Hawaii Energy Facts & Figures

June 2012

- Bioenergy
- Electric Vehicles
- Energy Efficiency
- Geothermal
- Smart Grid
- Solar
- Undersea Cable

State of Hawaii Department of Business, Economic Development and Tourism

Hawaii State Energy Office

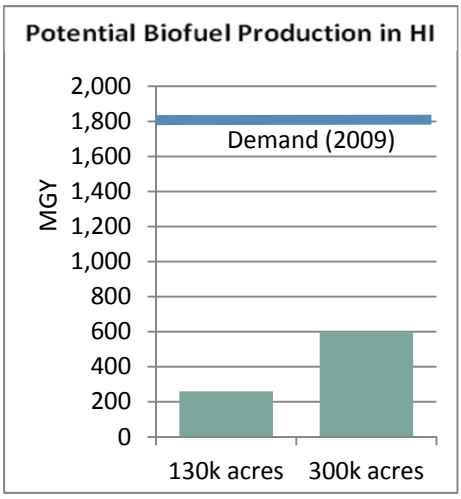
energy.hawaii.gov

Hawaii Bioenergy: Facts & Figures

Market

- Demand for oil in Hawaii is 50 million barrels per year (= $5.4 billion potential biofuel market at $107/barrel).

- Transportation is 2/3 of demand:
  - 12 m bbl jet fuel
  - 11 m bbl gasoline
  - 1 m bbl diesel (hwy)
- Electricity is 1/3 of demand:
  - 8.2 m bbl fuel oil
  - 2.6 m bbl diesel
  - 0.107 m bbl biodiesel



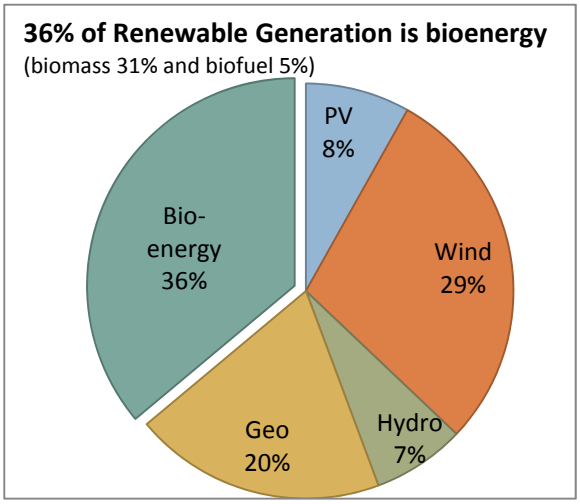
Source: 2007-2011 Annual RPS Reports, PUC

Long-term Contracts

- HECO RFP for up to 210 MGY/20 yr contracts; 10 proposals; 5 contracted/negotiating.
- DoD, Defense Production Act, Title III, RFI; 32 MGY drop-in replacement fuel with special consideration for Hawaii as a strategic location.
- USDA, US DOE and Navy to invest $510 million with matching private sector investment for biofuel refinery construction/ upgrades to produce advanced drop-in biofuels.

Capacity

- $2 billion of biofuels can potentially be produced in Hawaii by 2030, on 300,000 acres, at $150/bbl of oil (at $100/bbl of oil, the value would be $1.4 billion).
- High productivity (22 dry tons/acre/yr average; 45 tons possible).
- Year-round growing season (3+ crops / year).
- Major land owners invested (HC&S, 35k acres; HBE, 141k acres; federal; state).
- 29 utility scale bioenergy projects proposed.



Source: 2007-2011 Annual RPS Reports, PUC

Project Developers*

- AES Hawaii: 5MW to 20 MW; 15 jobs
- Aina Koa Pono (AKP); 24 MGY; 200/300 jobs
- Big Island Carbon
- BioEnergy Hawaii Inc.: 11MW; 27/60 jobs
- Cellana: 1.3 MGY; 45 jobs
- ClearFuels-Rentech; 40 jobs
- General Atomics
- Green Energy; 7 MW; 39/200 jobs
- Hawaii BioEnergy LLC (HBE); 10+ MGY; 150 jobs
- Hawaiian Commercial & Sugar Company (HC&S/A&B): 16 MW; 800 jobs
- Hawaiian Electric Industries
- Honeywell UOP: 50 MGY; 200/800 jobs
- Honua Power, LLC: 6 MW
- Hu Honua Bioenergy, LLC: 25 MW; 30/100 jobs
- Kauai Island Utility Cooperative (KIUC)
- Kuehnle AgroSystems
- Pacific Biodiesel: 5.5 MGY; 60/87 jobs
- PacWest: 20 MW & 10 MGY; 20 jobs
- Phycal Inc.: 3 MGY; 48/10
- Real Green Power
- The Gas Company: 1 MGY

**Current and projected capacity; ongoing/construction jobs*

Hawaii EV: Facts & Figures

- Ground transportation accounts for 30% of liquid fuel use in Hawaii.
- As of April 2012, there were 985,414 registered gasoline passenger vehicles, 11,545 passenger hybrid vehicles (no plug), and 751 electric passenger vehicles (with plug) in the state.
- On average, 50,000 vehicles are sold a year in Hawaii. In recent years, approximately 35,000 have been sold.
- Average turnover of vehicles is 50,000 each year. However, turnover in 2009 was only 33,000 and in 2008 only 42,000. Assuming 50,000 annual turnovers, it will take 20 years for a complete turnover of a fleet.
- EV lifecycle is estimated at 10 years with EV battery warranties ranging from 3, 6 to 8 years depending on model and manufacturer.
- Hawaii has over 200 charging locations at over 80 locations, soon to have six DC fast chargers.
- HECO offers EV TOU rates.
- The City and County of Honolulu offers online permits for residential EV charging installations.
- Enterprise Rent-A-Car currently has 30 EV's in fleet and is adding Nissan LEAFs to the Maui market in May 2012.
- In 2010, Vehicle Miles Traveled (VMT) in Hawaii totaled 10,111. Miles traveled per vehicle totaled 9,027.

American Recovery and Reinvestment Act Funded: EV Ready Program

In the last two years, Hawaii has invested over $5 million in ARRA funds to build an EV infrastructure.

- Over $2.8 million to install more than 200 charging spots and six DC Fast Chargers at over 80 locations.
  - HI nation's leader on a per-capita basis for public EV charging availability. By August 2012, one charging station for every 5,500 residents.
- Over $2.2 million allocated in Hawaii EV Ready rebates
  - 455 Rebates for Electric Vehicles; 279 Charger Rebate
- In partnership with University of Hawaii Maui College via a US DOE EV Planning grant
  - DBEDT would like to build a Application and Website listing EV charging locations

EV Ready Awardees by Organization	Funding	Project	Accomplishments: 200 new EV charging stations at over 80 locations statewide
Better Place	$581,943	Install Level 2 Charging Stations on all islands, conduct grid integration analysis and partner with rental car companies to acquire EVs for their fleets.	After conducting over 150 individual site assessments at numerous locations in all Islands across Hawaii, installed 65 Level 2 Charging Stations with 130 charging spots at 43 different locations.
AeroVironment	$820,000	Install Level 2 Charging stations and DC Fast Charging Stations on all islands and partner with Hawaii Auto Dealers Association to install charging stations at local EV dealerships.	After conducting over 250 individual site assessments across numerous locations in all Islands across Hawaii, including dealerships, AeroVironment installed 75 Level 2 Charging Stations at 50 different locations. Aerovironment also installed 6 DC Fast Charging Stations: 1 on Kauai, 4 on Oahu, and 1 on

			Maui, currently being installed. The DC Fast-charging stations will allow owners of Nissan Leafs, Mitsubishi I-MiEV and other plug-in EVs with the CHAdeMO DC Quick charger port to re-charge their vehicles in less than 30 minutes.
GreenCar Hawai'i	$200,000	Purchase EVs for a car sharing service (renting EVs by the hour to hotel guests and the public) and install Level 2 Charging Stations accessible to GreenCar's EVs. The EVs will be operated by guests of the Hotels and the public.	Green Car purchased 4-Nissan Leafs, and 4-Mitsubishi iMiEV. Green Car also installed 2-ECOtality Blink charging stations at the Honolulu DoubleTree.
County of Kauai	$267,000	Install Level 2 Charging Stations on the Garden Island and purchase EVs for County fleets.	Installed 10 Level 2 AeroVironment Charging Stations and purchased 5 EVs assigned to different County Agencies and Divisions.
City & County of Honolulu	$400,000	Install Charging Stations on Oahu, purchase EVs for City Use and deploy a new online Permitting System for residential charger installations.	City and County of Honolulu aims to install 8 Level 2 chargers by 8/31/12 and to purchase 2 EVs for City motor pool use.
Plug In America	$50,000	Develop a Hawaii specific guidebook for the installation of EV Charging Stations at retail and commercial sites. Conduct public education and outreach.	Plug In America wrote the EV Ready Guidebook for commercial charging station installations and participated in public forums that brought attention to opportunities and benefits of operating EVs on the Islands.
Total	By the end of 2012, Hawaii will have more installed Level 2 EV charging stations per capita 1: 5,500 residents than any other state. EV drivers in Hawaii will be able to charge up at over 200 charging sites, at more than 80 locations statewide. The new stations were made possible by private, Hawaii business investment and $2.8 million in federal ARRA stimulus funds through the EV Ready Grant Program.		

Hawaii Dealers

- According to Nissan North America Hawaii makes the top ten list at number 7 in total LEAF sales since Nissan launched in Hawaii with now over 415 Leafs. The top 6 in order are: CA, WA, TX, OR, TN, AZ
- Currently the Nissan LEAF, Chevy Volt, Toyota Plug in Prius, and the Mitsubishi I MiEV are available in Hawaii
- In Hawaii there are 62 dealerships, 30 of which are EV certified or in the process of becoming EV certified to sell EVs in Hawaii.

Targets

- HCEI Transportation Goals call for the reduction in the use of petroleum in ground transportation by 70% or approximately 385 Million Gallons Year by 2030.
- The current baseline is approximately 550 MGY. Focus pathways have been identified:
  - 40% (150 MGY) Expand the use of renewable fuels for transportation
  - 30% (120 MGY) Improve the efficiency of the standard vehicle fleet
  - 20% (75 MGY) Accelerate the deployment of EV /related infrastructure
  - 10% (40 MGY) Reduce the overall number of vehicle miles traveled

HCEI EV TARGETS	2015	2020	2025	2030	TOTAL FUEL REDUCTION (2030)
Annual Sales	4,000	10,000	20,000	30,000	75 Million Gallons a Year by 2030 reduced via EV Adoption in Hawaii
Total Market Penetration	10,000	50,000	100,000	210,000	

Hawaii Energy Efficiency: Facts & Figures

Performance Contracting for State 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 $158,864,577. 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 $325 million for all projects.

- ✓ The projects will include over 145 buildings and over 4 million square feet.

- ✓ Annual cost savings for all projects is $36M, representing 33% savings.

- ✓ Hawaii is ranked 1st in the nation for performance contracting. (Energy Services Coalition)

Over 20 years, the projects will:

- ✓ Save over $311M in electricity costs.

- ✓ Save the equivalent in energy to power over 290,000 homes a year in Hawaii.

- ✓ Create 8,210 jobs. (National Association of Energy Service Companies)

- ✓ Provided over $448 million of direct (total investment) and indirect (repair/maintenance/taxes) impact to the economy.

- ✓ Claim $700,000 in utility rebate incentives.

**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.*

Hawaii Geothermal: Facts & Figures

Projects	Puna Geothermal Venture Power	Ormat Exploration	UH Exploration
Island:	Hawaii	Maui (Haleakala)	Hawaii, Maui (TBD)
Technology:	Dispatchable power	Geophysics Geochemistry	Magnetotellurics
Description:	38 MW	Characterizing the resource	ID potential hot fluids
Project Status:	Active/Ongoing	Active/Ongoing	Development

- Cheaper than oil and most other renewable resources (LCOE estimated $0.08-$0.12 /kWh).
- Geothermal energy provides between 15% to 19% of the energy needs of the residents and businesses on the Big Island of Hawaii.
- Although it's abundant in the state, sources for geothermal are geographically limited to areas on the Big Island and Maui, which are the youngest islands and still have heat in their volcanoes.
- Puna Geothermal Venture, owned by Ormat Technologies, runs the only geothermal plant in Hawaii. This plant converts volcanic heat into steam to generate 38 MW of electricity.
- HELCO would like to add 50 MW of geothermal capacity. The expansion could provide as much as 48% of the Big Island's peak load.
- Studies estimate there are more than 1,000 MW in geothermal reserves.
- Geothermal has the potential to provide 74% to 210% of Hawaii's Renewable Portfolio Standards goal.
- Reaching that level of production would require an undersea cable to connect the island grids and allow the Big Island to export the electricity to Oahu and other islands where the energy is needed.

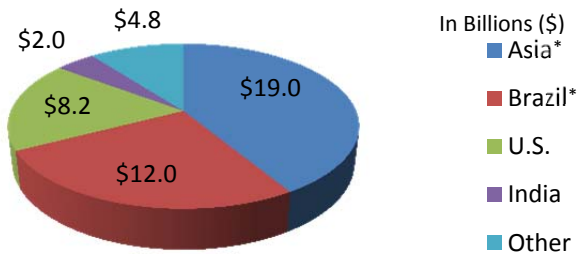
Hawaii Smart Grid: Facts & Figures

Benefits of Smart Grid

- Allows for increased renewable energy penetration
- Demand response reduces the need for spinning reserves
  - Reduces the amount of oil imported
  - Increases grid reliability

Smart Grid Market is Growing

Worldwide Smart Grid Market: $46 Billion in 2015



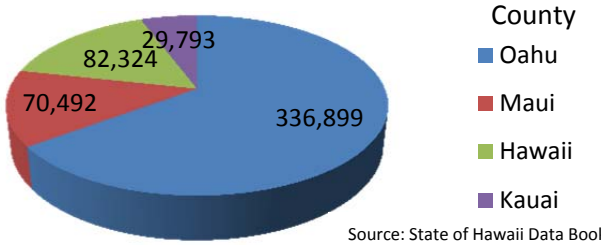
*Asia and Brazil data is for 2016

- DOE gave $3.4 billion in grants for smart grid projects and grid upgrades in recent years

Potential Market in Hawaii

- Home management systems along with commercial building energy management will be part of smart grid.

2010 Houses & Condos: 519,508 Statewide



Source: State of Hawaii Data Book 2010

- There are also tens of thousands of commercial and government buildings which will add to the smart grid market in Hawaii.

Peak Electricity Demand and Total Generation Capacity

	Oahu	Hawaii	Maui	Lanai	Molokai	Kauai
Total Capacity (MW)	**1672**	**270**	**261**	**9.3**	**11.8**	**128**
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

- Potential demand reduction made available by smart grids can replace reserve capacity
- DBEDT is currently studying how to integrate up to 1 GW of intermittent renewables on Oahu's grid

Existing Smart Grid Projects in Hawaii

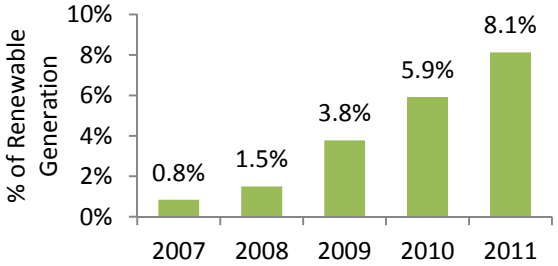
Name	Company	Location
RDSI Maui Smart Grid Project	HNEI	Maui Meadows, Kihei
Hawaii – Okinawa Smart Grid Demonstration Project	NEDO	Wailea, Maui
Oahu Smart Grid Demonstration	Honeywell	Oahu

Existing Battery Storage Projects in Hawaii

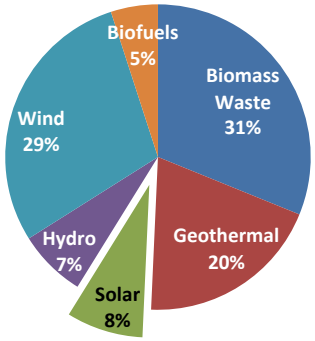
Name	Company	Location	Size (MW)
KIUC Battery Storage Project	Xtreme Power	Kauai	1.5
First Wind Kahuku Project	Xtreme Power	Kahuku, Oahu	15
Waiawa High-Penetration Circuit	Altairnano	Waiawa, Oahu	1
Lanai La Ola PV Project	Xtreme Power	Lanai	1.125
Kaheawa Wind Project 1	Xtreme Power	Kaheawa, Maui	1.5
Kaheawa Wind Project 2	Xtreme Power	Kaheawa, Maui	10
Wind Farm BESS Demonstration	Altairnano	Hawi, Hawaii	1
HNU Energy BESS Demonstration	International Battery	Kihei, Maui	1
HREDV/Gen-X BESS Demonstration Project	Altairnano	Hawi, Hawaii	0.1
Auwahi Wind Project	A123	Ulupalakua, Maui	11
Maui Renewable Energy Storage System	Premium Power	Kahului, Maui	0.25
HELCO BESS	Saft	Hawaii Island	0.1
MEDB Renewable Energy Generation & Storage Demonstration	HNU	Kihei, Maui	0.16
Total	**7 companies**	**4 counties**	**43.7 MW**

Hawaii Solar: Facts & Figures

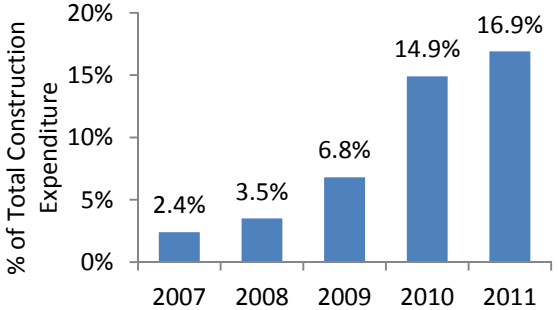
Solar generation increased from less than 1% of total renewable generation in 2007 to more than 8% in 2011. Solar generation is approximately 1% of total electricity generation.



Source: 2007-2011 Annual RPS Reports, PUC

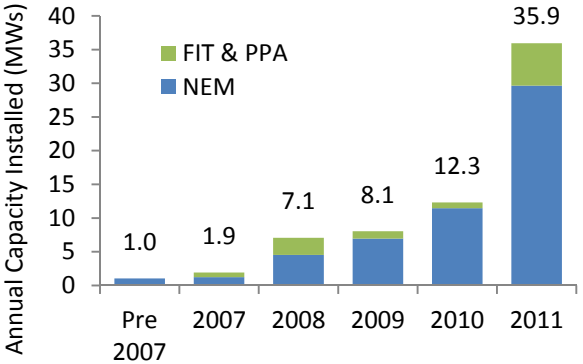


Solar-related construction expenditures reached nearly 17% of total construction expenditures



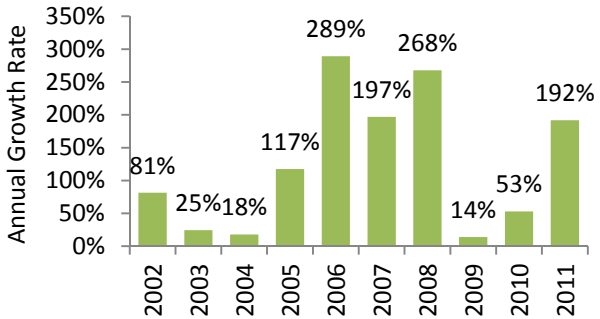
Source: DBEDT, March 2012

66 MWs of cumulative solar capacity installed statewide, including distributed and utility-scale systems



Source: 2001-2011 NEM, FIT Annual Reports, PUC Dockets

10-Year Compound Annual Growth Rate of Solar Capacity Installed: 117%



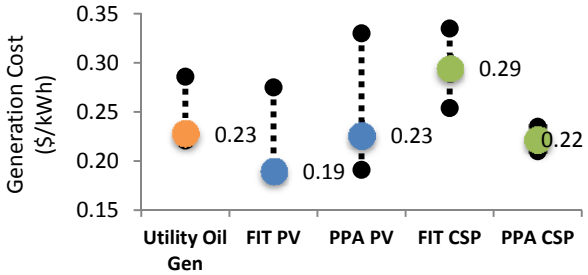
Source: 2001-2011 NEM, FIT Annual Reports, PUC Dockets

Cost per watt for PV installation has dropped by half in the past decade

Estimated Cost $/Watt Installed	2002	2012	%Δ
Residential PV	$ 10.60	$ 5.50	-48%
Commercial PV	$ 8.82	$ 3.75	-57%

Source: Dr. Thomas Loudat, University of Hawaii

PV generation cost on par with oil generation cost at ~$130/bbl



Source: 2011 FIT Report, PUC Dockets, Monthly

Average statewide solar capacity factor: 19%-20%

PV	Hawaii	Kauai	Lanai	Maui	Molokai	Oahu
Max	21%	20%	21%	21%	21%	20%
Min	10%	17%	20%	18%	19%	18%
CSP	**Hawaii**	**Kauai**	**Lanai**	**Maui**	**Molokai**	**Oahu**
Max	20%	19%	22%	22%	21%	20%
Min	15%	14%	19%	15%	18%	15%

Source: August 2008 PV and CSP Resource Maps, NREL

Hawaii solar installation Incentives

- Public Benefits Fund Solar Water Heating Rebate: *$750*
- Public Benefits Fund Solar Water Heating Interest Loan Buy-Down: *$1,000*
- State Renewable Energy Tax Credit: *35% Non-refundable; 24.5% Refundable*
- Federal Renewable Energy Tax Credit: *30% Non-refundable*

3 of the Largest Proposed PV Projects

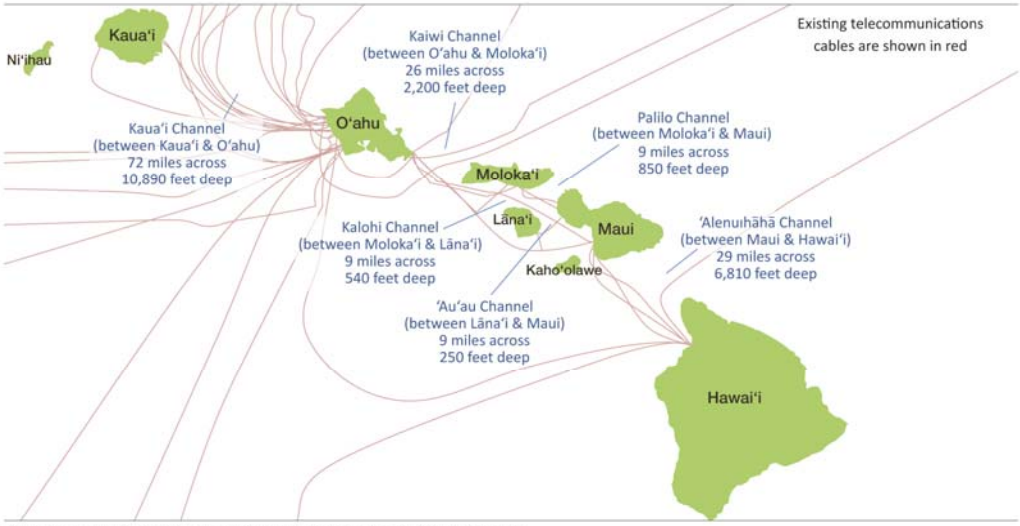
Developer	Castle & Cooke	KIUC KRS One	McBryde Hawaii
Island	Oahu	Kauai	Kauai
Location	Mililani	Anahola Bay	Port Allen
Potential	20 MWs	12 MWs	6 MWs

Source: DBEDT, May 2012

PV – Photovoltaic
CSP – Concentrated Solar Power
NEM – Net Energy Metering
FIT – Feed-In-Tariff
PPA – Power Purchase Agreement

Hawaii Undersea Cable: Facts & Figures

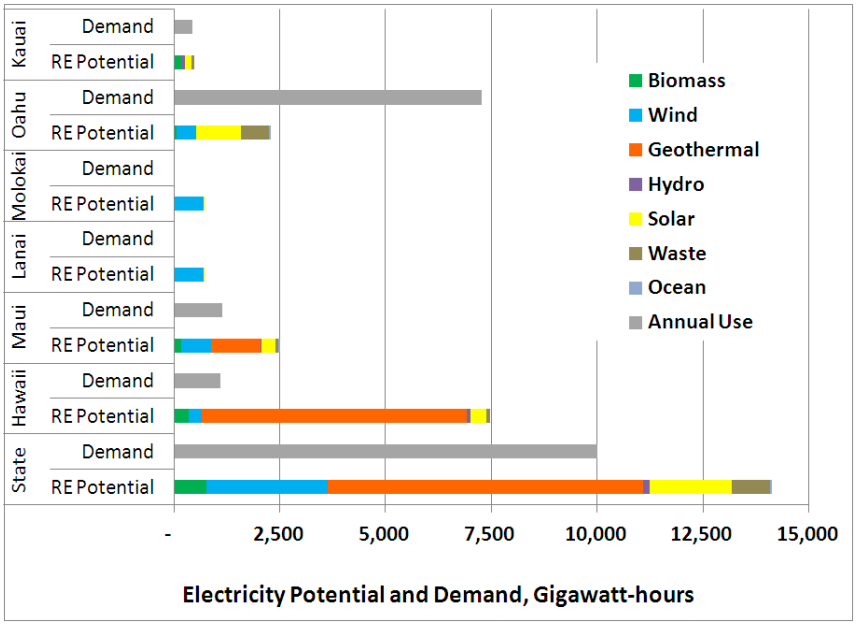
- Hawaii has the highest electricity prices in the nation, 3 times higher than the U.S. average: $0.32 vs. $0.10 per kilowatt-hour (kWh). This is due to:
  1. Hawaii's unique over-dependence on petroleum-based fuels. (Hawaii is 77% dependent on oil for electricity; the U.S. average is 1%.)
  2. Hawaii's six separate electric grids are small and isolated.



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

- Legislation recently passed (SB 2785) describes how a private developer can finance, build, and operate one or more undersea cables.
- With low sulfur fuel oil at $135/bbl, the cost of **just the oil** is $0.24 per kWh.
- The projected cost to deliver power via an 80-120 mile (50-75 km) transmission cable is less than $0.10/kWh at 40% capacity. At a higher capacity it drops below $0.07 per kWh. Renewable energy generation estimates are between $0.08 and $0.18 per kWh.

- A 400 MW high voltage direct current (HVDC) 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 in the picture is 500 MW.
- It is likely the cable will run underground at shorelines, as telecommunication cables do now.
- 400 MW system at 40 percent capacity = 14% of Hawaii (20% of Oahu) needs, equal to the mount used by 194,000 households. 400 MW @ 80 percent = 28% of Hawaii (40% of Oahu) needs, nearly equal to the energy used by all of Hawaii's households.
- Undersea cables are in use worldwide. The largest submarine cable network in operation has a capacity of 2000 MW, or more than Hawaii's entire statewide electricity demand. Some have been in service continuously for more than 30 years. For example, SACOI (Sardinia-Corsica-Italy-France) is a 300 MW, 75-mile undersea cable installed in 1967.

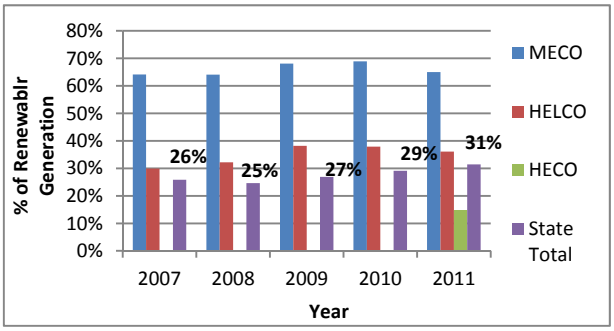


Source: DBEDT

Hawaii Wind: Facts & Figures

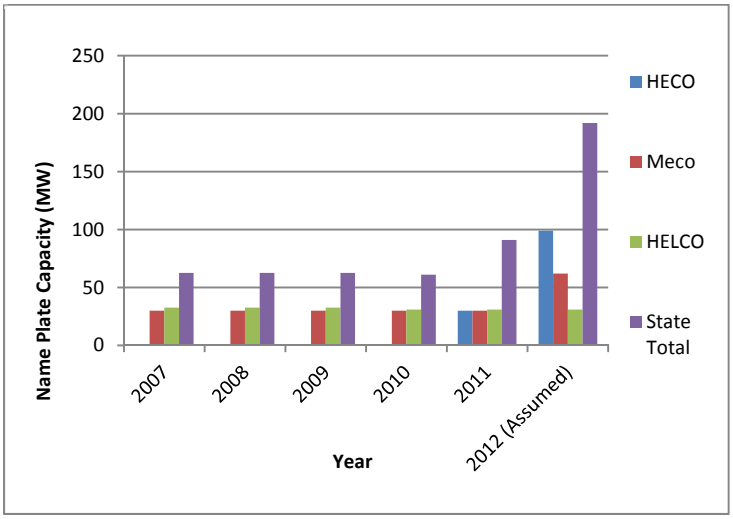
Existing and Under Development Projects

- Wind energy first made an appearance on Hawaii's electrical grid in the early 1980s when it was only in its infancy. Today wind is Hawaii's second most utilized renewable accounting for almost 31% of the state's total renewably generation.



Source: HECO, KIUC RPS Reports, 2007-2011

- Existing projects are currently limited to the islands of Oahu, Maui, and Hawaii. While Kauai has a very good wind resource, it has a high number of endangered or threatened avian species that make utiltiy scale wind devleopment very challenging. While wind energy growth has been fairly slow over the last five years, projects currently under construction will make 2012 a record year for wind installation in Hawaii, bringing the state's total to just under 200 MW of installed wind.



Source: HECO, KIUC RPS Reports, 2007-2011

Project	Hawi Wind Farm	Kaheawa Wind Farm	Pakini Nui Wind Farm	Kahuku Wind Farm
Developer	Hawi Renewable	First Wind	Tawhiri Power	First Wind
Island	Hawaii	Maui	Hawaii	Oahu
Size (MW)	10.5	30	20.5	30
Year installed	2006	2006	2007	2011

Potential

Hawaii has a robust and consistent wind regime with capacity factors typically between 30% and 40%. While studies have shown a possible potential capacity at 3,000 MW on land and 7,800 MW off-shore (0-60 m deep) of theoretical wind potential, a multitude of factors make these number very unrealistic. A more realistic land based potential capacity for the state is closer to 900 MW.

Island	Oahu	Kauai	Maui	Hawaii	Lanai	Molokai	State Total
Capacity (MW)	175	1	200	85	200	200	**861**

Cost

Wind has typically been one of the most affordable forms of renewable energy. While Hawaii's unique environmental, cultural and geographic challenges make it more expensive than projects on the mainland, it is still the most affordable of Hawaii renewables at an estimated capital cost $2,600 per installed kWh.

Challenges

- **Endangered birds** and plants make siting a wind farm particularly difficult. Most developers mitigate for incidental takes by creating habitat conservation plans that protect and encourage net gains for a specific endangered species.
- **Cultural and social issues** also make siting wind farms challenging as burials and unique cultural sites often times make great wind resources impossible to develop.
- **Grid interconnection** can be difficult as Hawaii's electrical grids are small and pose a challenge for intermittent renewables such as wind and solar. Developers have been forced to install expensive batteries to interconnect to Hawaii grids.