WORLD BANK GROUP ESMAP
Energy Sector Management Assistance Program

THE WORLD BANK CLEAN ENERGY GLOBAL SOLUTIONS GROUP
ESMAP VARIABLE RENEWABLE ENERGY GRID INTEGRATION SUPPORT PROGRAM

RENEWABLE ENERGY INTEGRATION FOR ISLANDS

May 23 – 27, 2016

The Case of Hawaii

MISSION

The Energy Sector Management Assistance Program (ESMAP) is a global knowledge and technical assistance program administered by the World Bank. It provides analytical and advisory services to low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth. ESMAP is funded by Australia, Austria, Denmark, Finland, France, Germany, Iceland, Lithuania, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom, as well as the World

RENEWABLE ENERGY INTEGRATION FOR ISLANDS
THE CASE OF HAWAI'I

The World Bank Clean Energy Global Solutions Group and the Energy Sector Management Assistance Program (ESMAP) have organized a study tour to Hawaii, May 23 – May 27, 2016. The study tour is an opportunity for policy makers and technical experts from client island countries to learn about the experience of Hawaii in supporting, deploying, and integrating multiple renewable energy (RE) and storage technologies into local grids.

Through visits to sites and institutions on Oahu and Big Island, the participants will have an opportunity to interact with local experts and learn about the regulatory/policy side of renewable deployment as well as about technologies suitable for deployment in an island environment. The objective is to familiarize client countries with state-of-art renewable energy and storage technologies suitable for an island environment, their integration into island grids, and enabling regulatory and policy environment necessary for achieving successful integration.

WORLD BANK GROUP ESMAP
Energy Sector Management Assistance Program

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ITINERARY

Day 1: Monday, May 23 – Oahu

TIME	Session	VENUE
-	*Breakfast at place of choice*	
9:00	**Welcome, Logistics, and Day 1 Briefing**	Lobby of Aston at the Executive Centre Hotel 1088 Bishop St, Honolulu, HI 96813

10:00	**Visit to the Hawaii Public Utilities Commission**
	• Introductions
	• Commission overview
	  o Commission role and key stakeholders
	  o Hawaii's current energy developments
	  o Planning for future – process and policies
	• Open discussion
	  o Current energy developments and issues in visitor nations
	  o Regulatory structure(s) comparison
	• Lessons learned and any key takeaways
		465 South King Street, #103
		Honolulu, HI 96813

13:30	**Lunch**	

15:00	**Visit to Hawaii Electric Company**
	• Welcome
	• Hawaiian Electric Overview Presentation
	• System Operations Overview Presentation
	• Integration of Renewables
	  o Hawaiian Electric Program & Policies
	  o Issues, Opportunities & Lessons Learned
	  o Technical Tools & Partnerships
	  ▪ Microplanet LV Regulators
	  ▪ Varentec Pilot Projects
	• Group Discussion / Audience Q&A
		ASB Tower
		1001 Bishop St.
		8th Floor Conference Room
		Honolulu, HI 96813

18:00	**Return to Aston at the Executive Centre Hotel**	
19:00	**Dinner at place of own choice**	

Day 2: Tuesday, May 24, 2016 – Oahu

TIME	SESSION	VENUE
	Breakfast at place of own choice	
09:00	**Day 2 Briefing**	Lobby of Aston at the Executive Centre Hotel 1088 Bishop St, Honolulu, HI 96813
09:30	**Visit to the Hawaii Natural Energy Institute** • Welcome • HNEI overview • GridStart Program • Utility Assets Ownership models • Q&A	1680 East-West Rd Honolulu, HI 96822
13:00	**Lunch**	
14:00	**Visit to DBEDT - Hawaii State Energy Office** • Introduction to DBEDT and HSEO • Guiding Policy Directives • Holistic approaches to planning • Modernizing the Grid • Q&A	Department of Business, Economic Development & Tourism Hawaii State Energy Office Honolulu, HI 96804
16:00	**Session with Clean Energy Solutions Centre** • Services provided by the Clean Energy Solutions center (CESC) • Experience with CESC in SIDS and CARICOM • Open discussion	Department of Business, Economic Development & Tourism Hawaii State Energy Office Honolulu, HI 96804
18:30	**Return to Aston at the Executive Centre Hotel**	
19:30	**Dinner at place of own choice**	

Day 3: Wednesday, May 25, 2016 – Oahu

TIME	SESSION	VENUE
-	**Breakfast at place of own choice**	
09:00	**Day 3 Briefing** **Departure from Aston**	Lobby of Aston at the Executive Centre Hotel 1088 Bishop St, Honolulu, HI 96813
09:30	**Visit to SolarCity HQ in Hawaii** • Introduction to SolarCity • Smart Energy Home • KIUC Dispatchable Solar PV-Storage Plant • Open Discussion	SolarCity HQ 599 Kahelu Avenue Mililani, HI 96789
12:30	**Lunch at SolarCity HQ**	
14:30	**Visit to H-Power (Covanta)** • Tour of facilities and discussions with technical staff	Campbell Industrial Park 91-174 Hanua Street, Kapolei, HI 96707
16:00	**Return to hotel**	
19:00	**Dinner at place of own choice**	

Day 4: Thursday, May 26, 2016, Oahu - Big Island

TIME	SESSION	VENUE
	Breakfast at place of own choice	
08:00	**Hotel Check out and Departure for Oahu Airport by taxi**	Lobby of Aston at the Executive Centre Hotel 1088 Bishop Street, Honolulu, HI 96813
09:10	**Hotel check in** **Departure from Marriott Courtyard**	Lobby of Marriott Courtyard King Kamehameha 75-5660 Palani Road, Kailua-Kona, HI 96740
12:00	**Visit to Natural Energy Laboratory of Hawaii (NELHA)** • Meetings with NELHA companies o Dewpoint Systems o The Ocean Thermal Energy Conversion Facility o The Aquion Battery/Solar Storage Test Array (Cellana)	Hawaii Ocean Science & Technology (HOST) Park 73-987 Makako Bay Drive Kailua Kona, HI 96740
13:30	**Lunch**	
15:00	**Visit to Blue Planet Foundation Ranch** • Arrival and introductions - Brief overview of Blue Planet Foundation and the ranch microgrid • Tour of the microgrid and lab o Primary generation (solar and wind; controls) o Storage (batteries; hydrolyzer) o Hydrogen (storage, electricity, and other uses)b o Technical Q&A and discussion • Presentation on Blue Planet Foundation and discussion of Hawaii energy landscape and solutions o How and why Hawaii adopted the 100% renewable energy target and other key evolving energy policies o Highlight effective and ineffective past/current programs o Discussion of pending solutions and barriers o Policy Q&A and discussion • Introduction and discussion re: Renewable Islands project o Concept and genesis o Status update on participation by other islands	Pu'u Wa'awa'a Ranch Kailua-Kona, HI 96740
19:00	**Evening Off**	Marriott Courtyard King Kamehameha 75-5660 Palani Road, Kailua-Kona, HI 96740

Day 5: Friday May 27, 2016 - Big Island

TIME	SESSION	VENUE
08:00	**Breakfast at place of choice & Day 5 Briefing**	Marriott Courtyard King Kamehameha 75-5660 Palani Road, Kailua-Kona, HI 96740
09:00	**Bus departure to Puna Geothermal Venture** [2 hours transport]	Marriott Courtyard King Kamehameha 75-5660 Palani Roadd, Kailua-Kona, HI 96740
11:00	**Visit to Puna Geothermal Venture (PGV)** • Tour of facilities and discussion with management and technical staff on geothermal power generation	14-3860 Pohoiki Road Pāhoa, Hawaii 96778
13:00	**Lunch in Puna at place of choice**	
15:00	**Optional: Visit to Hawai'i Volcanoes National Park**	Hawai'i Volcanoes National Park 1 Crater Rim Drive, Volcano, HI 96785
19:00	**Return to hotel & Reflections on Lessons Learned**	Marriott Courtyard King Kamehameha 75-5660 Palani Road, Kailua-Kona, HI 96740
20:00	**Dinner at place of choice**	Marriott Courtyard King Kamehameha 75-5660 Palani Road, Kailua-Kona, HI 96740

CONTACT INFORMATION

COMPANY	ADDRESS	CONTACT
Aston at the Executive Center Hotel (Hotel in Honolulu, Oahu)	1088 Bishop Street Honolulu, HI 96813	(808) 539-3000
Courtyard King Mahemahela (Hotel in Kona, Big Island)	75-5660 Palani Road Kailua-Kona, HI 96740	(808) 329-2911
Hawaii Public Utilities Commission	465 South King Street, #103 Honolulu, Hawaii 96813	Germaine Salim, Utility Analyst Phone: (808) 586-3757 Germaine.Salim@hawaii.gov
Hawaii Electric Company	1001 Bishop St #2900 Honolulu, Hawaii 96813	Robb Tanaka Robb.tanaka@hawaiianelectic.com
Hawaii Natural Energy Institute	1680 East-West Rd Honolulu, Hawaii 96822	Richard Rocheleau, Director Office: 808 956-8346 Cell: 808 389-9944 rochelea@hawaii.gov
Department of Business, Economic Development & Tourism (DBEDT - Hawaii State Energy Office)	Hawaii State Energy Office Honolulu, Hawaii 96804	Mary Alice Evans maryalice.evans@hawaii.gov Keiralyn J. Pease keiralyn.j.pease@hawaii.gov
Clean Energy Solutions Centre	NA	Mike Callahan, PE, CEM National Renewable Energy Laboratory Office: 808-473-0605 Cell: 303-305-9619 Michael.callahan@nrel.giv
SolarCity HQ in Hawaii	599 Kahelu Avenue Mililani, Hawaii 96789	Bob Rudd, VP, Project Development, Energy Storage & Microgrids Office: 650.963.5100, x55508 Cell: 415.827.5653 rrudd@solarcity.com
Covanta - H-POWER	Campbell Industrial Park 91-174 Hanua Street Kapolei, HI96707	Iris Loui, Administrative Assistant Office: 808-682-0227 Fax: 808-682-5203 ILoui@covanta.com
Natural Energy Laboratory of Hawaii (NELHA)	Hawaii Ocean Science & Technology (HOST) Park 73-987 Makako Bay Drive Kailua Kona, Hawaii 96740	Laurence Sombardier, Chief Marketing Officer 808-327-9585, x244 laurences@nelha.org
Blue Planet Foundation	Pu'u Wa'awa'a Ranch Kailua-Kona, HI 96740	Raya Salter Phone: 808.954.6144 rayacsalter@gmail.com
Puna Geothermal Venture (PGV)	14-3860 Pohoiki Rd, Pāhoa, Hawaii 96778	Mike Kaleikini Mkaleikini@ormat.com
Hawai'i Volcanoes National Park	Hawai'i Volcanoes National Park 1 Crater Rim Drive Volcano, HI 96785	Phone:(808) 985-6000

THE HAWAIIAN CONTEXT

QUICK FACTS

- With its mild tropical climate, Hawaii had the third-lowest per capita energy use in the nation in 2013. The transportation sector accounted for about half of Hawaii's energy demand in 2013, led by commercial and military aviation fuel use.
- In 2013, Hawaii imported 91% of the energy it consumed and, in 2014, the state had the highest electricity prices in the nation.
- Hawaii is one of seven states with installed geothermal capacity. In 2014, 19% of Hawaii's renewable net electricity generation came from geothermal energy.
- Hawaii's utility-scale electricity generation from solar energy more than doubled in 2014. Hawaii generated 29% of its renewable electricity from both utility-scale resources and small-scale solar photovoltaic panels installed on rooftops across the islands.
- Hawaii is the first state to set a goal of producing 100% of its electricity from renewable energy sources. The state plans to reach that goal by 2045.

RECENT ECONOMIC DEVELOPMENTS

- Hawaii's economy is expected to continue positive growth for the rest of 2016 and into 2017. This outlook is based on the most recent developments in the national and global economies, the performance of Hawaii's tourism industry, labor market conditions, and the growth of personal income and tax revenues.
- Hawaii's economy depends significantly on conditions in the U.S. economy and key international economies, especially Japan. According to the January 2016 Blue Chip Economic Consensus Forecasts, U.S. real GDP is expected to increase by 2.5% in 2016, 0.1 of a percentage point lower than the 2.6% growth rate projected in the November 2015 forecast. For 2017, the consensus forecast predicts an overall 2.5% growth in U.S. real GDP.
- Overall, Hawaii's economy, as measured by real GDP, is projected to show a 2.3% increase in 2016; the same as the growth rate forecasted last quarter. The real GDP growth forecast in 2017 is 2.4%, also same as the growth rate forecasted last quarter.
- Hawaii's unemployment rate is projected to be 3.5% in 2016, 0.2 of a percentage point lower than the previous forecast. The unemployment rate in 2017 is now projected to be 3.3%, also 0.2 of a percentage point lower than the previous forecast.
- Beyond 2017, the economy is expected to continue its expansion path, with job growth projected to be 1.1% in 2018 and 2019. Visitor arrivals are expected to increase 1.8% in both 2018 and 2019. Visitor expenditures are expected to increase 4.1% in 2018 and 2019. Real personal income is projected to increase 3.0% in 2018 and 2019. Hawaii's real GDP growth is expected to increase 2.4% in 2018 and 2.2% in 2019. The unemployment rate is expected to decrease to 3.1% in 2018 and 2019.

ENERGY SECTOR IN HAWAII

Isolated by the Pacific Ocean, Hawaii is the most petroleum-dependent state in the nation.

Hawaii's islands stretch more than 1,500 miles across the central Pacific Ocean, from the Big Island of Hawaii in the southeast to the Kure Atoll in the northwest. The eight main islands, and the more than 100 uninhabited reefs, shoals, and atolls, are farther from a major landmass than any other island group on earth. Located 1,800 miles north of the equator, Hawaii is tropical, but its climate is moderated by steady trade winds and the surrounding ocean. Extremes of heat, cold, and rainfall occur in the mountains, but weather at low altitudes is generally mild, with little variation year-round. Most of the state's population lives on Oahu. On all the Hawaiian islands, residents are clustered in the coastal areas.

Hawaii's geographic isolation makes its energy infrastructure unique among the states. In recent years, more than one-tenth of the state's gross domestic product has been spent on energy, most of that for imported crude oil and petroleum products. More than four-fifths of Hawaii's energy comes from petroleum, making it the most petroleum-dependent state in the nation. The state of Hawaii and the U.S. Department of Energy entered a partnership in 2008 called the Hawaii Clean Energy Initiative (HCEI), aimed at reducing the state's dependence on petroleum and optimizing use of sustainable local energy sources. In 2015, Hawaii became the first state to set a goal of obtaining 100% of its electricity from sustainable renewable sources. The state plans to reach this goal by 2045.

Hawaii's largest industry is tourism. Major economic sectors also include the U.S. military and agriculture. Transportation accounts for about half of all energy consumed. Overall, Hawaii's economy is not energy intensive and per capita energy consumption is among the lowest in the nation.

Electricity

Petroleum-fired power plants have supplied more than three-fourths of Hawaii's net electricity generation in the past 20 years. In 2014, for the first time, net generation from petroleum slipped below 70%, and renewable sources—mainly wind, biomass, and geothermal generators—supplied 13% of the state's electricity from utility-scale generators. Coal supplied most of the remaining electricity. Use of small-scale distributed renewables, like rooftop solar panels, has increased, and if net generation from distributed sources is included, Hawaii generated more than 21% of its electricity from renewable sources in 2014.

Hawaii's dependence on petroleum and its isolated island grids result in the highest electricity prices in the nation.

Hawaii's electric utility is exploring the feasibility of converting some or all of its petroleum-fired generating units to LNG, both to reduce costs and to comply with tightening federal emissions standards. Hawaii's islands have six separate electricity grids that are not connected by undersea electric transmission cables. Each island must generate its own power. Hawaii is encouraging initiatives to interconnect the island grids to enable more efficient power generation and to support increased development of renewable energy resources.

The state's heavy dependence on imported petroleum and the isolated island grids result in Hawaii's having the highest retail electricity prices of any state in the nation. Hawaii's electricity demand is among the lowest in the nation, both in total amount consumed and in per capita consumption. About 3 in 10 households in Hawaii use electricity as their primary energy source for home heating, but, with the mild tropical climate, heating is rarely needed, and nearly two-thirds of households have no heating system at all.

Renewable Energy

Hawaii is the first state to set a goal of producing all its electricity from renewable sources.

Hawaii's renewable portfolio standard (RPS), as amended by the legislature in 2009, requires 40% of electricity to be generated by renewable sources by 2030. In June 2015, the legislature extended the RPS to 2045 and required 100% of electricity to come from renewable resources by that year, making Hawaii the first state in the nation to set a target of 100% renewable electricity. State regulators also set separate energy efficiency portfolio standards, which are aimed at reducing anticipated electricity consumption 30% by 2030. The overall state goal is 70% clean energy, counting both renewable sources and efficiency, by 2030, and 100% clean energy by 2045. Technologies recognized in the RPS include: wind; solar thermal and photovoltaic (PV); geothermal; biogas, including landfill methane; biomass, including municipal solid wastes; hydroelectricity; seawater-chilled air conditioning; and wave, tidal, and ocean energy.

Hawaii has substantial renewable resources throughout the island chain. Utility-scale **wind** potential is found both onshore and offshore. The state's six commercial wind farms are on Oahu, Maui, and the Big Island of Hawaii. Smaller wind projects power a water treatment plant and an irrigation system on the Big Island. A 400 MW wind project has been proposed for federal waters off Oahu.

Hawaii has significant solar resources and is generating increasing amounts of electricity from distributed **solar PV** installations on all the inhabited islands. Hawaii's capital, Honolulu, has more solar capacity installed per capita than any other U.S. city, and the state is a leader in solar installations per capita. At the end of 2014, Hawaii had 381 MW of small-scale solar capacity installed on more than 51,000 residential and commercial properties and 33 MW installed at nine utility-scale facilities on

Oahu, Kauai, and Lanai. Solar power provided 29% of Hawaii's renewable electricity generation. Hawaii has used net metering and tax incentives to encourage installation of more distributed solar facilities, and state regulators and grid operators are balancing increasing numbers of solar connection requests with grid stability requirements.

With the islands' small grids, some larger projects using **variable wind and solar technologies** are incorporating energy storage or continuous voltage regulation to smooth out variability. The 6-MW Port Allen project on Kauai includes a 3-MW battery energy storage system. Government agencies and private sector firms are developing energy storage technologies, including batteries and hydrogen fuel cells, to support increased renewable energy penetration. Since 2010, state building codes require all water heaters in new single-family homes to be solar powered. One small solar thermal power plant on the Big Island closed in 2014. Solar thermal technologies for seawater desalination are also in development.

Biomass, mainly agricultural wastes such as bagasse from sugarcane, has long been used in Hawaii to generate heat and electricity. The state's agricultural sector is shrinking, and more biomass is coming from municipal solid waste. The H-POWER plant provides 10% of Oahu's electricity from municipal solid waste and the plant is being expanded from 46 to 73 MW. A former coal-fired plant north of Hilo on the Big Island is being refurbished to run on local plant biomass, and other biomass electricity generators are operating or being developed on Oahu, Kauai, and Maui. Hawaii also aims to substitute sustainably produced biofuels for some petroleum-based fuels at utility generating plants. The 110-MW Campbell Industrial Park Generating Station, believed to be the world's largest commercial electricity generator fueled exclusively with sustainable biofuel, was brought into service on Oahu in 2010. The HCEI says more use of biomass and biofuels can also help boost the state's agricultural sector.

In 2014, Hawaii was one of seven states with operating commercial-scale **geothermal** power production. Its single geothermal generating plant is located on the Kilauea Volcano on the Big Island and supplied about one-fourth of the island's electricity in 2014. State utilities are seeking more projects to tap the earth's heat on the Big Island, Maui, and Oahu.

Hawaii does not have rivers appropriate for **hydroelectric** dams. A handful of small hydroelectric turbines use run-of-river flow at sites on Maui and the Big Island, and studies have identified nearly 50 sites for additional small-scale projects. Kauai's electric cooperative is exploring raising the island's hydropower generation from 8 – 20% of consumption. The state is also looking to the surrounding ocean for renewable energy. The U.S. Navy has been testing wave energy technologies to supply power to its island bases. Studies indicate **wave energy** could provide anywhere from about one-third to all of the electricity Hawaiians use, depending on technological advances. **Ocean thermal energy** technology, which generates electricity through temperature differences between warm, shallow waters and cool, deep waters, is being explored. **District cooling**, drawing up cold deep sea water to chill air-conditioning units, is being commercially developed in Honolulu.

HONOLULU, OAHU

Honolulu, on the island of Oahu, is the capital and largest city of the state of Hawaii. It is the center of government, transportation, and commerce for the state; home to a population of nearly 1 million people in the metro area (80% of the state's population) and Hawaii's best known tourist destination, Waikiki Beach. In 2015, Honolulu was ranked as one of the safest cities in the United States.

In central Honolulu, the two main streets are King Street and Beretania Street. The two streets are one way for most of their route; King Street runs from 'Ewa to Diamond Head, and Beretania Street from Diamond Head to 'Ewa. Both streets run parallel through downtown Honolulu.

STUDY TOUR VISITS

The Hawaii Public Utilities Commission

The State of Hawaii Public Utilities Commission (PUC) regulates all franchised or certificated public service companies operating in the State; prescribes rates, tariffs, charges, and fees; determines the allowable rate of earnings in establishing rates; issues guidelines concerning the general management of franchised or certificated utility businesses; and acts on requests for the acquisition, sale, disposition, or other exchange of utility properties, including mergers and consolidations.

The Commission regulates four electric utility companies or entities engaged in the production, purchase, transmission, distribution, and sale of electric energy in the State: Hawaiian Electric Company (HECO), serving the island of Oahu; Maui Electric Company (MECO), serving the islands of Maui, Lanai, and Molokai; Hawaii Electric Light Company (HELCO), serving the island of Hawaii (collectively, the HECO Companies); and Kauai Island Utility Cooperative (KIUC), serving the island of Kauai. MECO and HELCO are wholly owned subsidiaries of HECO, which is, in turn, a wholly owned subsidiary of Hawaiian Electric Industries, Inc.

Hawaii Electric Company

Hawaiian Electric Company and its subsidiaries provide electricity and services to 95 percent of the State's 1.4 million residents. The company is also one of the State's leading employers and a major contributor and supporter of community and educational programs.

The demand for power that has fueled the growth of the Hawaiian Islands has been met by Hawaiian Electric for well over a century. And as the next millennium unfolds, the company is committed to providing quality service and seeking clean local energy sources to power generations of Hawaiian families and businesses to come.

- First Wind's 30-MW wind farm in Kahuku went into operation in early 2011.
- Hawaiian Electric and Maui Electric Company are honored for Solar Energy Adoption by the Solar Electric Power Association in 2012.
- In 2012, critical investments to upgrade and modernize electrical systems include replacing 210,000 feet of underground power cable on Oahu (up from 97,000 in 2011), 1300 utility poles (1,000 in 2011), and 24 transmission structures (1 in 2011).
- Compared to 2008, when new clean energy targets were first set, 500,000 barrels of oil have been eliminated from annual use, the equivalent of $69 million in 2012.
- In 2012, Going Solar, online solar resource center, was launched to provide customers information on choosing a contractor, financing, siting, and sizing photovoltaic and more.
- Also in 2012, a photovoltaic system was added to the 120-MW biofueled generation station at Campbell Industrial Park to help power the facility and run two electric vehicle chargers.
- As the portfolio of renewable energy continues to grow and Hawaii residents use electricity more efficiently, less oil is used and, in doing so, strengthening Hawaii's economy and energy security while helping to protect the environment of Hawai'I's islands and the world.

The Hawaii Natural Energy Institute

Hawaii Natural Energy Institute (HNEI) conducts essential energy research relevant to Hawaii and the world. Programs focus on identifying technically sound, cost effective solutions and practical strategies that can be implemented to deliver commercially viable renewable energy. The ultimate goal is to achieve a stable and cost-effective energy mix for Hawaii, while reducing the State's dependence on oil and other fossil fuel resources.

The GridSTART program empowers islanded grids and remote communities to optimize power systems and reliably integrate greater levels of renewables. It focuses on research, development, test, and evaluation (RDT&E) of advanced grid control architectures, enabling policies, and new technologies and methods for effective integration of renewable energy resources and power system optimization (e.g., demonstration project of a smart grid system on a portion of the Maui Electric Company electric grid at Wailea on Maui). HNEI is also active in the fields of alternative fuels, renewable energy, energy storage, energy efficiency, and transport.

DBEDT - Hawaii State Energy Office

The Hawaii State Energy Office is leading the state's charge toward clean energy independence. With a goal to achieve 100% renewable energy generation by 2045, the Hawaii State Energy Office is committed to developing and deploying high impact solutions that will maximize Hawaii's renewable energy resources and improve efficiency and transportation standards. Through effective policies and innovative programs, the Hawaii State Energy Office has positioned Hawaii as a proving ground for clean energy innovation, which will generate quality jobs, attract investment opportunities, and accelerate economic growth.

The Clean Energy Solutions Center

The Clean Energy Solutions Center offers no-cost expert policy assistance, webinars and training forums, clean energy policy reports, data, and tools provided in partnership with more than 35 leading international and regional clean energy organizations.

The "Ask an Expert" service provides no-cost clean energy policy assistance through a global network of over 30 experts for government agency representatives and the technical institutes assisting them. To date, this service has supported more than 120 requests for assistance from over 60 countries. The Ask an Expert service makes it easy to request targeted, first-rate expert assistance and receive in-depth answers and support for your policy questions.

Webinars are designed in collaboration with global partner institutions, and engage diverse global audiences in interactive discussions on important clean energy policy topics covering energy efficiency, renewable energy, energy access, and transport issues. E-learning courses, podcasts and videos are also offered.

The Solutions Center features an extensive collection of almost 3,000 clean energy resources, including reports on best-practice policies, data, and analysis tools for the benefit of policymakers. As part of this resource library, the Solutions Center collaborates with Bloomberg New Energy Finance to provide biannual newsletters summarizing global clean energy investment trends.

SolarCity HQ in Hawaii

SolarCity is America's largest solar power provider making clean energy available to homeowners, businesses, schools, non-profits, and government organizations at a lower cost than they pay for energy generated by burning fossil fuels like coal, oil, and natural gas. SolarCity's customers include tens of thousands of homeowners, more than 400 schools (incl. Stanford University), government agencies (i.e., U.S. Armed Forces, Department of Homeland Security), and well-known corporate clients (incl. eBay, HP, Intel, Walgreens, and Walmart).

In 2016, KIUC will develop a 17-MW solar PV power plant to be built by SolarCity. The package will come with a 52-MWh battery energy storage system. KIUC has signed a private purchase agreement with SolarCity to buy power from the project for 20 years. The 52-MWh battery system will feed up to 13 MW of electricity onto the grid to reduce the evening peak, which lasts from 5:00pm to 10:00pm.

City and County of Honolulu - H-Power

The Honolulu Program of Waste and Energy Recovery (H-POWER) is a one-of-a-kind power plant in Campbell Industrial Park on Oahu, turning municipal solid waste to power. It is the only operating plant in the United States that combines the best of refuse-derived fuel (RDF) technology and mass burn (MBN) technology, allowing the plant to manage more types of waste for the City and County of Honolulu (City). The original facility began operations in 1990 and consists of two 100-tph waste processing trains (the daily processing capacity = 2,160 tpd in a single shift).

H-POWER, owned by the City & County of Honolulu and operated by Covanta, expanded by adding a third boiler and other equipment in 2012, which should bring its capacity to about 73 MW.

KONA, BIG ISLAND


Kailua Kona, often referred to as "Kona" by the locals, is the main western city, population 34,000 (2012), of the Big Island of Hawaii. It is nestled on the western coast of the Hualalai Volcano. Because the mountains block the northeasterly trade winds, Kona gets very little rain and enjoys more than 300 days of sunshine a year.

STUDY TOUR VISITS

Natural Energy Laboratory of Hawaii (NELHA)

Hawaii's innovative economic development park plays a significant role in Hawaii's growth in ocean energy technologies and sustainable development. Hawaii Ocean Science & Technology (HOST) Park's applied energy zone houses enterprises that test renewable energy technologies on the cusp of commercialization. Activities at the park fulfill statewide priorities and complement the visitor industry in West Hawaii. NELHA's mission is to develop and diversify the Hawaii economy by providing resources and facilities for energy and ocean-related research, education, and commercial activities in an environmentally sound and culturally sensitive manner.

- HOST Park's energy portfolio consists of OTEC and a microalgae biofuels demonstration plant, solar PV and CSP technologies, sea-water air-conditioning system, and an energy storage facility for a mini-grid are located in the Park.
- OCEAN THERMAL ENERGY CONVERSION (OTEC). HOST Park has established itself as a leading test facility for OTEC technology since 1974. Closed and open cycle systems, as well as onshore and offshore systems, which aim to produce electricity using the temperature difference between cool deep and warm shallow sea water, have been built and tested by various groups.
- CONCENTRATED SOLAR POWER (CSP) concentrates solar thermal energy into a small area to heat a working fluid, which then, in turn, can drive a heat engine to produce power. HOST Park's high insolation and warm year-round climate make it an ideal site for the demonstration of new CSP technology. Keahole Solar Power established its first pilot plant at HOST Park in 2007 to demonstrate novel concentrating solar panels that could withstand storms and thermal energy storage systems.
- PHOTOVOLTAICS (PV). Various solar companies have taken advantage of HOST Park's prime location and tested innovative PV systems. Concentrating photovoltaic pioneer, Solfocus examined the effect of marine environments on their CPV systems. HOST Park is the site of a

new solar test bed funded by the National Renewable Energy Laboratory (NREL). The test bed will allow to compare various solar modules' power generation, energy storage systems and their incorporation into a real world electrical grid with state of the art power monitors. Many HOST Park clients take advantage of the ideal insolation and close to 1.5 MW of commercial PV is either installed or will be operational in the very near future.

- BIOFUELS. HOST Park is one of the best places in the world to grow microalgae and consequently is home to leaders in the field of microalgae production and biofuels R&D. Over US$100 million has been invested in Cellana LLC's 6-acre state of the art demonstration plant at HOST Park.
- SEA WATER AIR CONDITIONING (SWAC) uses cold, deep seawater to cool buildings. In general, the seawater is passed through a heat exchanger and the resulting cooled air is delivered to the buildings. The very first real-world SWAC system was developed at HOST Park. But the technology is now used throughout the world including Sweden, Netherlands, Canada, and New York. All of NELHA's administrative buildings are cooled by sea water. Many of NELHA's clients also take advantage of the significant savings provided by a SWAC system and have installed their own.

Blue Planet Foundation Ranch

The Blue Planet Foundation is a non-profit organization created to change our world's energy culture, to raise global awareness in order to develop and adopt practical programs to implement clean, efficient, and renewable energy and to create a global response to climate issues.

On the Pu'u Wa'awa'a Ranch on the Big Island, Blue Planet Foundation is experimenting with a number of technologies for producing and storing energy. They are testing seven different solar PV technologies, as well as various energy storage and fuel cell technologies. The roof over the lab is host to 360 solar PV panels with a capacity of 85 kW — enough to power about 17 average homes in Hawaii – while also using the electricity from the solar panels to produce hydrogen, which then supplies the only hydrogen refueling station on the Big Island.

Puna Geothermal Venture (PGV)

Located in the Puna district on the Big Island in Hawaii, Puna Geothermal Venture (PGV) is the only geothermal power plant in the state. PGV is comprised of two air-cooled power plants, a combined cycle system and a binary system with a total original generating capacity of 30 MW. PGV has improved the plant by adding capacity of 8 MW by utilizing the heat contained in the hot water that is currently re-injected. The facility includes several features that make it environmentally friendly including: noise reduction enclosures a low-profile, small-footprint design; near-zero emissions; 100% geothermal fluid reinjection; and, continual monitoring measures. The PGV power plant sells its electrical output to Hawaii Electric Light Company under three long-term power purchase agreements.

PGV commenced commercial operation in 1993. It was acquired by Ormat Technologies, Inc. in June 2004. Ormat is the only vertically integrated company primarily engaged in the geothermal and recovered energy power business. The Company designs, develops, owns and operates geothermal and recovered energy-based power plants around the world. Additionally, the Company designs, manufactures, and sells geothermal and recovered energy power units and other power-generating equipment, and provides related services. The Company has more than four decades of experience in the development of environmentally sound power, primarily in geothermal and recovered-energy generation. Ormat products and systems are covered by 75 U.S. patents. Ormat has engineered and built power plants that it currently owns or has supplied to utilities and developers worldwide, totaling approximately 1,300 MW of gross capacity.

LIST OF PARTICIPANTS (BY COUNTRY)

NAME	TITLE	ORGANIZATION	COUNTRY
Devon Gardner	Program Manager, Energy	CARICOM	Regional
Fitzroy Vidal	Principal Director for Energy	Ministry of Science Energy & Technology	Jamaica
Kireua Bureimoa	Head Energy Planning Unit	Ministry of Public Works and Utilities	Kiribati
Tenikoria Kataua	Acting Power Engineering Manager	Public Utilities Board	Kiribati
Ahmed Saif	Senior Engineer	State Electricity Company Ltd (STELCO)	Maldives
Akram Waheed	Project Coordinator	Ministry of Environment and Energy	Maldives
Dr. Jawaharlall Lallchand	Chairman	National Ocean Council	Mauritius
Dr. Arjoon Suddhoo	Chairman	National Research Council	Mauritius
Sylvester Clauzel	Permanent Secretary	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Barrymore Felicien	Chief Utilities Officer and Head of Energy Unit	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Bethia Thomas	Science and Technology Officer	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Sallyane Cotter	Legal Officer	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Benise Joseph	Energy Officer	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Charlin Bodley	Energy Officer	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Aloysius Barthelmy	Geothermal Technical Coordinator	Ministry of Sustainable Development, Energy, Science & Technology	Saint Lucia
Martin Sam	Chief Engineer	Solomon Islands Electricity Authority	Solomon Islands
Dr. BMS Batagoda	Secretary	Ministry of Power and Renewable Energy	Sri Lanka
Dr. Ajith P. Perera	Deputy Minister	Ministry of Power and Renewable Energy	Sri Lanka
Mafalu Lotolua	Managing Director	Tuvalu Electricity Corporation	Tuvalu
Leith Veremaito	Program Manager	Vanuatu Rural Electrification Program	Vanuatu
Christopher Simelum	Acting Director	Department of Energy	Vanuatu
Karan Capoor	Senior Energy Specialist	World Bank	
Silvia Martinez Romero	Senior Energy Specialist	World Bank	
Martin Schroeder	JPO	World Bank	
Gunjan Gautam	Consultant	World Bank	
Heather Austin	Communications	World Bank	

TOUR AT A GLANCE

DAYS 1 – 3 || Honolulu on Oahu

TIME	VENUE	LOCATION
Monday 23 May	Welcome	Lobby of Aston at the Executive Centre Hotel 1088 Bishop Street Honolulu, HI 96813
	Hawaii Public Utilities Commission	465 South King Street, #103 Honolulu, HI 96813
	Hawaii Electric Company	ASB Tower 1001 Bishop St. 8th Floor Conference Room Honolulu, HI 96813
Tuesday 24 May	Hawaii Natural Energy Institute	1680 East-West Rd Honolulu, HI 96822
	DBEDT - Hawaii State Energy Office	Department of Business, Economic Development & Tourism Hawaii State Energy Office Honolulu, HI 96804
	Clean Energy Solutions Centre	Department of Business, Economic Development & Tourism Hawaii State Energy Office Honolulu, HI 96804
Wednesday 25 May	SolarCity HQ in Hawaii	SolarCity HQ 599 Kahelu Avenue, Mililani, HI 96789
	H-Power (Covanta)	Campbell Industrial Park 91-174 Hanua Street, Kapolei, HI 96707

DAYS 4 – 5 || Kona on Big Island

TIME	VENUE	LOCATION
Thursday 26 May	Morning Flight to Kona	
	Natural Energy Laboratory of Hawaii (NELHA)	Hawaii Ocean Science & Technology (HOST) Park 73-987 Makako Bay Drive Kailua Kona, HI 96740
	Blue Planet Foundation Ranch	Pu'u Wa'awa'a Ranch Kailua-Kona, HI 96740
Friday 27 May	Puna Geothermal Venture	14-3860 Pohoiki Road Pāhoa, HI 96778
	Optional: Hawai'i Volcanoes National Park	Hawai'i Volcanoes National Park 1 Crater Rim Drive, Volcano, HI 96785
	Reflections on Lessons Learned	Marriott Courtyard King Kamehameha 75-5660 Palani Road, Kailua-Kona, HI 96740

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