Major highlights of the agreement included:
  - A commitment to integrate as much as 1100 megawatts (MW) of already identified additional renewable energy on the Hawaiian Electric companies' grids (700 MW to be implemented within five years).
  - The construction of an undersea cable connecting Maui, Moloka‘i and Lāna‘i into one electrical grid to allow the integration of an additional 400 MW of renewable wind power generated in Maui County for transmission to O‘ahu.
  - A requirement that 40 percent of electric power come from renewable resources by 2030, doubling the current Renewable Portfolio Standard requirement law.
  - A "feed-in" tariff system designed to dramatically accelerate the addition of renewable energy from new sources by providing published purchased power prices for renewable power providers, which would encourage increased development of alternative energy projects.

- Seeking prompt approvals from the Hawai‘i Public Utilities Commission for the immediate deployment of advanced meters and for implementation of time-of-use rates that reward customers with lower electric rates for using power during off-peak times.
- Changing the way Hawaiian Electric is compensated by moving away from a business model that places reliance on increased electric sales.
- Commitment from the Hawaiian Electric companies to retire older fossil fuel powered energy generation plants.
- Conversion of existing fossil fuel generators to renewable biofuels, ultimately using crops grown locally and in a sustainable manner.
- A prohibition on the construction of any new coal plants in Hawai‘i.
- Expanding the Pay-As-You-Save program under which customers can install solar water heating systems without having to pay money up front, but can acquire energy-saving improvements through shared savings on their electric bills.
- Eliminating existing system-wide caps on net energy metering to allow customers on each island to produce their own renewable energy and obtain credit on their electric bills for any excess exported to the grid.
- Submitting a proposal to the PUC for establishment of “lifeline” rates, which provide a cap for certain low income customers.
- Committing the state and Hawaiian Electric Companies to a program that will identify and implement incentives needed to encourage adoption of electric vehicles for individual and fleet use, and also lead by example by acquiring hybrid or electric-only vehicles for government and utility fleets.

- USDOE awarded DBEDT $9.5 million in Energy Efficiency and Conservation Block Grant funds. The grant includes funding for DAGS and DHHL, which will used the funds for photovoltaics, solar water heaters, and efficient lighting. DBEDT used the grant to augment current rebate programs to retrofit government and nonprofit buildings with energy-efficient appliances and lighting.

2009

- The Hawaii RPS was significantly expanded again by Act 155 as follows:
  - 10% of its net electricity sales by December 31, 2010;
  - 15% of its net electricity sales by December 31, 2015;
  - 25% of its net electricity sales by December 31, 2020; and
  - 40% of its net electricity sales by December 31, 2030.

- Act 155 also created a separate Energy Efficiency Portfolio Standards (EEPS), which set a goal of 4,300 gigawatt-hour (GWh) reduction in electricity use by 2030.

- Act 155 also stated that starting from January 1, 2015, energy savings brought about by the use of energy efficiency technologies or renewables to displace or off-set electricity demand will no longer count towards compliance with the RPS. RPS must be entirely met by electricity generated from renewable energy sources.

- The City and County of Honolulu and Maui County adopt the updated International Energy Conservation Code – 2006, modified for Hawaii conditions.

- The legislature mandates that new homes in the state include solar hot water heating unless a variance is granted to install “instant-on” gas water heater.

- First power purchase agreement implemented by a state agency which provided nearly 1 MW of photovotaics installed at State Department of Transportation Airports and other facilities.

2010

- The Hawaii Public Utilities Commission (PUC) issued decisions on two landmark issues—decoupling and feed-in tariffs (FIT)—which will change the way the utilities operate and facilitate renewable energy development.

- In the fall of 2010, FITs for renewable technologies—photovoltaics, concentrated solar, hydropower and wind—took effect. There are separate rates for projects of up to 20 kilowatts (kW), and for those generating more than 20 kW. Ceilings vary by technology and by island.
- The HECO companies' Tariff Rule 14H governs the interconnection standards and procedures for distributed generation facilities connecting to, and operating in parallel with, the utility grid. Due to concern by DBEDT and other parties, the PUC opened a docket in 2008 to examine proposed revisions to the tariff.
- HECO filed a petition seeking exemption from the PUC's Competitive Bidding framework for Castle & Cooke's proposed 20 MW Mililani Solar Park, which would consist of four contiguous 5-MW facilities, separately owned. The e Competitive Bidding Framework requires all renewable energy projects with capacities greater than 5 MW to submit competitive bids to HECO in response to a HECO request for bids.
- A new statewide building energy code incorporates Hawaii-specific amendments. The code was based on International Energy Conservation Code (IECC) 2006 and was adopted by the state in June 2010.
- Instituted law mandating solar water heating systems for new single family homes.
- A rebate program for Energy Star refrigerators was conducted under the Hawaii Energy Efficiency Program using American Recovery and Reinvestment Act (ARRA) funds.
- Hawaii was named as one of the top four energy-saving states in the nation by the American Council for an Energy-Efficient Economy (ACEEE) when it announced the winners of its inaugural Energy-Efficiency Award. ACEEE, a Washington, D.C. based nonprofit, cited the state's Lead by Example program, administered by DBEDT.
- The County of Kauai adopts the International Energy Conservation Code – 2009.
- The City and County of Honolulu adopts the International Energy Conservation Code – 2010, modified for Hawaii's conditions and exempting residences which are not air conditioned.
- DBEDT awarded $74,000 competitive grant from the US Environmental Protection Agency Region IX, in support of a Green Internship Program to hire student interns to assist with the expansion of the Hawaii Green Business and Green Government Challenge Programs.

Glossary

Clean energy: Clean energy is any energy that causes little or no harm to the environment. Wind energy, solar energy (in all its forms--photovoltaic, geothermal, solar thermal, etc.), hydrogen and fuel cells, wave and tidal energy, and biomass are all examples of clean energy. In this portal, clean energy encompasses "green" and "renewable" energy, but also includes entities such as building systems and enhanced conventional power.

Renewable electrical energy: Electrical energy generated using renewable energy as the source + electrical energy savings.

Renewable energy: Energy generated or produced using the following sources: (1) wind; (2) the sun; (3) falling water; (4) biogas, including landfill and sewage-based digester gas; (5) geothermal; (6) ocean water, current, and waves, including ocean thermal energy conversion; (7) biomass, including biomass crops, agricultural and animal residues and wastes, and municipal solid waste and other solid wastes; (8) biofuels; and (9) hydrogen produced from renewable energy sources.

Electrical energy savings: Electricity savings brought about by (1) the use of renewable displacement or off-set technologies, and (2) the use of energy efficiency technologies

Renewable displacement or off-set technologies include solar water heating, seawater air conditioning district cooling systems, solar air-conditioning, and customer-sited, grid-connected renewable energy systems. As stated in Act 155, Hawaii Session Law 2009, beginning January 1, 2015, electrical energy savings shall not include customer-sited, grid-connected renewable-energy systems.

Energy efficiency technologies include heat pump water heating, ice storage, ratepayer-funded energy efficiency programs, and use of rejected heat from co-generation and combined heat and power systems, excluding fossil-fueled qualifying facilities that sell electricity to electric utility companies and central station power projects.

Renewable portfolio standards (PRS) Under the RPS, each electric utility company that sells electricity for consumption in Hawaii must establish the following percentages of "renewable electrical energy" sales:

10% of its net electricity sales by December 31, 2010;
15% of its net electricity sales by December 31, 2015;
25% of its net electricity sales by December 31, 2020; and
40% of its net electricity sales by December 31, 2030

Demand Side Management refers to actions taken on the customer's side of the meter to change the amount or timing of energy consumption. Utility DSM programs offer a variety of measures that can reduce energy consumption and consumer energy expenses. Electricity DSM strategies have the goal of maximizing end-use efficiency to avoid or postpone the construction of new generating plants.

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