Hawaii Energy Facts & Figures

January 2013

DBEDT STATE OF HAWAII

State of Hawaii Department of Business, Economic Development and Tourism

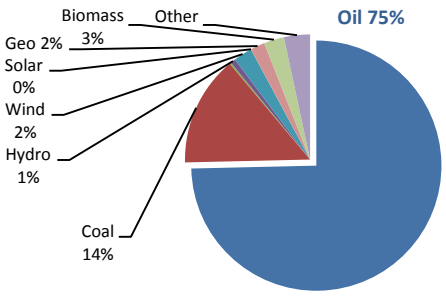
Hawaii State Energy Office

energy.hawaii.gov

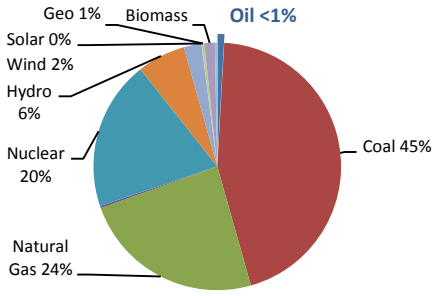
Hawaii Energy Overview

Hawaii is the only state that depends so heavily on petroleum for its energy needs. Whereas less than 1% of electricity in the nation is generated using oil, Hawaii relies on oil for 75% of its electricity generation.[1]

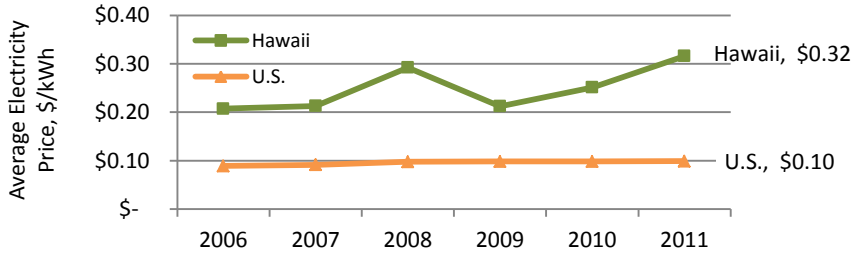
Hawaii Electricity Production, By Source, 2010



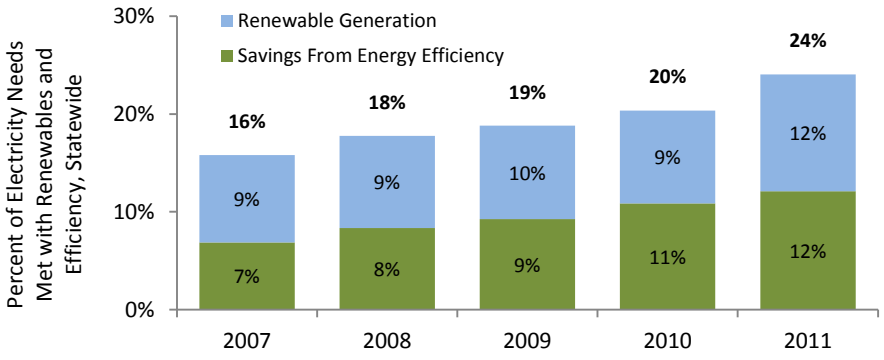
U.S. Electricity Production, By Source, 2010



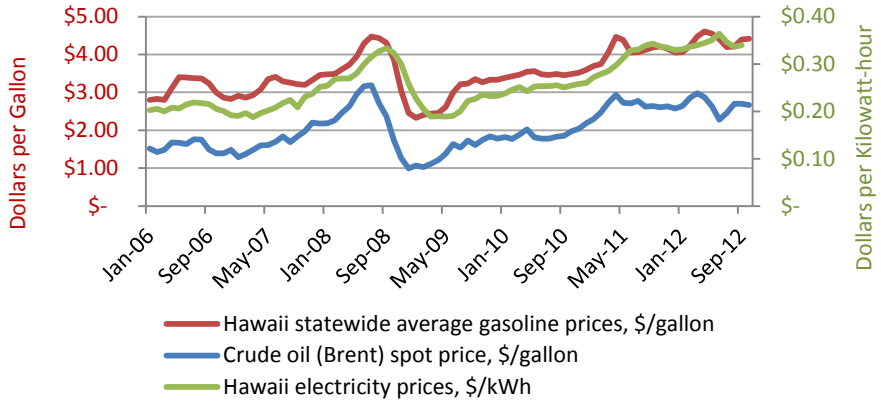
Hawaii's **electricity prices are three times higher** than the U.S. average.[2]



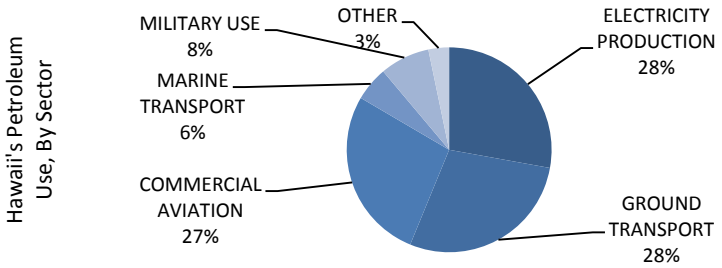
Although Hawaii's electricity production and costs are still heavily reliant on oil, **energy efficiency and renewable energy have been increasing**[3] in all counties.



In Hawaii, both electricity and gasoline prices **follow the price of petroleum**. The graph below shows the prices of Brent crude oil, gasoline, and electricity.[4]



Electricity and gasoline are just part of Hawaii's energy picture. Large quantities of jet fuel are also used (this is different from the Mainland, where most petroleum is used for ground transportation). In Hawaii, roughly equal amounts of petroleum are used for electricity production, ground transportation, and commercial aviation, with the rest used for marine transport, military, and other uses.[5]



Statewide electricity generation capacity (gigawatts)	**2.3**	Total petroleum use (million barrels per year)	**43**
Renewable Energy (RE) generation capacity (gigawatts)	**0.5**	Total petroleum use (million gallons per year)	**1800**
Statewide electricity generation (terawatt-hours)	**10**	Fuel for electricity production (million gallons per year)	**500**
Statewide % of electricity from renewables (2011)	**12%**	Jet fuel (million gallons per year)	**500**
Average monthly residential electricity use (kWh)[6]	**600**	Fuel for ground transportation (million gallons per year)	**500**
Average monthly residential electricity bill	**$200**	Average monthly gasoline cost/vehicle[7]	**$158**

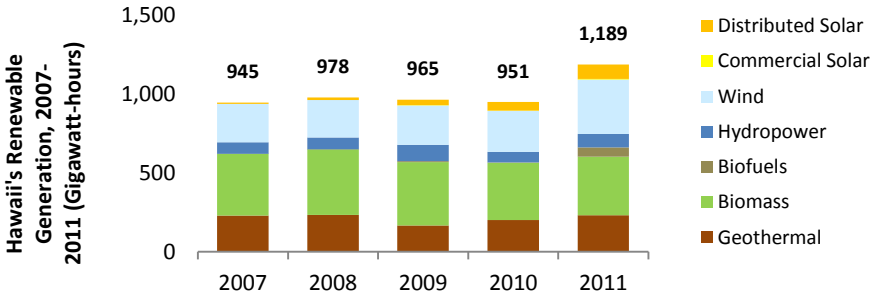
*See Appendix for all footnotes.

Renewable Energy

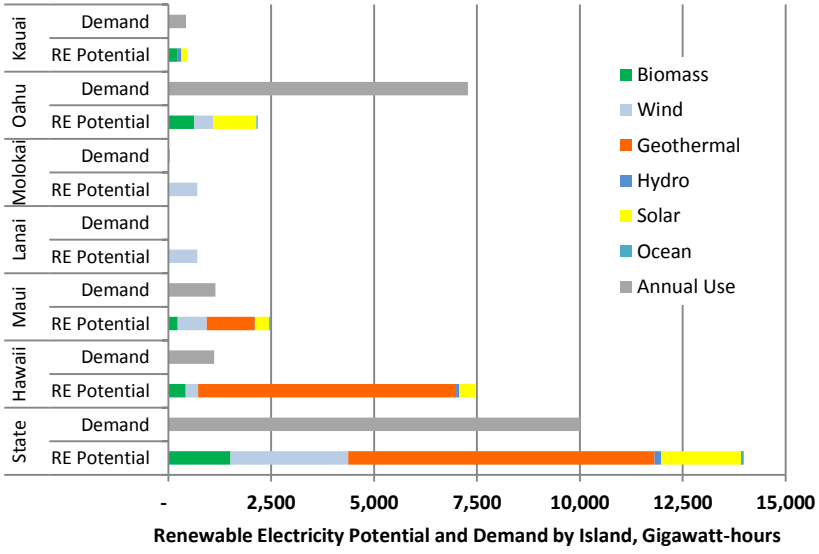
"Renewable Energy" is[1] energy from:

- Sun (i.e. solar)
- Wind
- Falling water (i.e. hydropower)
- Bioenergy, including biomass (e.g. crops, agricultural and animal residues, municipal and other solid waste); biofuels, and biogas
- Geothermal
- Ocean water, including ocean thermal energy conversion (OTEC) and wave energy
- Hydrogen produced from renewable energy sources

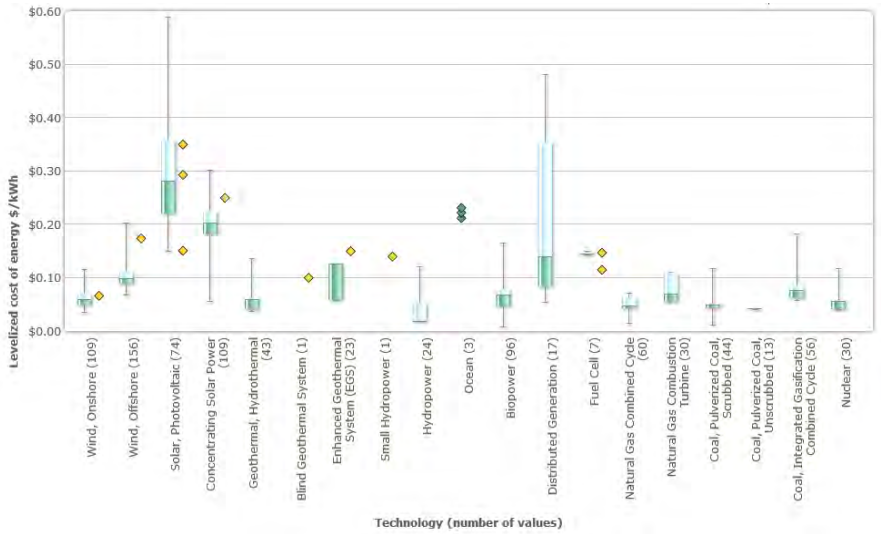
In 2011, 12% of Hawaii's electricity was generated from renewable sources. Renewable electricity production is primarily from bioenergy, wind, and geothermal, with solar increasing rapidly.[2]



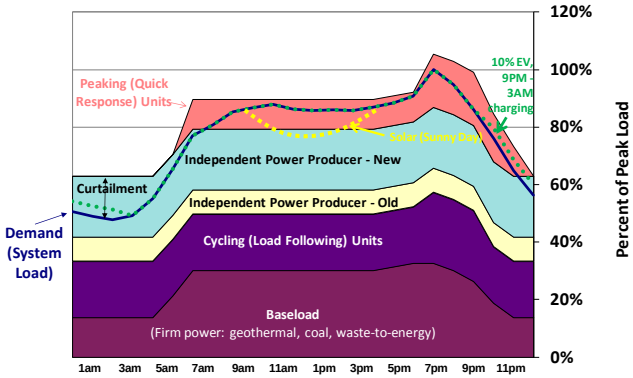
Renewable resource potential, statewide, is greater than current electricity demand.[3] Since electricity must be used, transmitted, or stored at the instant it is produced, practical use of most renewable resources is constrained by time and location of production.



"Levelized Cost of Energy" is the price per kilowatt-hour in order for an energy project to break even; it does not include risk or return on investment. Costs (land, construction, labor) are different for every project. The Transparent Cost Database[4] compiles cost information; results are shown in the chart. Yellow diamonds are US Department of Energy estimates.



Baseload generation facilities produce energy at a constant rate. They are generally not able to react (ramp up or ramp down) quickly. Dispatchable (cycling and peaking) units produce power when called upon by the utility, to fill gaps between production and load; they can ramp up and down quickly. Photovoltaic and wind systems (often independent power producers) provide intermittent (as-available) energy. At times of low load, they may be curtailed (i.e. energy may not be purchased even if it is available). Electric vehicle charging, if managed so that it occurs at times of low load, can use otherwise curtailed energy.



Percent of Hawaii's electricity from renewable sources (2011)	**12%**	Renewable generation required (i.e. Renewable Portfolio Standard, "RPS") by 12/31/2015[5]	**15%**
Renewable generation required (RPS) by 12/31/2020	**25%**	Renewable generation required (RPS) by 12/31/2030	**40%**

Bioenergy

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

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

Hawaii's demand for liquid fuels – currently made from petroleum – is shown below. Locally-produced biofuels could be blended with several petroleum-based fuels listed in the table.

Hawaii's Liquid Fuel Demand (approximate)

Use	Fuel	Petroleum-based fuels (million gallons per year)[1]	Biofuel (mgpy)	Goal
ELECTRICITY PRODUCTION	Fuel Oil	390		
	Diesel	90	4	
	Naphtha	30		
GROUND TRANSPORTATION	Gasoline	400	40	
	Diesel	50	1	
COMMERCIAL AVIATION	Jet Fuel	450		
MARINE TRANSPORTATION	Bunker Fuel	70		
	Diesel	130		
MILITARY USE	JP8 Jet	80		25% (32 mgpy) renewable by 2018
	JP5 Jet	10		
	Diesel	40		
OTHER USES	Methane, Propane	60		
TOTAL (Rounded)		**1800 mgpy (1.8 billion gallons/yr)**		

Bioenergy facilities:

- Kauai: Green Energy is building a 6.7 megawatt biomass-fired generator that will produce 11% of Kauai's electricity once completed.
- Oahu: H-POWER[2] produces 4 - 5% of Oahu's electricity from trash.
- Maui:
  - Hawaiian Commercial and Sugar (HC&S) generates 10% of Maui's electricity from the fiber (bagasse) by-product of sugar production.
  - Maui County is planning a 15 MW waste to energy and a 1 MW landfill gas facility.
- Hawaii Island: Hu Honua is developing a 21.5 MW facility that will produce 10% of the Big Island's electricity when completed.

Waste materials (such as used cooking oil) and by-products from food, feed, or fiber production, although limited in quantity, are often the first bioenergy feedstocks, due to their relatively low cost and the need for reduced waste management costs.

Since biodiesel fuel imports for electricity production began in 2010, the relative cost per gallon of the imported biodiesel fuel has been significantly higher than for the fossil-based fuels used for electricity generation in Hawaii[3] (2011 average per gallon: fuel oil, $2.81; diesel, $3.07; biodiesel, $5.22).

Crops may also be cultivated to produce biomass materials (oils, fiber, sugar) usable for electricity or fuel production.

Studies indicate that 136,000 suitable acres could be available without displacing current farming in Hawaii; with biomass production of 10 - 20 tons of fiber per acre per year, potential would be about two (1.4 - 2.7) million tons of biomass per year.[4] Two million tons of biomass, if burned in conventional biomass combustion processes, would generate energy equivalent[5] to two million barrels (84 million gallons) of oil. Or, two million tons could be converted (at 80 gallons per ton,[6] via thermochemical processes) into 160 million gallons of fuel.

Algae has also been receiving attention, due to high yields per acre and potential use of CO_2. The 11 million tons of CO_2 produced by large energy facilities (power plants and refineries) in Hawaii could theoretically support the production of over 400 million gallons of oil per year.

Hawaii Biofuel Projects

Facility	Input (feedstocks)	Output (products)	Production Capacity
Aina Koa Pono	1. Remove invasive species. 2. Plant crops.	Renewable diesel, gasoline, biochar	24 million gallons per year (mgpy) (planned)
Big Island Biodiesel	Used cooking oil, grease trap waste, crop oils	Biodiesel, glycerin, animal feed	5.5 mgpy (built)
Cellana	Algae	Algae oil, animal feed	1.26 mgpy (planned)
Hawaii BioEnergy, LLC Renewable Fuels Project	Eucalyptus, energy grasses, other	Renewable fuel oil, jet fuel, gasoline; feeds, fertilizers, electricity possible	Fuel oil replacement: 10 mgpy; others: confidential (planned)
HawaiiGas Renewable Natural Gas (RNG) Plant	Animal and plant fats and oils	Renewable methane, hydrogen, propane	1 mgpy (built)
Phycal	Algae	Fuel oil; renewable jet fuel; renewable diesel	100,000+ gallons per year pilot, followed by 3 mgpy demonstration (planned)
UOP Honeywell Integrated Biorefinery	Woody materials, agricultural residues, algae	Renewable gasoline; diesel; jet fuel	62,000 gpy, pilot (under construction); 50 mgpy facility (potential)

Bioenergy, a renewable energy source that can be stored and transported in a manner similar to fossil fuels, can often be used in existing equipment and be blended with petroleum fuels.

Hawaii's current use of petroleum-based fuels (million gallons/yr)	**1,800**	Hawaii's biofuel production potential (million gallons/year)	**100-300**
Potential land available (1000+ acres per parcel, previously farmed, not displacing current farming)	**136,000** acres	Algae oil yields demonstrated on Kauai[7]	**2000** gal/acre
Tons of biomass per acre per year[8]	**10 - 20**	Tons CO_2 from energy facilities[9]	**11** million
Biomass potential from 136,000 acres (million tons/year)	**2**	Pounds of animal feed per gallon of biodiesel from crop oil	**25**
1 ton of biomass replaces	**1** bbl oil	Animal feed used in Hawaii (million pounds/year)[10]	**100-200**
Levelized Cost of Biomass Energy[11]	**1¢-17¢/kWh**	Target cost per gallon, bio-based jet fuel[12]	**$3**

Electric Vehicles

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

Based on statewide averages, the amount of fossil fuel used to power an electric vehicle in Hawaii is 31% less than the fossil fuel required to power a similar gasoline-fueled vehicle.[1] This is expected to get even better as renewable energy increases in Hawaii.

Electricity is most commonly delivered to an electric vehicle's batteries at night, through a home vehicle charger. Electric vehicles can also use publically available charging stations.

Registered Electric Vehicles (EVs) and Publically Available Charging Stations in Hawaii, 2012

County	Electric Vehicles	Level 2 [2] Charging Stations	Ports[3]	Level 3 [4] Charging Stations
Oahu	870	170	182	4
Hawaii	83	23	37	0
Kauai	32	19	22	1
Maui	151	30	36	1
State of Hawaii	**1136**	**242**	**277**	**6**

- Public charging, including fast charging, is needed as a convenience for EV drivers and to reduce range anxiety.
- The cost for a government or commercial property owner to install a Level 2 charging station is typically approximately $6,000-$8,000 per station. [5]
- The State of Hawaii has launched a new mobile application (app) designed to help drivers locate EV charging stations. The free "EV Stations Hawaii" app is available for Apple and Android smartphones and mobile devices.

EVs have a greater initial purchase price[6] than comparable gasoline-fueled vehicles. Most experts, including Hawaii's auto dealers, believe that widespread acceptance of EVs will grow as a full battery charge provides greater driving range and the cost of EVs more closely matches the cost of conventional internal combustion engine (ICE) vehicles.

Hawaii EV Dealers by County

County	Nissan Leaf	GM/Chevy Volt	Mitsubishi iMiEV	Toyota plug-in Prius	Ford Focus EV
Oahu	3	3	1	3	3
Maui	1	1	0	1	1
Hawaii	0	1	0	2	0
Kauai	1	1	0	1	1
State of Hawaii	**5**	**6**	**1**	**7**	**5**

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

Fuel Cost Comparison

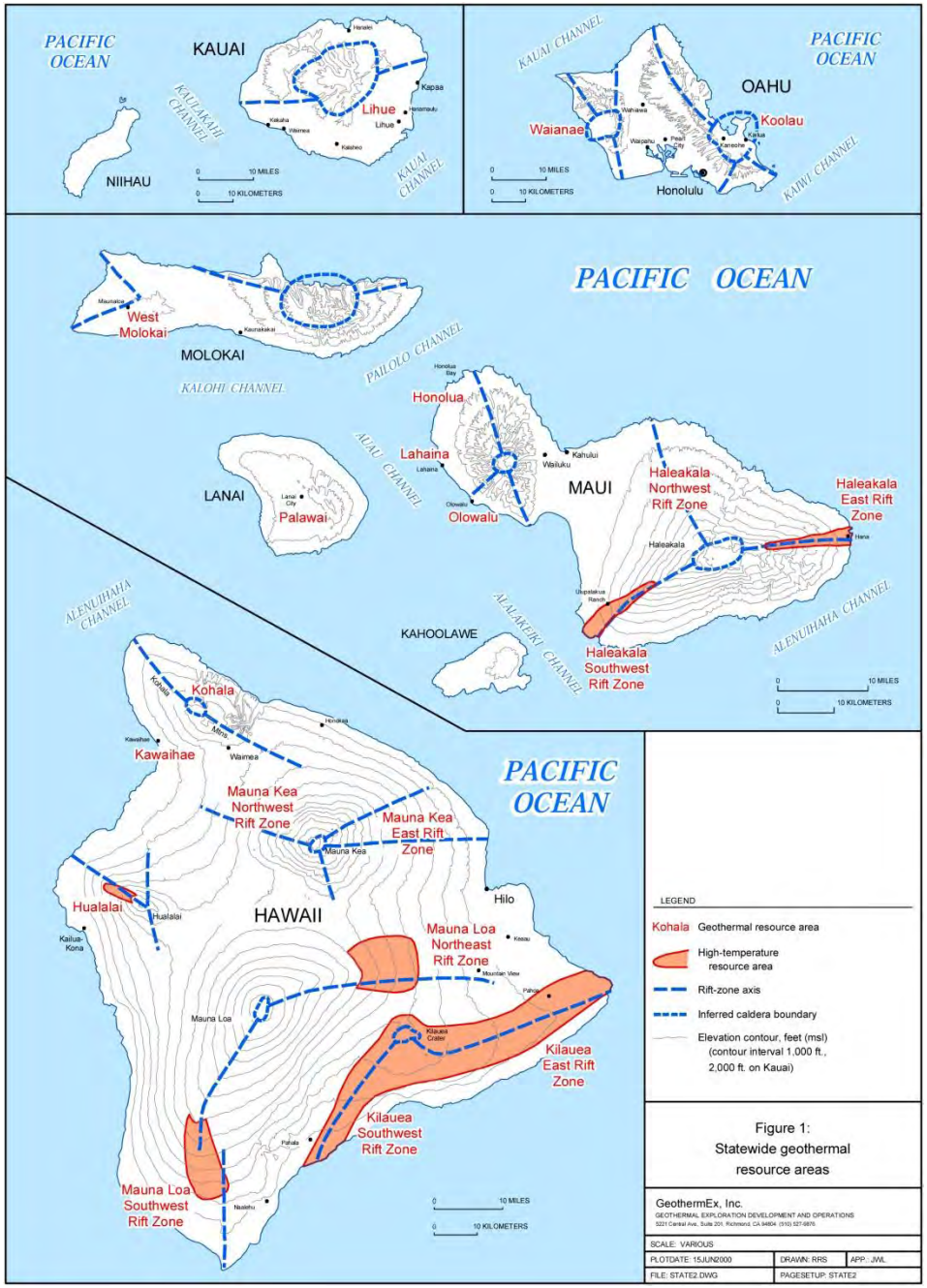
Vehicle	2012 Nissan Versa	2012 Honda Civic	2012 Nissan Leaf[7]
Fuel Type	Gasoline	Gasoline	Electricity
Miles Per Gallon (MPG)	27mpg Combined	32mpg Combined	99 Combined MPGe
Fuel Costs	$4.10/gallon	$4.10/gallon	Electricity: $0.347/kWh
Fuel Cost per Mile	$0.1519	$0.1281	$0.11798
Fuel Cost per Year[8]	$1,370	$1,156	$1,064
Fuel Cost Savings per Year	$306	$92	

Hawaii's electric vehicle policies and incentives that successfully convinced major automobile manufacturers to target Hawaii as early launch market for EVs included:

- Free parking is provided in State and County Government lots, facilities, and at parking meters (Act 168 of 2012, formerly Act 290 of 1997).
- Vehicles with Electric Vehicle license plates are allowed access to High Occupancy Vehicle lanes (Act 168 of 2012).
- Parking lots with at least one hundred public parking spaces are required to have at least one parking space, equipped with an EV charging system, reserved exclusively for EVs (Act 089 of 2012, formerly Act 156 of 2009).
- Multi-family residential dwellings or townhouses cannot prohibit owners from installing EV chargers in their assigned parking spaces (Act 186 of 2010).
- Recovery Act funding provided electric vehicle grants and rebates (2009-2012).

Electric Vehicle Land Speed Record	**303** miles per hour	Electric Vehicle Distance Record on a Single Charge	**423** miles[9]
Average distance driven by US driver in one day. Distance easily managed by current EV technology.	**35** miles per day	Best temperature range to operate Lithium ion batteries (most common EV batteries today).	**68°- 95°** Fahrenheit
EPA rating for 2013 Ford Fusion Energi plug in hybrid	**108** mpg city, **92** mpg hwy	Hawaii national rank for public EV charging stations per capita.	**1**

Geothermal



Map of Geothermal Resource Areas (Source: GeothermEx, 2005)

Hawaii's single geothermal power plant, the Puna Geothermal Venture (PGV) facility located on the Island of Hawaii, produced 233 gigawatt-hours (GWh) in 2011[1]. This represents approximately 20% of the total electricity consumed on Hawaii Island as well as **20% of the renewable electricity** generated statewide. The facility, which began operating in 1993, produces both baseload and dispatchable electricity.

The Hawaii Electric Light Company (HELCO) has issued a draft Request for Proposals for an additional 50 MW of dispatchable geothermal power for the island of Hawaii. This amount of geothermal capacity could allow HELCO to retire one of its fossil fuel power plants.

On the island of Maui, a similar draft Request for Proposals for 30 MW of renewable firm dispatchable capacity resources for Maui Electric Company, which could include geothermal, is scheduled for early 2013.[2]

Continued geothermal **exploration** will contribute to better understanding of Hawaii's geothermal resources. Ormat is exploring on Maui, focusing on the southwest rift zone of Haleakala, with partial funding from the U.S. Department of Energy. The University of Hawaii will also be exploring rift zones on several islands using a non-invasive technique called magnetotellurics.

Geothermal resources are difficult to characterize without exploration and drilling since Hawaii's high-temperature resources are usually more than a mile beneath the surface. However, estimates from exploration efforts in the 1970s and '80s indicate that there may be more than 1,000 MW of geothermal reserves[3] (recoverable heat at drillable depths) on Maui and Hawaii islands, sufficient to provide more than 200% of the State's Renewable Portfolio Standards goal. Reaching that level of production would require interconnection of the islands' grids.

Geothermal electricity is cheaper than that produced from petroleum fuels in Hawaii, and also generally cheaper than other forms of renewable electricity.

Current geothermal Production Capacity in Hawaii	**38** MW	Contracted price for first 25 MW of electricity from PGV[4]	**20.6¢** on peak **15.4¢** off peak per kilowatt-hour (kWh)
Estimated probable reserves, Maui & Hawaii	**1,000** MW	Contracted price for next 5 MW	**11.8¢ / kWh**
Levelized cost of geothermal energy[5]	**4¢ - 14¢** per kWh	Contracted price for next 8 MW	**9¢ / kWh**

Inter-Island Transmission Cable

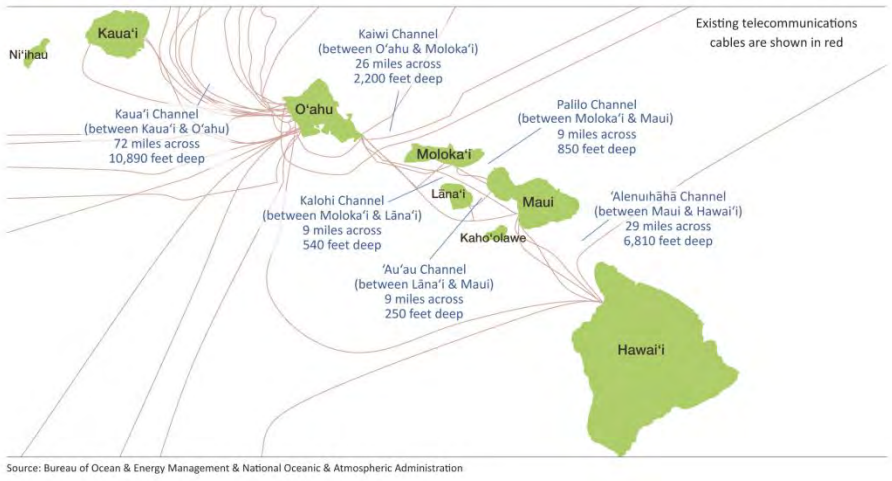
One or more inter-island cables could connect us with power and high speed broadband. This concept is called the "undersea transmission cable" or "interisland cable."

Connecting the islands' transmission systems with an interisland cable will help Hawaii develop more renewable energy and reach the target of 70% energy independence by 2030.

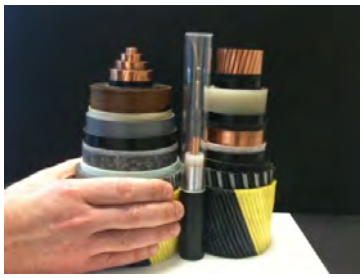
Undersea cables, for telecommunications and transmission of electricity, are in use all over the world. Undersea high voltage direct current (HVDC) and alternating current (AC) power cables connect islands with one another, connect islands to a nearby mainland, transmit power across channels or rivers, and transmit power to offshore drilling sites or from offshore wind farms.

In 1881, Hawaii's King David Kalakaua discussed with Thomas Edison the possibility of using power from Hawaii's volcanoes to produce electricity, and transmitting this power by submarine cable to the other islands.

Hawaii's islands are already connected by several telecommunications cables, shown below.



Source: Bureau of Ocean & Energy Management & National Oceanic & Atmospheric Administration



A 400 MW high voltage direct current transmission cable is about four inches in diameter. When combined with a return cable and fiber optic communication cable, the bundle is about 10 inches in diameter.

The bundle shown in the picture is for transmission of 500 MW.

A 400 MW cable, being utilized at 40% capacity, could deliver 14% of Hawaii's electricity: 1.9 terawatt-hours, 20% of Oahu's use; equivalent to the electricity used by 194,000 households.

At 60% capacity, a 400 MW cable could deliver 21% of the State's electricity.

The largest submarine cable network in operation has a capacity of 2000 MW: more than Hawaii's entire statewide electricity demand. Some cables have been in service for more than 30 years. There are a variety of HVDC systems in use around the world, including:

- Baltic Cable (Germany - Sweden), 155 miles: 500 megawatts (MW) installed in 1994.
- Basslink (Victoria – Tasmania, Australia), 183 miles: 500 MW installed in 2006.
- BritNed (Britain – Netherlands), 162 miles: 1000 MW installed in 2011.
- Cross-Channel (UK - France), 28 miles: **2000 MW** installed in 1986.
- Cross Sound Cable (New York - Connecticut), 24 miles: 330 MW installed in 2002.
- Estlink (Estonia - Finland), 65 miles: 350 MW installed in 2006.
- Fenno-Skan (Sweden - Finland), 124 miles: 572 MW installed in 1989; 800 MW in 2011.
- Gotland (Sweden) (**first** commercial HVDC submarine cable), 60 miles: 20 MW in **1954**; 260 MW in 1987.
- Hokkaido-Honshu (Japan), 27 miles: 150 MW in 1979; 300 MW, 1980; 600 MW in 1993.
- Inter-Island (New Zealand), 26 miles: 700 MW installed in 1965.
- Italy-Greece, 75 miles: 500 MW installed in 2001.
- Jeju Island Cable (Korea), 60 miles: 300 MW installed in 1998.
- Kii Channel (Japan), 31 miles: 1400 MW installed in 2000.
- Kontek (Germany - Denmark), 32 miles: 600 MW installed in 1995.
- Konti-Skan (Sweden - Denmark), 54 miles: 300 MW installed in 1988.
- Leyte - Luzon (Philippines), 13 miles: 440 MW installed in 1997.
- Neptune (US, New York-New Jersey), 50 miles: 660 MW installed in 2007.
- NorNed (Netherlands – Norway) (**longest HVDC submarine cable**), **360 miles**: 700 MW installed in 2008.
- SACOI (Sardinia-Corsica, Italy-France), 75 miles undersea: 300 MW installed in 1967.
- SAPEI (Italy) (**deepest** HVDC submarine cable, at **5380 feet**), 261 miles: 1000 MW installed in 2011.
- Swepol (Poland and Sweden), 152 miles: 600 MW installed in 2000.
- Trans Bay Cable (US, California), 53 miles: 660 MW installed in 2010.

Longest undersea power cable	**360** miles	Percent of Hawaii's electricity that could be delivered by a 400 MW cable, at 60% capacity	**21%**
Deepest undersea power cable	**5,380** feet	Estimated transmission cost per kWh at 60% capacity factor	**7¢**
Highest capacity undersea HVDC system	**2,000** MW	Estimated transmission cost per kWh at 40% capacity factor	**10¢**
Year of installation, first HVDC undersea power cable	**1954**	Estimated installed cost of cable and converter stations	**$ 800 million**
Expected undersea transmission cable life in years	**30-40**	Estimated oil cost savings over 30 years[1]	**$ 7,000 million**
Diameter of cable bundle	**10** inches	2012 legislation: regulatory structure for inter-island power cables	**Act 165**

Ocean

Surrounded by the Pacific Ocean, Hawaii is rich in ocean renewable energy resources. Ocean energy includes both **hydrokinetic and thermal** resources.

Hydrokinetic technologies tap the movement in the ocean—waves, currents and tides—to generate electricity. Ocean Thermal Energy Conversion (OTEC) makes use of the temperature differences between warm surface waters and cold, deep ocean waters.

Hawaii has **superior potential for wave energy and OTEC**. However, ocean current and tidal resources are not as promising with presently-envisioned technologies in Hawaii.

Ocean energy research, development and demonstration projects are taking place in Hawaii and elsewhere in the world.

The **Hawaii National Marine Renewable Energy Center** (HINMREC) at the University of Hawaii-Manoa is one of three federally-funded centers for marine energy research and development in the nation. HINMREC is working with the Department of Defense to establish a multiple-berth wave energy test center at Kaneohe Bay, Oahu.

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

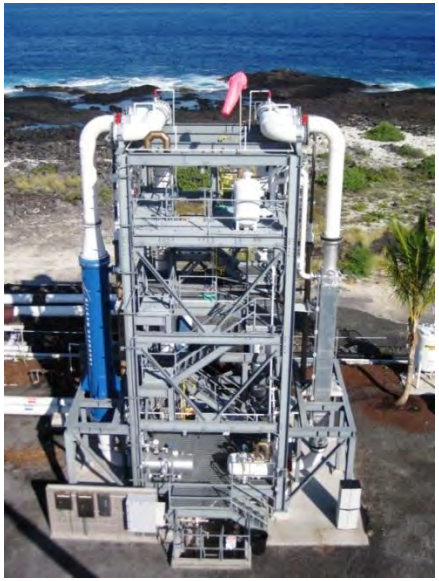
OPT's PB40 PowerBuoy in Kaneohe Bay, Oahu

The **Natural Energy Laboratory of Hawaii Authority** (NELHA) at Keahole Point, Kona, is among the world's premier OTEC research centers. Major milestones in OTEC were achieved at NELHA in the 1980s and '90s, including a 1-MW floating OTEC pilot plant, Mini-OTEC (the world's first demonstration of net power output from a closed-cycle plant) and other demonstrations in both open- and closed-cycle OTEC.

NELHA's cold seawater supply pipes are the deepest large-diameter pipelines in the world's

NELHA's cold seawater supply pipes are the deepest large-diameter pipelines in the world's oceans, extending to 2,000-foot depths. The laboratory's location, with access to both warm surface water and cold deep ocean water, makes it a prime site for OTEC RD&D. Presently, a heat exchanger test facility is operating at NELHA, testing components and materials.

A one-megawatt OTEC demonstration facility at NELHA is in the planning stages and power plants up to 100 MW in capacity have been proposed for locations off Oahu.



OTEC heat exchanger test facility at NELHA

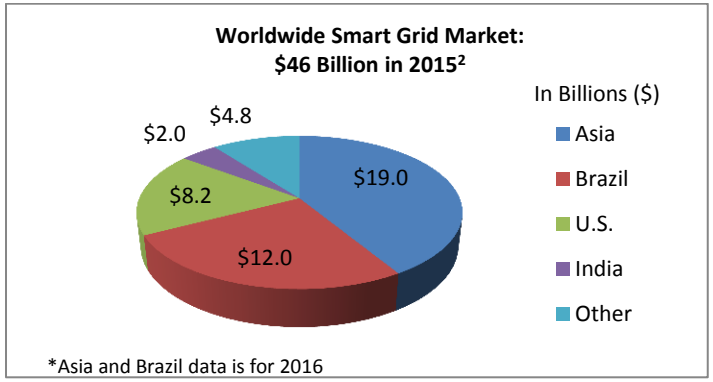
Number of berths expected at Kaneohe wave test center	**3**	Projected Levelized Cost of Electricity (LCOE) for commercial ocean energy[1]	**21¢-23¢/kWh**
Energy potential of tradewind waves in Hawaiian waters[2]	**15-25** kW/meter	Temperature of cold, deep seawater at NELHA[3]	**6°C (43°F)**
Number of operating hours achieved by OPT PowerBuoy PB40 at Kaneohe Bay[4]	**>5,600** hours	Temperature range of warm surface seawater at NELHA[5]	**24° – 28.5°C (75° – 83°F)**

Smart Grid

What is Smart Grid?[1]

- Smart Meters
  - Provide timely and more detailed energy usage information
  - Allow for time of use rates
- Energy Storage
  - Allows for increased renewable energy penetration
  - Stabilizes grid by conditioning power and smoothing fluctuations
- Demand Response--managing electricity use in response to available supply
  - Reduces the need for spinning reserves
  - Reduces the amount of oil imported

Smart Grid Market is Large



- DOE gave $3.4 billion in grants for smart grid projects & grid upgrades in recent years.[3]

Potential Market in Hawaii

- Residential and commercial building energy management systems may become even more effective when connected to an utility-wide smart grid.
- Over 500,000 housing units and condos[4], and tens of thousands of commercial and government buildings statewide, can take advantage of smart grid technologies.
- Over $57 million has been invested in Smart Grid demonstration projects in Hawaii.[5]

Peak Electricity Demand and Total Generation Capacity

	Oahu	Hawaii	Maui	Lanai	Molokai	Kauai
Total Capacity (MW)	**1672**	**270**	**261**	**9.3**	**11.8**	**128**
Percent of Statewide Capacity	71.1%	11.5%	11.1%	0.4%	0.5%	5.4%
Net peak demand (MW)	1216	203	204	5.4	6.3	78
Total Reserves (MW)	456	67	57	3.9	5.5	50

- DBEDT is currently studying how to integrate up to 1 GW of intermittent renewables on Oahu's grid

Existing Smart Grid Projects in Hawaii

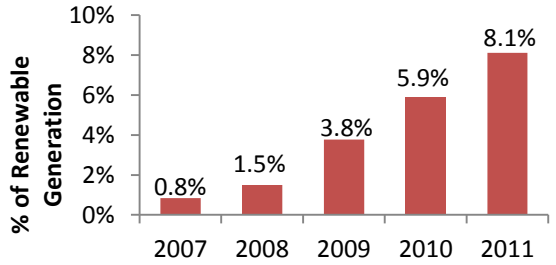
Name	Description	Key Companies	Location
DOE Renewable and Distributed Systems Integration (RDSI) Maui Smart Grid Demonstration Project	Develop a distribution management system that aggregates distributed generation, energy storage, and demand response technologies with $7 million in DOE funds and $8 million in industry funds.[6]	HNEI, HECO/MECO, General Electric, First Wind	Maui Meadows, Wailea
Japan U.S. Island Grid Project	Develop advanced technologies that automate EV charging and demand response to allow more renewable energy on the grid. NEDO will invest $37 million in the project.[7]	NEDO, Hitachi, Mizuho, Cyber-Defense, US DOE, NREL, HECO/MECO, HNEI, MEDB, & Maui County	Kihei, Maui
KIUC Smart Grid Demonstration	Installation of advanced metering infrastructure (AMI) and other smart grid technologies for grid management and energy efficiency information. Total cost of around $11 million for 33,000 meters in five years.[8]	KIUC, U.S. DOE	Kauai
Honeywell Fast Demand Response	Industrial and Commercial programs available for designating non-essential facilities that can be turned off during critical energy situations with ten minutes notice or less.[9]	HECO, Honeywell	Oahu
Korea-Oahu Smart Grid Demonstration	Gov. Neil Abercrombie signed a letter of intent with officials from South Korea to develop a micro smart grid demonstration project in Hawaii.[10]	Korea Smart Grid Institute, LG Electronics, Nara Controls, Hyosung, KT, Royal Hawaiian, Moana Surfrider, Sheraton Waikiki	Oahu

Solar

Due to Hawaii's extremely high energy prices, great solar resource, and progressive energy policies, the state has experienced unprecedented growth in solar generation.

Solar energy in 2011 provided eight percent of Hawaii's renewable energy generation.

Solar Energy as a % of Total Renewable Generation in Hawaii[1]

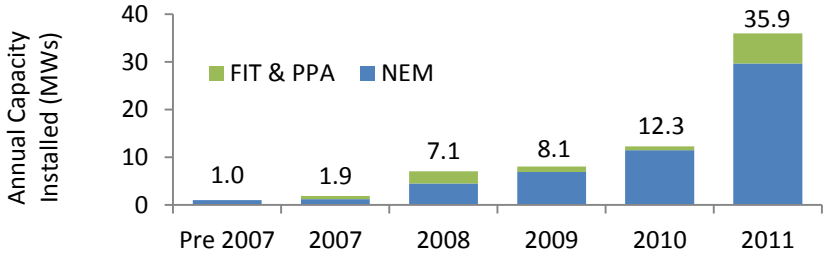


Progressive energy polices include:

- Net Energy Metering (NEM), which allows residential customers to receive full retail value for excess solar energy occasionally fed to the grid; and
- Feed in Tariffs (FIT), which allow the owners of small renewable energy projects to receive fixed rates for renewable electricity provided to the grid.

Power Purchase Agreements (PPA) are contracts between independent power producers and the electric utility. Utility-scale PV systems have completed PPAs on several islands..

Cumulative solar capacity installed statewide, including distributed and utility-scale systems[2]

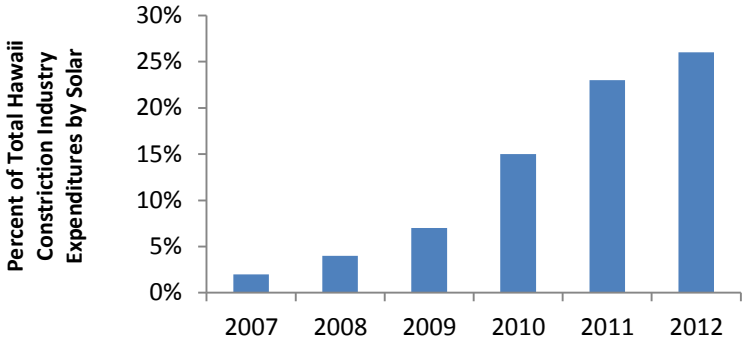


Due to the intermittent nature of solar as well as Hawaii's small, individual, non-interconnected island grids, the integration of large amounts of solar generation can be challenging. However the State and local utilities are working on solutions that include battery storage as well as interconnecting the island grids to help Hawaii incorporate even more solar projects into Hawaii's electric generation portfolio.

Existing Utility Scale Solar Projects

Project Name	Year Installed	Island	Developer	Capacity
La Ola Solar Farm	2006	Lanai	Castle & Cooke	1.1 MW
Kapolei Sustainable Energy Park	2011	Oahu	Forest City Hawaii, Hoku	1.18 MW
Kapaa Solar Project	2011	Oahu	Kapaa Solar, KIUC	1.21 MW
Port Allen Solar Facility	2012	Kauai	A&B, McBryde Resources, Inc., KIUC	6 MW

Rooftop distributed solar has become one of the state's leading industries, accounting for almost 26% of all construction expenditures in 2012.



Average statewide solar capacity factor[3]	**19%-20%**	Nationwide rank of solar water heaters installed per capita[4]	**1st**
Total statewide percentage of electricity generated by solar[5]	**1%**	Nationwide rank of cumulative installed PV capacity per capita[6]	**3rd**
Percent of total statewide construction expenditures in 2012 attributed to solar[7]	**26%**	Levelized cost of photovoltaics[8]	**15¢-35¢** /kWh

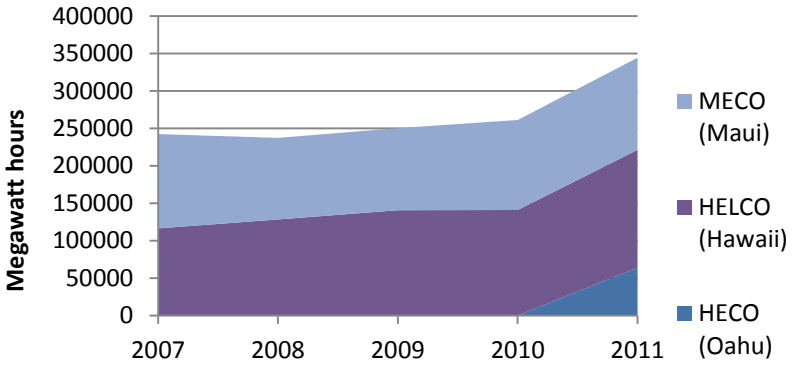
Wind

- Wind energy is Hawaii's second most utilized renewable energy resource, accounting for almost 31% of the state's total renewable energy generation.[1]

- Hawaii has one of the most robust and consistent wind regimens in the world, with capacity factors exceeding those found elsewhere. In 2011, the capacity factor of the Pakini Nui wind farm on the Big Island was 65%; Kaheawa I on Maui was 47%; and the Hawi wind farm on the Big Island was 45%.[2]

- Existing projects in Hawaii are located on the islands of Oahu, Maui, and Hawaii. Although the island of Kauai has several excellent resource areas, sensitivity about several endangered and threatened avian species on Kauai may limit wind energy development on Kauai.

Electricity Produced from Wind Energy in Hawaii, by Island and Service Area[3]



Challenges Facing Wind Energy Development in Hawaii

- Several excellent wind resource sites could provide over 1000 MW of wind energy, which could produce 94%[4] of the State's Renewable Portfolio Standards goal. Since over 70% of Hawaii's energy load is on Oahu but over 90% of the existing wind potential is on the outer islands, reaching that level of production would require interconnection of the islands' grids.

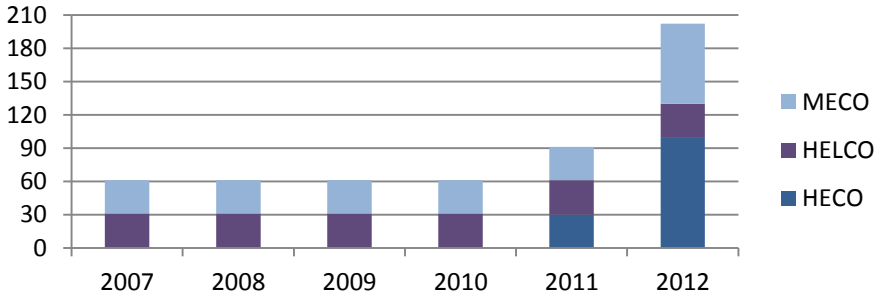
- Endangered avian and plant species can complicate the siting and development of wind projects in Hawaii's unique environments. Proactive measures, such as the development of area-wide habitat conservation plans, could be helpful for species protection as well as project siting.

- Given the height of wind turbines and limited sites suitable for wind development in Hawaii, visual impacts may be of concern; they should be identified early and addressed carefully, working with local communities.

Existing Utility Scale Projects

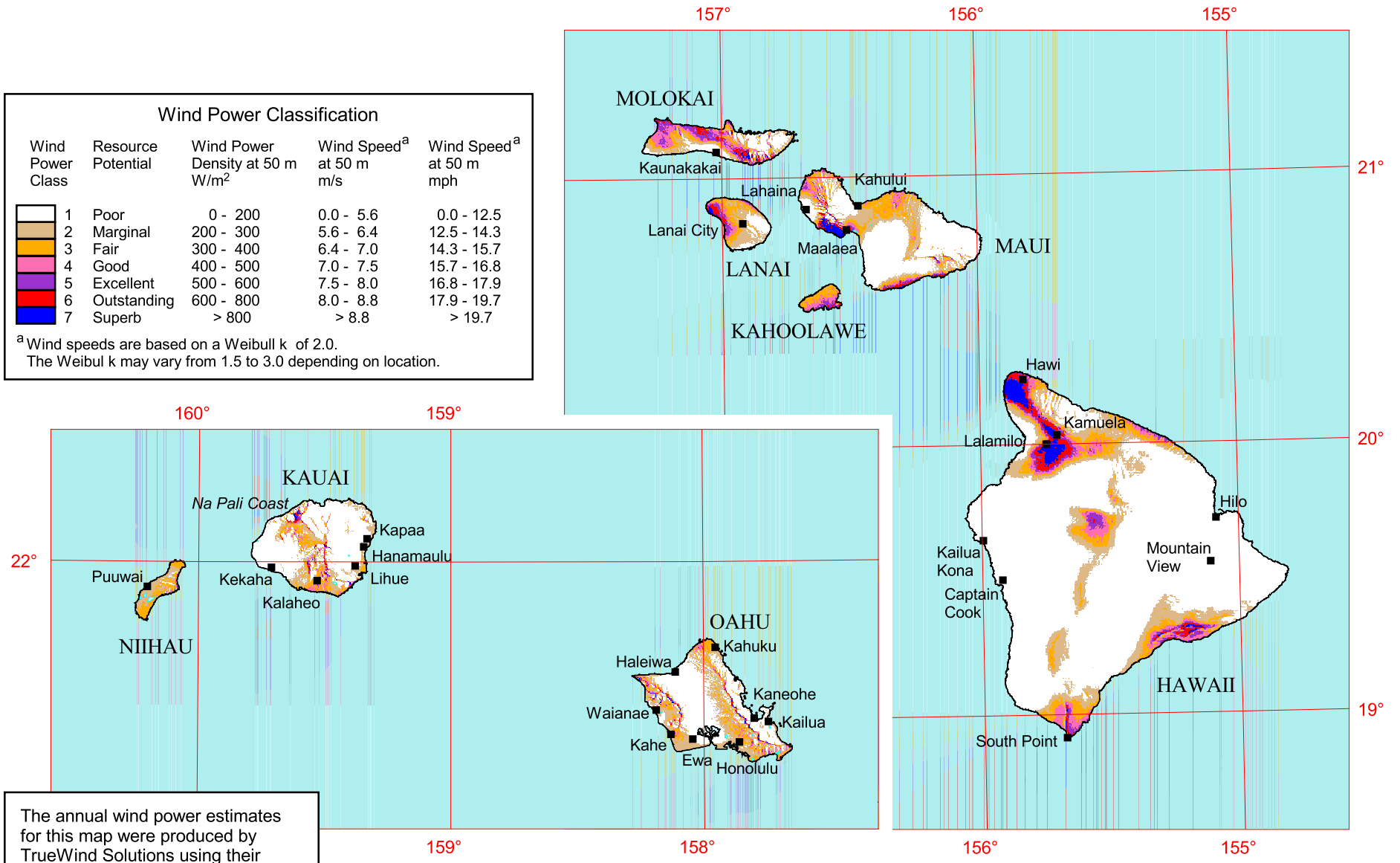
Project Name	Year Installed	Island	Developer	Capacity
Hawi Wind Farm	2006	Hawaii	Hawi Renewables	10.5 MW
Kaheawa I Wind Farm	2006	Maui	First Wind	30 MW
Pakini Nui Wind Farm	2007	Hawaii	Tawhiri Power	20.5 MW
Kahuku Wind Farm	2011	Oahu	First Wind	30 MW
Kawailoa Wind Farm	2012	Oahu	First Wind	69 MW
Kaheawa II Wind Farm	2012	Maui	First Wind	21 MW
Auwahi Wind	2012	Maui	Sempra Generation	21 MW

Installed Wind Energy Production Capacity by Service Area[5]



Current installed wind capacity in Hawaii[6]	**202** MW	Wind Resource Potential for all Hawaiian Islands[7]	**1087** MW
Average land area needed per MW of wind including both temporary and permanent impacts[8]	**85.25** acres	Total number of wind related habitat conservation plans in Hawaii[9]	**4**
Height of 2.3 MW wind turbine[10]	**456** ft.	Levelized cost of wind energy[11]	**7¢** per kWh

Hawaii - 50 m Wind Power



Wind Power Classification

Wind Power Class	Resource Potential	Wind Power Density at 50 m W/m^2	Wind Speed[a] at 50 m m/s	Wind Speed[a] at 50 m mph
1	Poor	0 - 200	0.0 - 5.6	0.0 - 12.5
2	Marginal	200 - 300	5.6 - 6.4	12.5 - 14.3
3	Fair	300 - 400	6.4 - 7.0	14.3 - 15.7
4	Good	400 - 500	7.0 - 7.5	15.7 - 16.8
5	Excellent	500 - 600	7.5 - 8.0	16.8 - 17.9
6	Outstanding	600 - 800	8.0 - 8.8	17.9 - 19.7
7	Superb	> 800	> 8.8	> 19.7

[a] Wind speeds are based on a Weibull k of 2.0.
The Weibul k may vary from 1.5 to 3.0 depending on location.

The annual wind power estimates for this map were produced by TrueWind Solutions using their Mesomap system and historical weather data. It has been validated with available surface data by NREL and wind energy meteorological consultants.

U.S. Department of Energy
National Renewable Energy Laboratory

12-JUL-2005 2.1.5

Permitting

- Permitting costs in Hawaii can range from **1% to 20% of overall project construction costs**.[1]
- Large energy projects in Hawaii **average 15 federal, state, and county permits**, with some facilities requiring over 40 such approvals.
- It can take **1-5 years to permit** a large renewable energy project in Hawaii.
- **Permitting costs are a risk** paid without assurance of project construction.

Common permitting issues for renewable energy projects in Hawaii

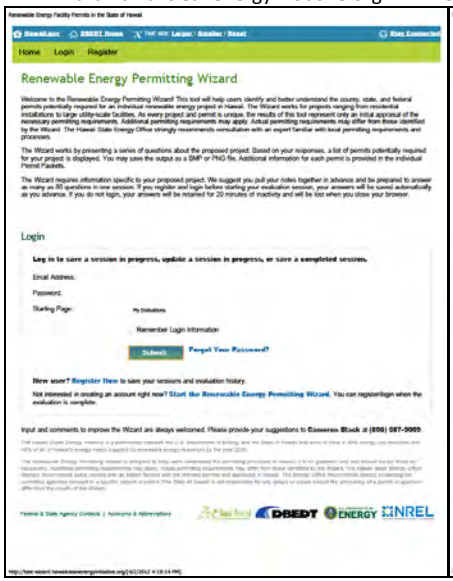
- Hawaii's many protected cultural, historic, and ecologic resources
- Hawaii's many overlapping land use jurisdictions
- Renewable energy projects present new technological and permit issues
- Time and effort spent going back and forth between applicant and permitting agency
- Public interest in renewable energy projects, use of resources and land
- Utility interconnection requirements/approvals, grid capacity issues

Common solutions to renewable energy permitting issues in Hawaii

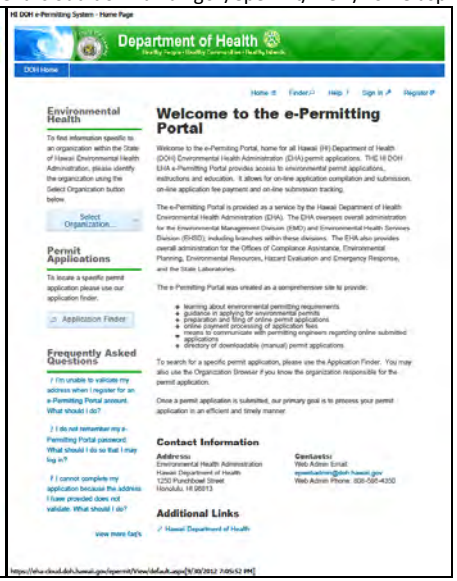
- Electronic permit processing – maximizes staff time, reduces back and forth
- Agency pre-coordination – HRS 201N, increased inter-agency communication
- Educate developers and agencies – permitting guides, websites, seminars
- Lawmaking – allowances for renewables, clarity in permitting processes
- Engage public early in the project development process
- Connect developers to consultants familiar with Hawaii regulations

Electronic tools to facilitate renewable energy permitting in Hawaii

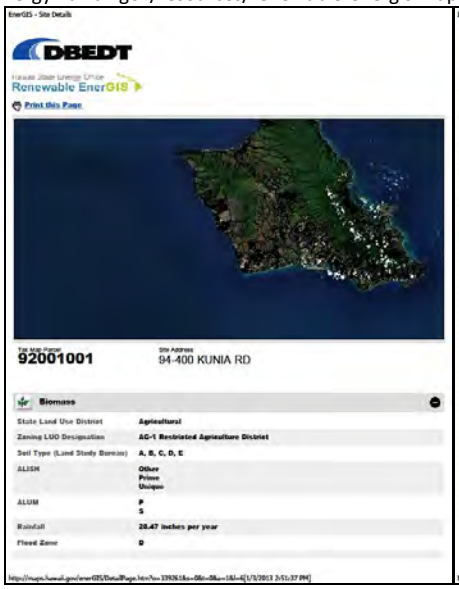
State Energy Office *Permit Wizard*
wizard.hawaiicleanenergyinitiative.org



Dept. of Health *e-Permitting Portal*
eha-cloud.doh.hawaii.gov/epermit/View/home.aspx



DBEDT *Renewable EnerGIS*
energy.hawaii.gov/resources/renewable-energis-map

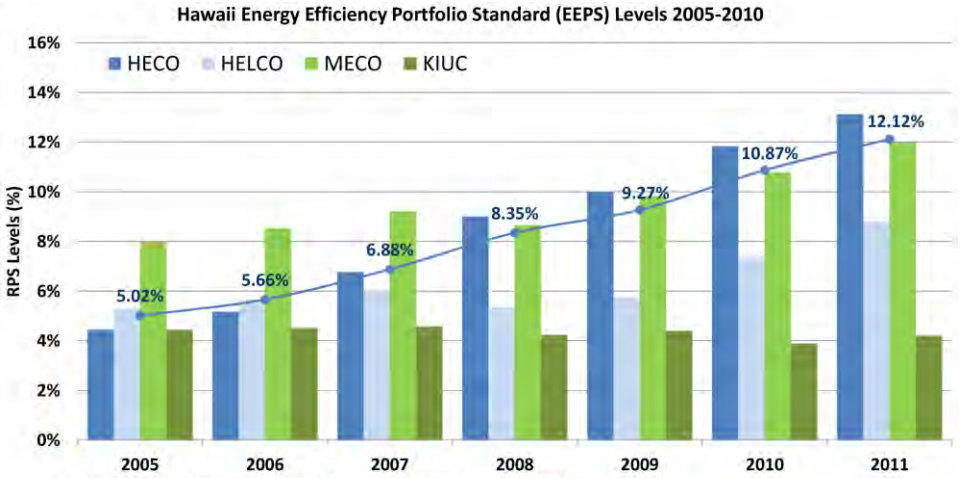


C&CH/DPP *Online Building Permits*
dppweb.honolulu.gov/dppweb

Energy Efficiency

Energy Efficiency Portfolio Standards (EEPS)

This graph shows Hawaii's Energy Efficiency Portfolio Standards (EEPS) levels from 2005-2011. The EEPS requires that by 2030 annual energy savings amount to 30% of annual electricity sales statewide. In 2005 the statewide EEPS level was 5.02%. By 2011 the EEPS level rose to 12.12%. A major contributor to EEPS is Hawaii Energy (HE), a ratepayer-funded program administered by the Hawaii Public Utilities Commission and serving all islands except Kauai. The HE proposed funding for FY 2013 is nearly $35M. For FY12, the HE estimated budget was just over $32M with$25.7M spent. Of expended funds, $17.1M went directly to commercial and residential customers who invested $81.7M of their own money to save 159.2GWh and a total bill cost savings of $51.7M – or a lifetime savings of 1,339GWh/$407.6M. Kauai Island Utility Cooperative also offers efficiency programs for its customers. Kauai Island Utility Cooperative also offers efficiency programs for its customers.



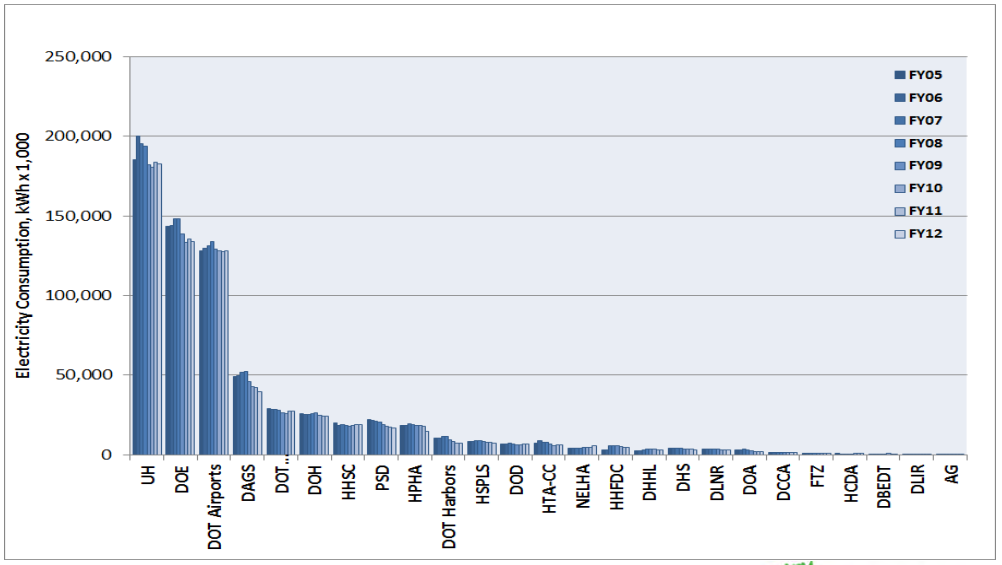
State and County Performance Contracting

Energy savings for these projects over 20 years (1.1 billion kWh) is equivalent to powering an estimated 171,623 households for one year. Jobs maintained or created: 4,501 (source: National Association of Energy Service Companies)

Agency	Facilities	Investment Value (2011$)	Average Annual Savings	Savings Over 20 Years
UH-Hilo	NA	$11.3M	$770,644	$15.4M
HHSC	5 hospitals	$32.6M	$2.3M	$45.1M
Judiciary	5 courthouses	$2.1M	$423,684	$8.5M
City and County of Honolulu	4 buildings	$16.6M	$1.1M	$21.9M
County of Hawaii	28 buildings	$2.9M	$343,489	$6.9M
County of Kauai	34 buildings	$904,102	$53,782	$1.1M
DAGS Phase I	10 Downtown Buildings	$34.5M	$3M	$60M
UHCC	4 Oahu campuses, Kauai CC	$32.8M	$4.5M	$90M
Public Safety	Halawa high security and med security, OCCC, 1 jail	$25.5M	$2.3M	$46M
DAGS Phase II	33 buildings	$22.5M	$1.5M	$30M
City and County of Honolulu	Kailua Wastewater Treatment Plant	$12M	$772,000	$15.4M
Total		$193.7M	$15M	$341.3M

Lead By Example

During FY12 state agencies' energy consumption decreased by 1.2% from FY11 levels, but the state paid 19.4 % more than FY11. When comparing FY12 figures against the 2005 baseline year, energy consumption dropped 5.7%, but, due to the increasing cost for electricity, costs rose 93.8%. Consumption (kWh) by agency by year is shown in the chart below.



Green Buildings

State Office Tower Certified Prestigious LEED Gold

First large office building, public or private, in the state to be certified Gold under LEED for Existing Buildings: Operations & Maintenance.

Leadership in Energy and Environmental Design (LEED) for Existing Buildings: Operations and Maintenance

Green Building Strategies

Water Efficiency
Water reduction: 39%
All fixtures low-flow and low-flush

Energy and Atmosphere
ENERGY STAR Rating: 96 (i.e., top 4% in energy efficiency among similar buildings nationally)
Improved indoor air quality

Materials and Resources
Waste diversion rate: 58%

Indoor Environmental Quality
50% of all cleaning products are green cleaning products

Green Sun

Green Sun Hawaii is a public-private partnership with the ability to leverage $2.72 million in federal funds into $54.0 million in energy efficiency and renewable energy equipment loans statewide. Impacts include:

GreenSun Hawai'i currently covers 54 low interest loans amounting to over $1.3 million

Estimated energy savings of 356,000 kilowatt hours annually (7.1 million over the life of the installations)

Savings in the participants' electricity bill in excess of $143,000 annually ($2.9 million over the life of the system)

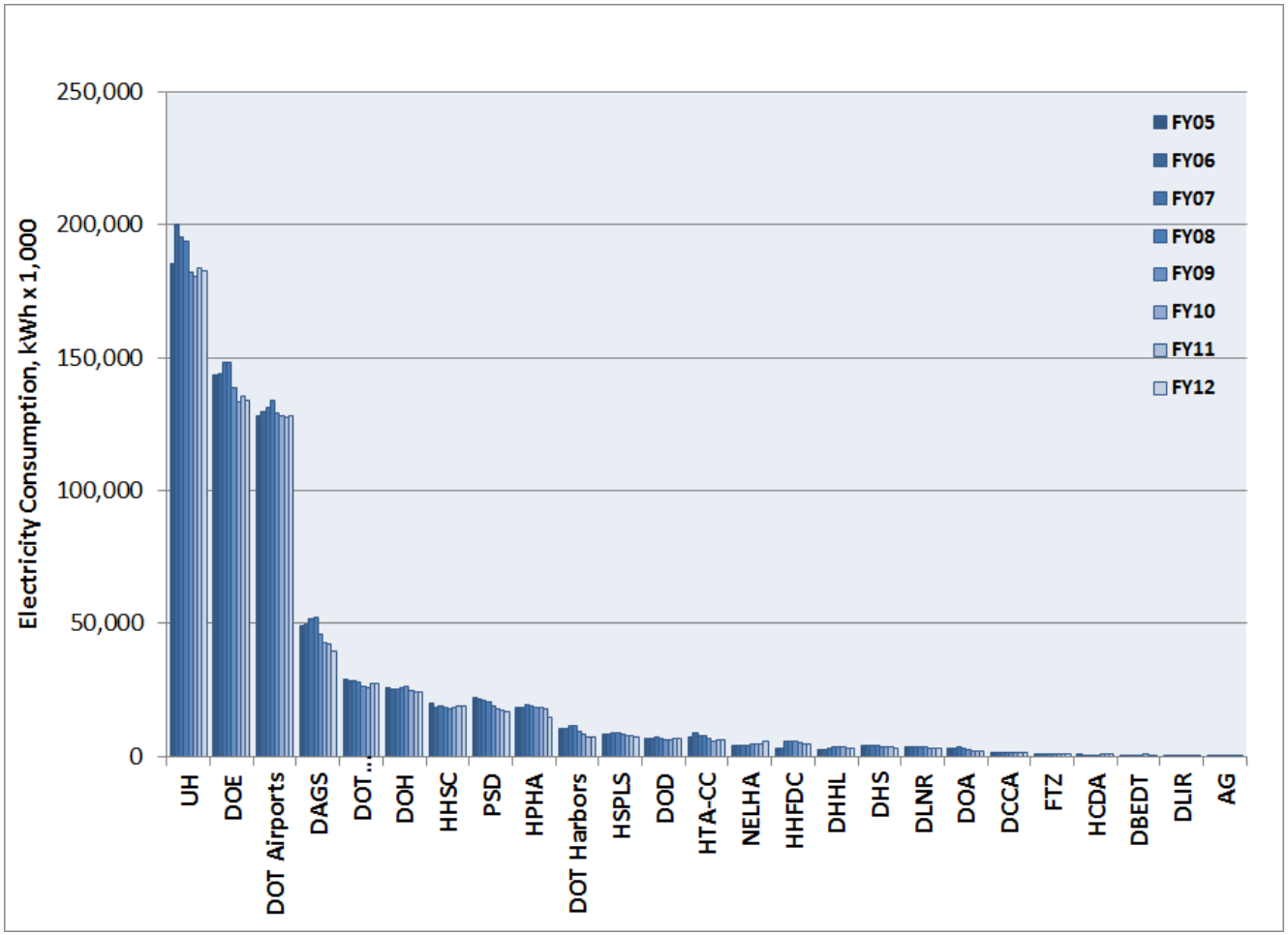
Annual CO2 reduction of 506,000 lbs. (10.1 million lbs. over the life of the installations)

Annual energy savings is equivalent to powering 460 households a year

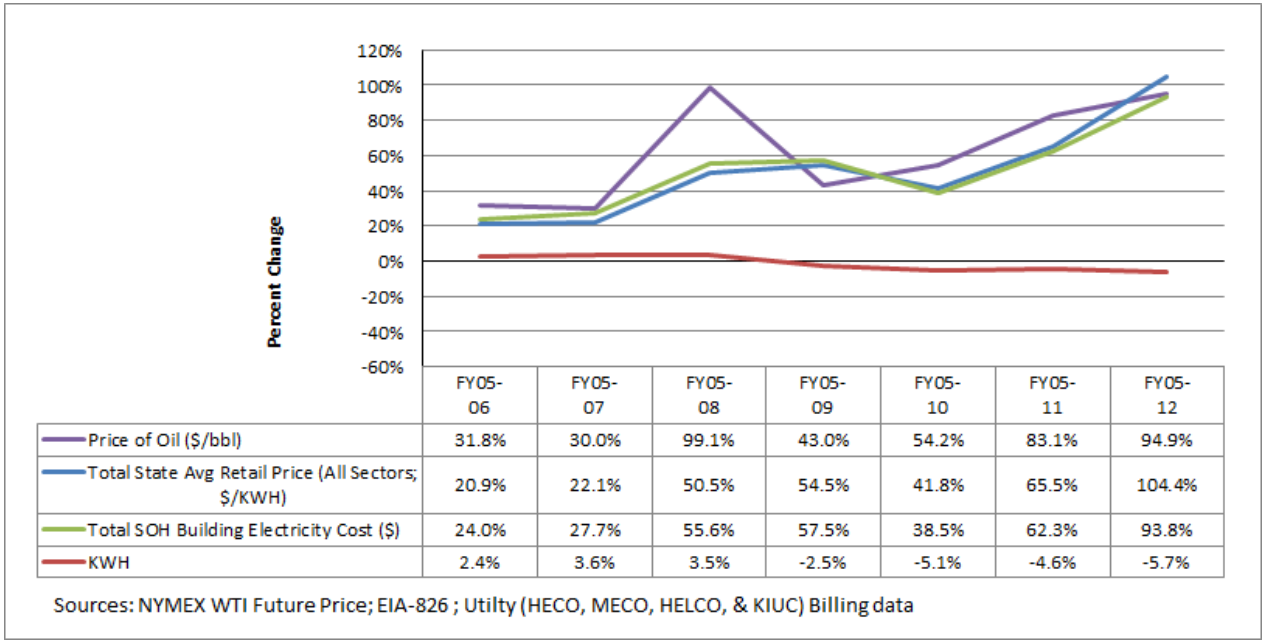
State of Hawaii Agencies Lead By Example (December 2012)

Overview

During FY12 state agencies' energy consumption decreased by 1.2% from FY11 levels, but the state paid 19.4 %, more than FY11. When comparing FY12 figures against the 2005 baseline year, energy consumption dropped 5.7%, but, due to the increasing cost for electricity, costs rose 93.8%.



The following chart shows the percentage of change from the baseline year each year since the Lead By Example program began. Shown are the price of oil, the average retail price of electricity (based on EIA-826 reporting, dividing utility total revenues by total kWh sold and including fuel adjustment cost), total State of Hawaii electricity costs and the State of Hawai'i electricity consumption (kWh).



	FY05-06	FY05-07	FY05-08	FY05-09	FY05-10	FY05-11	FY05-12
Price of Oil ($/bbl)	31.8%	30.0%	99.1%	43.0%	54.2%	83.1%	94.9%
Total State Avg Retail Price (All Sectors; $/KWH)	20.9%	22.1%	50.5%	54.5%	41.8%	65.5%	104.4%
Total SOH Building Electricity Cost ($)	24.0%	27.7%	55.6%	57.5%	38.5%	62.3%	93.8%
KWH	2.4%	3.6%	3.5%	-2.5%	-5.1%	-4.6%	-5.7%

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

- State agencies have received more than $6.69 million in efficiency rebates since 1996 from the Hawaiian Electric Company (HECO) and its subsidiaries and from Hawai'i Energy. These rebates combined have resulted in estimated cumulative dollar savings of over $153.6 million and electricity savings of over 67 million kilowatt-hours. Over the life of the equipment, the savings will be equivalent to approximately 157,000 households' annual electricity use. In FY12 state agencies received $495,784 in rebates.
- 21 State Buildings have been benchmarked and verified as Energy Star (upper 25% in energy efficiency for similar buildings in the US).

Performance Contracting

1st in nation in 2012 for energy savings performance contracting per capita at $132.25/person; national average is $36.36/person. (Total savings for state agencies from performance contracting: $66M)

Leadership in Energy and Environmental Design (LEED)

- The State Office Tower (SOT) received the prestigious LEED Gold for Existing Buildings: Operations and Maintenance. It is the only major office building, public or private, to receive this distinction in the state. The ENERGY STAR rating is 96, which means that the SOT ranks in the top four percent in energy efficiency among similar buildings nationally.

- To date, sixteen state facilities have been certified as meeting LEED standards or have been completed and are awaiting certification by USGBC. A significant number of additional buildings which are anticipated to meet LEED Silver standards or better are either being planned or are in the design phase.
- Hawaii remains a member of the U.S. Green Buildings Council (USGBC), the non-profit entity which administers the LEED program. DAGS is developing LEED application guidelines to be used by state agencies.
- There are over 30 LEED Accredited Professionals on staff at six state agencies; DAGS, DBEDT, DOE, DOT, HPHA and UH. There are currently additional state personnel in training for this goal. The state requires all new construction and major renovation to meet LEED Silver standards, to the extent possible. DBEDT continues to offer LEED training opportunities for state agency staff. Six years ago, there was only one LEED Accredited Professional (AP) working for the state.
- A total of 18 workshops and other events relating to LBE topics were held in FY12, attracting at least 930 participants, including many from state agencies. In some cases, DBEDT provided American Reinvestment and Recovery Act (ARRA) funds so that other executive agencies' staff members could attend the training.

Power Purchase Agreements

- DOT-Airports signed a 20-year power purchase agreement in 2009 for a total of seven (7) photovoltaic systems totaling 901 kW of capacity.

	Utility kWh	Hoku kWh	Total		Utility $	Hoku $	Total $
FY2008	25,593,580	0	25,593,580	**FY2008**	$7,757,716	$0	$7,757,716
FY2009	25,319,886	217,682	25,537,568	**FY2009**	$7,859,866	$74,722	$7,934,588
FY2010	25,183,956	1,345,475	26,529,431	**FY2010**	$6,656,506	$466,998	$7,123,504
FY2011	24,881,079	1,432,550	26,313,629	**FY2011**	$7,631,471	$504,653	$8,136,123
FY2012	24,520,683	1,397,630	25,918,313	**FY2012**	$8,836,160	$508,313	$9,344,473

- Through a second round of power purchase agreements in 2011, DOT-Airports awarded development of photovoltaic renewable energy generation systems at 15 sites. Seven (7) power purchase agreements have been signed for a total capacity of 606 kW. The remaining eight (8) are pending, but are planned for an additional 2.69 MW.

- DOE has signed a power purchase agreement for 19 schools with anticipated completion by close of 2013.

State Building Code Update: The State Building Code Council voted to update the International Energy Conservation Code of 2009; Administrative Rules must be prepared.

Performance Contracting for State & County Agencies

Performance contracting provides building owners with the opportunity to design, install, and maintain energy-efficient equipment without the significant upfront cost. Costs are paid over time from the energy savings. DBEDT provides technical assistance on performance contracting to state and county agencies.

Seven (7) projects initiated since 1996:

- University of Hawaii at Hilo
- Hawaii Health Services Corporation
- Judiciary
- Department of Accounting and General Services Phase I
- Department of Accounting and General Services Phase II
- Department of Public Safety (4 prisons)
- University of Hawaii Community Colleges

Preliminary data show:

- Total investment of all projects represented in 2011 dollars is $193,781,027. Another project with the State Department of Transportation (15 airports, 5 harbors, and highway facilities) is under development and is estimated to result in over $166 million in investment value for a total of about $359 million for all projects.
- The projects will include over 145 buildings and over 4.5 million square feet.
- Annual cost savings for all projects is $37.5M, representing an average of 27% savings.
- Hawaii is ranked 1st in the nation for performance contracting. (Energy Services Coalition)

Over 20 years, the projects will:

- Save over $341M in electricity costs.
- Save the equivalent in energy to power over 316,000 homes a year in Hawaii.
- Create 8,983 jobs. (National Association of Energy Service Companies)
- Provided over $472M of direct (total investment) and indirect (repair/maintenance/taxes) impact to the economy.
- Claim over $1.5 million in utility rebate incentives.

State & County Performance Contracting Projects 1990-2012

Agency	Facilities	Investment Value (2011$)	Average Annual Savings	Savings Over 20 Years
UH-Hilo	NA	$11.3M	$770,644	$15.4M
HHSC	5 hospitals	$32.6M	$2.3M	$45.1M
Judiciary	5 courthouses	$2.1M	$423,684	$8.5M
City and County of Honolulu	4 buildings	$16.6M	$1.1M	$21.9M
County of Hawaii	28 buildings	$2.9M	$343,489	$6.9M
County of Kauai	34 buildings	$904,102	$53,782	$1.1M
DAGS Phase I	10 Downtown Buildings	$34.5M	$3M	$60M
UHCC	4 Oahu campuses, Kauai CC	$32.8M	$4.5M	$90M
Public Safety	Halawa high security and med security, OCCC, 1 jail	$25.5M	$2.3M	$46M
DAGS Phase II	33 buildings	$22.5M	$1.5M	$30M
City and County of Honolulu	Kailua Wastewater Treatment Plant	$12M	$772,000	$15.4M
Total		$193.7M	$15M	$341.3M

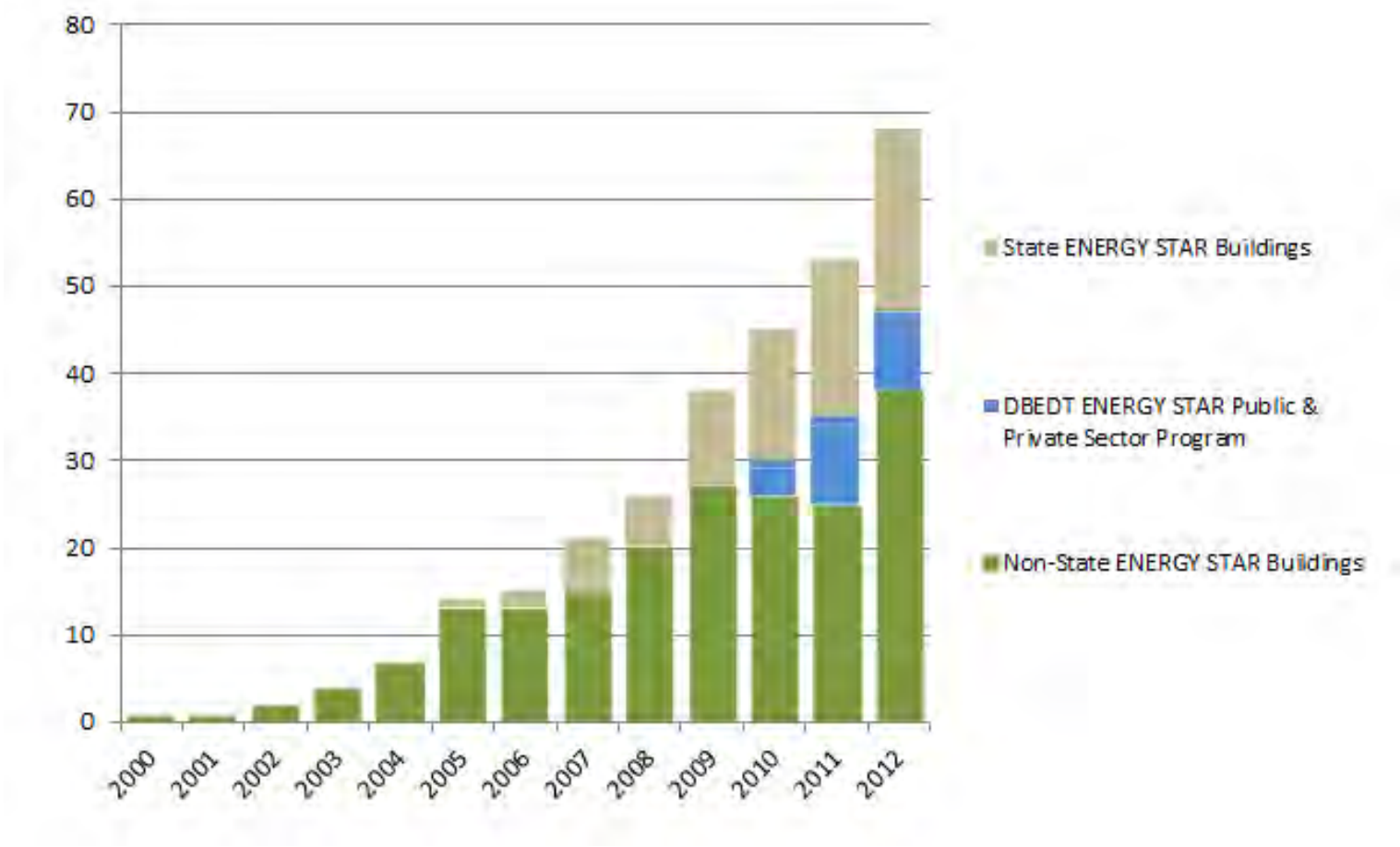
Energy savings for these projects over 20 years (1.1 billion kWh) is equivalent to powering an estimated 171,623 households for one year. Jobs maintained or created: 4,501 (source: National Association of Energy Service Companies)

Additional projects not included below, but under development, include: Department of Transportation (15 airports/5 harbors and highways facilities), City and County of Honolulu Board of Water Supply, City and County of Honolulu Honoulili and Sand Island Waste Water Treatment Plants, and the University of Hawaii at Hilo.

ENERGY STAR Buildings 2000-2012

Agencies and private sector building owners and managers can benchmark buildings to compare energy usage with other buildings in their portfolio or similar buildings nationally to identify investment priorities. If a building's performance, as reflected in its ENERGY STAR score, ranks in the top 25% of all buildings of its type, it can be certified as an ENERGY STAR building. Since 2000, 68 Hawaii buildings have received the ENERGY STAR certification. They include 30 public and 38 private buildings. During this time, DBEDT has assisted with the benchmarking and certification of 25 public and private (buildings should be certified annually). The chart below shows the rapidly increasing number of ENERGY STAR certified buildings in the state.

Total ENERGY STAR Certified Buildings in Hawaii



GreenSun Hawaii Loan Program (December 2012)

Program Objectives

- A state of Hawaii credit enhancement program funded by a grant from the U.S. Department of Energy
- Provides local financial institutions with access to a loan loss reserve (LLR) which may cover up to 100% of actual losses
- Enables participating lenders to:
    - Extend loan availability to a larger pool of borrowers
    - Offer more aggressive rates and terms than may otherwise be available without this credit enhancement
- Public-private partnership with the ability to leverage $2.72 million in federal funds into $54.0 million in energy efficiency and renewable energy equipment loans statewide

Program Purpose

- Supports loans for all property owners
    - Eligible Residential Loan Purposes:
        - ENERGY STAR Refrigerators & Air Conditioners
        - Solar Thermal Hot Water System
        - Solar Electric (PV) System
    - Eligible Non-Residential Loan Purposes:
        - Lighting Retrofits & Upgrades / Air Conditioning Retrofits & Upgrades
        - Solar Thermal Systems / Solar Electric (PV) Systems
        - Energy Efficiency Windows, Cool Roofs & all other installations eligible for Hawaii Energy / KIUC Rebates
        - Loan related fees
    - Requires energy efficiency improvements before renewable improvements are funded.

Participants

- 12 Participating Lenders statewide
- 38 Authorized Contractors statewide

Impacts

- GreenSun Hawaii currently covers 54 low interest loans amounting to over $1.3 million
- Estimated energy savings of 356,000 kilowatt hours annually (7.1 million over the life of the installations)
- Savings in the participants' electricity bill in excess of $143,000 annually ($2.9 million over the life of the system)
- Annual CO2 reduction of 506,000 lbs. (10.1 million lbs. over the life of the installations)
- Annual energy savings is equivalent to powering 460 households a year

Waikiki Seawater Air Conditioning (SWAC)

Under a $200,000.00 contract with DBEDT funded with federal funds, the University of Hawai‘i Sea Grant College Program conducted an investigation into the viability and effectiveness of installing seawater air conditioning in Waikiki. Conclusions were:

- SWAC consistency and reliability provides it with a solid advantage over more intermittent renewable energy technologies (such as wind and solar).
- SWAC's consistency and reliability is desirable for highly developed tourist area like Waikiki, where there is a constant demand for air conditioning.
- Survey of Oahu residents shows that a majority (62%-71%) support SWAC development in Waikiki.
- Oahu residents believe that SWAC will save energy and thereby reduce Hawai‘i’s dependence on fossil fuels.
- Should the SWAC outflow pipe be positioned too close to the surface, there is potential for algal growth in coastal waters.
- Investigation did not include field experiments into the release of nutrient dense deep ocean water into the Ala Wai Canal.
- Survey of Oahu residents shows concern about both the potential environmental impacts of SWAC and the cost of the system, particularly when it comes to the spending of public funds.

RECOMMENDATIONS

- Further research into the release of deep ocean water into the Ala Wai should be undertaken before developing a Waikiki SWAC system that discharges into the canal.

American Recovery and Reinvestment Act-funded Energy Efficiency Improvement Impacts in the Community

1) GREENSUN HAWAII LOAN PROGRAM

On October 26, 2011, the State launched its GreenSun Hawaii Loan Loss Reserve (LLR) Program for energy efficiency and renewable energy installations for residential and commercial (including multi-family and nonprofit) properties. The LLR Program gives participating lenders access to a loan loss reserve designed to cover a portion of the risk financial institutions face in making loans to finance energy efficiency measures and renewable energy systems. The program currently has ten Participating Lenders and 32 Authorized Contractors statewide.

GreenSun Hawaii has since passed the $1 million milestone in low interest loans issued. We estimate energy savings of 258,000 kilowatt hours annually (6,450,000 over the life of the installations) and a combined savings in the participants' electric bill in excess of $108,000 annually ($2.7 million over the life of the system). The energy saved annually is equivalent to powering 460 households a year.

2) ASSISTANCE TO BUSINESSES

Benchmarked and certificated 23 buildings as Energy Star, mainly hotels, office buildings, and medical facilities, and schools. We also worked with building owners to bring buildings to Energy Star standing.

3) ASSISTANCE TO NONPROFITS

Provided energy efficiency rebates through Hawaii Energy so that it could offer government and non-profit organization facilities up to 25 percent of costs to purchase and install customized energy efficiency measures: recipients included Castle Medical Center, the largest recipient of those funds, followed by Royal Iolani's Association of Apartment Owners (AOAO), Bishop Museum, Pali Momi Medical Center, 1717 Ala Wai AOAO, and Moana Pacific AOAO.

4) ASSSITANCE TO RESIDENCES

There were a number of programs covering all islands. Programs were provided through Hawaii Energy, Kauai Island Utility Cooperative, the State Department of Hawaiian Home Lands, and the State Department of Labor and Industrial Relations's Office of Community Services. Residences received one or more of the energy conservation measures noted below. Recipients varied depending on the programs and included residences such as utility rate payers to any utility in the state as well as low-income households that qualified under federal guidelines.

The aggregated from all energy conservation measures listed below are the equivalent of powering 9,485 homes for one year.

	Installed	Estimated Savings
CFL	4,359	$ 540,255.49
E* Refrigerators	8,280	$ 3,539,858.98
SWH	2,470	$13,898,240.83
Heat Pumps	37	$ 226,877.53
Clothes Washers	13	$ 10,916.91
A/C	8	$ 12,195.59
Power Strips	998	$ 1,016,195.29
Low-Flow Aerators	476	$0.00
Low-Flow Shower Heads	505	$ 603,391.93
Solar PV	33	$ 1,926,135.20
TOTAL		**$21,424,396.16**

5) ASSISTANCE TO GOVERNMENT AGENCIES
   - Provided technical assistance for performance contracting to state and county agencies that resulted in the Race to the Top Award.
   - Certified the State Office Tower for Leadership in Energy and Environmental Design (LEED) Gold for Existing Buildings: Operations & Maintenance.
   - Installed 1005 photovoltaic panels on the Kalanimoku Building.
   - Updated the State of Hawaii building code for state public buildings.

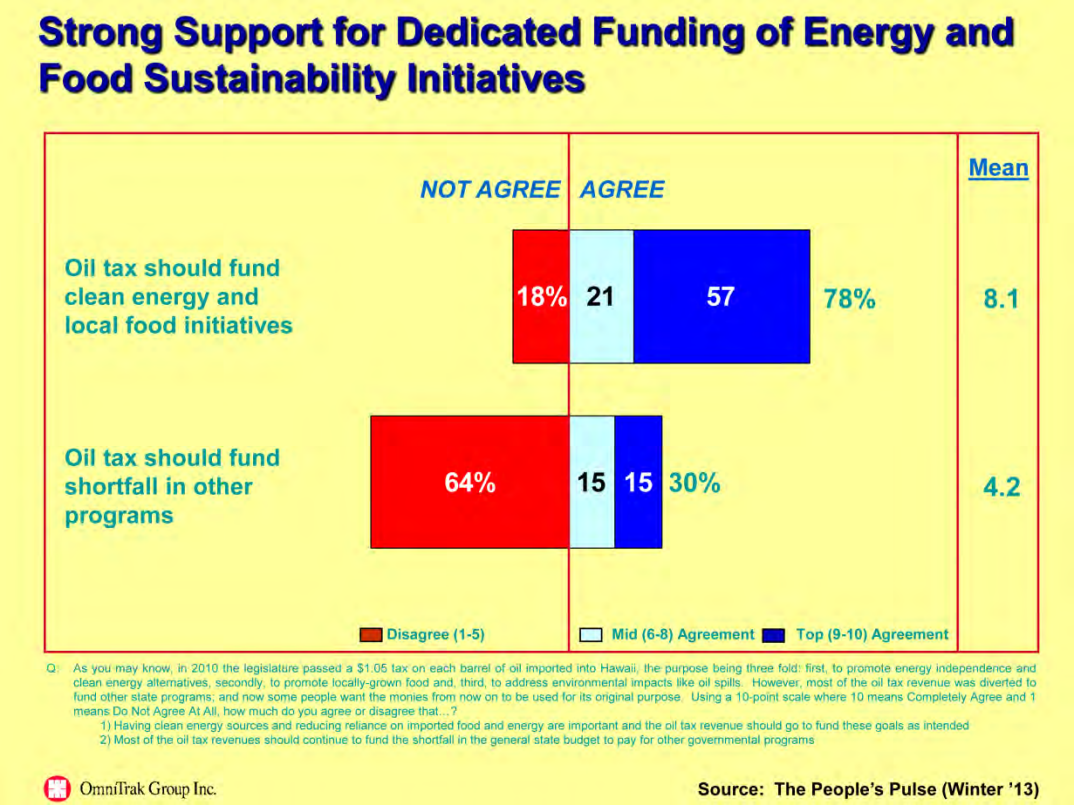
Energy Survey

2013 Energy Legislation – Public Opinion

A statewide random survey was conducted by Omnitrak Group, Inc. on behalf of the Hawaii State Energy Office in December 2012 to get public opinion on two energy-related issues. The survey sampled 700 adult residents from December 3 to 7, 2012 via landline and cell phone interviews.

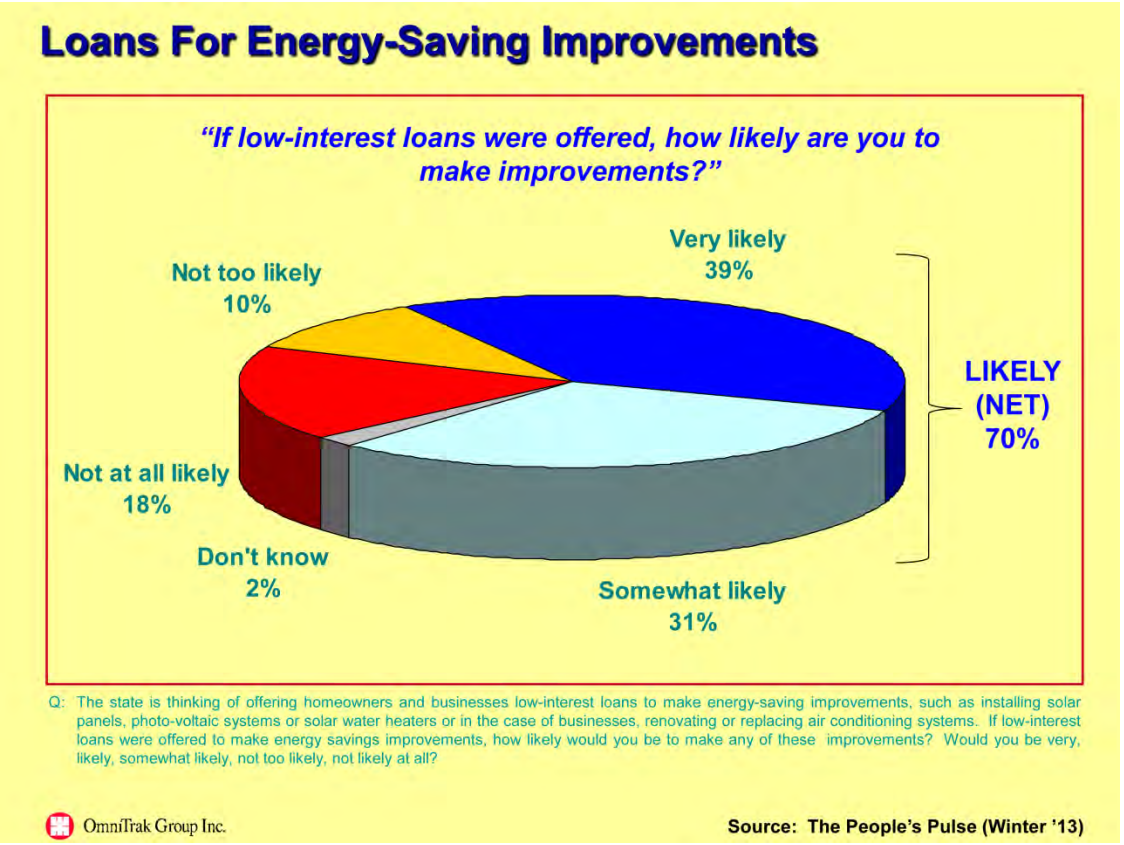
Funding Energy, Food Sustainability, Environmental Impacts

- Question – As you may know, in 2010 the legislature passed a $1.05 tax on each barrel of oil imported in to Hawaii, the purpose being threefold: FIRST, to promote energy independence and clean energy alternatives, SECOND, to promote locally grown food and THIRD, to address environmental impacts like oil spills. However, most of the oil tax revenue was diverted to fund other state programs; and now some people want the monies from now on to be used for its original purpose. Using a 10-point scale where 10 means Completely Agree and 1 means Do Not Agree At All, how much do you agree or disagree that…
  - Having clean energy sources and reducing reliance on imported food and energy are important and the oil tax revenue should go to fund these goals as intended
  - Most of the oil tax revenue should continue to fund the shortfall in the general state budget to pay for other governmental programs
- Results:



LOANS FOR ENERGY IMPROVEMENTS

- Question (for homeowners only) – The state is thinking of offering homeowners and businesses low-interest loans to make energy-saving improvements, such as installing solar panels, photovoltaic systems or solar water heaters or in the case of businesses, renovating or replacing air conditioning systems. If low-interest loans were offered, how likely would you be to make any of these improvements?
- Results:



Footnotes

Page 1, Hawaii Energy Overview

[1] Source: U.S. Energy Information Administration, www.eia.gov/electricity/data.cfm.
[2] Source: DBEDT's Monthly Energy Trends, hawaii.gov/dbedt/info/economic/data_reports/energy-trends.
[3] Source: *Hawaii's Energy Resources Coordinator's Annual Report, 2012*.
[4] Brent: http://www.indexmundi.com/commodities/?commodity=crude-oil-brent&months=120. Gasoline & electricity prices: DBEDT's Monthly Energy Trends.
[5] Source: *Biofuels Study*; DBEDT; 2012.
[6] Rounded. From DBEDT's Monthly Energy Trends:

Residential, 2011:	Oahu	Hawaii	Kauai	Maui	Molokai	Lanai
Average use, kWh/mo	611	523	473	615	374	438
Average cost per kWh	$ 0.28	$ 0.39	$ 0.41	$ 0.34	$ 0.43	$ 0.44
Average monthly bill	$ 171	$ 204	$ 194	$ 212	$ 161	$ 193

[7] 2011 average. Based on data from DBEDT's Monthly Energy Trends: 9,020 miles per vehicle, 19.5 miles per gallon, $4.09/gallon gasoline.

Page 2, Renewable Energy

[1] Hawaii Revised Statutes, chapter 269-91.
[2] Hawaii Public Utilities Commission, *Renewable Portfolio Standards Status Reports,* 2005-2011.
[3] National Renewable Energy Laboratory, *Hawaii Clean Energy Initiative Scenario Analysis*, 2012, and DBEDT.
[4] National Renewable Energy Laboratory, http://en.openei.org/apps/TCDB/, accessed January 9, 2013.
[5] Chapter 269-91 et.seq., Hawaii Revised Statutes.

Page 3, Bioenergy

[1] Naphtha data from facility-level data, USEPA (http://ghgdata.epa.gov/ghgp/main.do#/facility/) and USEIA (http://www.eia.gov/beta/api/qb.cfm?category=1017)
[2] The Honolulu Program of Waste Energy Recovery (HPOWER) is the waste-to-energy facility of the City and County of Honolulu.
[3] DBEDT, Biofuels Report to the Legislature in Response to Act 203, 2012.
[4] Hawaii Natural Energy Institute, Bioenergy Master Plan, 2010.
[5] Sugar industry rule of thumb, for combustion process without pre-drying of biomass (Hawaiian Commercial and Sugar, http://www.hcsugar.com/energy_and_the_environment.shtml).
[6] Biofuels Digest, http://www.biofuelsdigest.com/bdigest/2012/11/12/everyday-low-fuel-prices-drop-in-advanced-biofuels-for-under-100-per-barrel, November, 2012.
[7] With CO_2 from power plant. General Atomics, DARPA-funded Kauai algae facility, Congressional Briefings, Washington, D.C. (March 2012).
[8] Conservative estimate for industry. Specific projects may have significantly higher yields.
[9] US. EPA data for Hawaii, CO_2 only, 20 facilities, http://ghgdata.epa.gov/ghgp/main.do.
[10] From work by Anthony Ostrowski, Oceanic Institute.
[11] Transparent Cost Database, 96 values, last accessed January 10, 2013. Minimum: $0.01; Maximum: $0.17; Median $0.07. http://en.openei.org/apps/TCDB/
[12] Defense Advanced Research Projects Agency.

Page 4, Electric Vehicles

[1] State of Hawaii, *Driving EVs Forward: A Case Study of the Market Introduction and Deployment of the EV in Hawaii*, 2012.
[2] Level 2 charging is at 240 volts. All electric vehicles are equipped for this type of charging.
[3] A "charger" can have one or more ports. The number of "ports" determines how many vehicles each charger can service at a time. One "port" can service one vehicle.
[4] Level 3, also known as "fast charging," can provide an 80% charge for some vehicles in under 30 minutes, depending on vehicle and charger specifications. Not all vehicles can use fast charging.
[5] Based on data collected by the State Energy Office, a relatively simple project in Hawaii can range from $4,000 to $25,000; however, prices vary considerably.
[6] Ranging from mid-$30,000 to $40,000.
[7] Nissan Leaf: 24 kW battery; 0.34 kWh per mile; 100 miles per charge.
[8] 9,020 miles per year, from Hawaii State Data Book.
[9] The New York Times, "Father and Son Drive 423 miles on one charge," December 12, 2012.

Footnotes

Page 5, Geothermal

[1] From Renewable Portfolio Standards status reports to the Public Utilities Commission.
[2] Maui Electric Company, Competitive Bidding, www.mauielectric.com.
[3] GeothermEx, 2005*; Assessment of Energy Reserves and Costs of Geothermal Resources in Hawaii*.
[4] Avoided cost as of January 2013, http://www.heco.com/vcmcontent/StaticFiles/FileScan/ PDF/EnergyServices/Tarrifs/HECO/AvoidCost.pdf
[5] Levelized Cost of Energy Calculator and Transparent Cost Database, 43 values, last accessed January 9, 2013. Minimum: $0.04; Maximum: $0.14; Median $0.06. http://en.openei.org/apps/TCDB/

Page 6, Inter-Island Transmission Cable

[1] Assumes 400 MW, 40% capacity factor, 10,000 Btu/kWh, $100/bbl oil, 6 mmbtu/bbl.

Page 7, Ocean

[1] OpenEI Transparent Cost Database, http://en.openei.org/apps/TCDB/. Based on Intergovernmental Panel on Climate Change (IPCC) Annex 3.
[2] Data from HINMREC.
[3] NELHA website, http://nelha.org/about/facilities.html , accessed January 2013.
[4] Data from Ocean Power Technologies, Inc.
[5] NELHA website, http://nelha.org/about/facilities.html , accessed January 2013.

Page 8, Smart Grid

[1] Smart Grid .gov: http://www.smartgrid.gov/the_smart_grid
[2] Worldwide Smart Grid Spending to Hit $46 Billion in 2015: http://www.treehugger.com/clean-technology/worldwide-smart-grid-spending-hit-464-billion.html
[3] Recovery Act- Smart Grid Investment Grants: http://energy.gov/oe/technology-development/smart-grid/recovery-act-smart-grid-investment-grants
[4] Hawaii Data Book: http://hawaii.gov/dbedt/info/economic/databook/db2011/section01.pdf
[5] Sum of stated investment in "Existing Smart Grid Projects in Hawaii"
[6] University of Hawaii RDSI Demonstration Project: http://www.smartgrid.epri.com/doc/Hawaii%20RDSI%20Final.pdf
[7] DBEDT Press Release: http://energy.hawaii.gov/wp-content/uploads/2011/09/NR-MOU-Signing-NEDO-Hawaii.11.22.11.pdf
[8] KIUC Smart Meter FAQs: http://website.kiuc.coop/content/smart-meter-faqs
[9] Honeywell Press Release: http://honeywell.com/News/Pages/Honeywell-And-Hawaiian-Electric-To-Use-Demand-Response-To-Integrate-Renewables-And-Reduce-Fossil-Fuel-Dependence.aspx
[10] DBEDT Press Release: http://governor.hawaii.gov/governor-abercrombie-secures-agreement-with-republic-of-korea-for-smart-grid-development/

Page 9, Solar

[1] Source: 2007-2011 Annual RPS Reports, PUC dockets.
[2] Source: 2001-2011 NEM, FIT Annual Reports, PUC Dockets.
[3] Source: August 2008 PV and CSP Resource Maps, NREL.
[4] RPS reports and PUC fillings.
[5] Source: 2007-2011 Annual RPS Reports, PUC dockets.
[6] Hawaii Clean Energy Initiative Scenario Analysis (2008-2010).
[7] Source: DBEDT, March 2012.
[8] US Department of Energy program estimate, Transparent Cost Database, 74 values, last accessed January 9, 2013. Minimum: $0.15; Maximum: $0.59; Median $0.28. http://en.openei.org/apps/TCDB/

Page 10, Wind

[1] From RPS reports to the Public Utilities Commission from Maui Electric Company (MECO), Hawaii Electric Light Company (HELCO), and Hawaiian Electric Company (HECO).
[2] EIA 923 forms.
[3] RPS reports.
[4] Hawaii Clean Energy Initiative Scenario Analysis (2008-2010), using capacity factors of 35% for Oahu, Hawaii, and Kauai resources; 40% for Molokai and Lanai; 45% for Maui.
[5] RPS reports.
[6] RPS reports and PUC fillings.

[7] Hawaii Clean Energy Initiative Scenario Analysis (2008-2010).
[8] NREL land-use Requirements of Modern Wind Power plants in the United States (2009).
[9] http://hawaii.gov/dlnr/dofaw/hcp.
[10] Siemens turbines at Kawailoa, 90 m hub height.
[11] US Department of Energy program estimate, Transparent Cost Database, 109 values, last accessed January 9, 2013. Minimum: $0.04; Maximum: $0.12; Median $0.06. http://en.openei.org/apps/TCDB/

Page 11, Permitting

[1] *Renewable Energy Permitting Barriers in Hawaii*, National Renewable Energy Laboratory (2012).