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ECONOMIC DEVELOPMENT & TOURISM**

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December 12, 2016

DEPT. COMM. NO. 153

The Honorable Ronald D. Kouchi,
President and Members
of the Senate
Twenty-Eighth State Legislature
State Capitol, Room 409
Honolulu, Hawaii 96813

The Honorable Joseph M. Souki,
Speaker and Members of the
House of Representatives
Twenty-Eighth State Legislature
State Capitol, Room 431
Honolulu, Hawaii 96813

Dear President Kouchi, Speaker Souki, and Members of the Legislature:

For your information and consideration, I am transmitting a copy of the ***Status and Progress of Clean Energy Initiatives*** and ***Analysis of the Environmental Response, Energy, and Food Security Tax***, Hawaii Revised Statutes. In accordance with Section 93-16, Hawaii Revised Statutes, I am also informing you that the report may be viewed electronically at: <http://dbedt.hawaii.gov/overview/annual-reports-reports-to-the-legislature/>.

Sincerely,

Luis P. Salaveria

Enclosure

c: Legislative Reference Bureau



State of Hawaii

**STATUS AND PROGRESS OF CLEAN ENERGY INITIATIVES
AND
ANALYSIS OF THE ENVIRONMENTAL RESPONSE, ENERGY, AND
FOOD SECURITY TAX**

**REPORT TO THE
GOVERNOR AND THE LEGISLATURE
OF THE
STATE OF HAWAII**

Pursuant to

Act 73, Session Laws of Hawaii 2010



*Submitted by the State of Hawaii
Department of Business, Economic Development, and Tourism*

December 2016

EXECUTIVE SUMMARY

In 2016, Hawaii's clean energy transformation continued its momentum as more solar and wind power were added to the state's electrical grids, boosting renewable energy to nearly one-quarter of all utility electricity sales. Distributed solar resources played a key role: on Oahu, nearly a third of single-family homes now have rooftop PV systems – a significant achievement for a metropolitan area of its size.

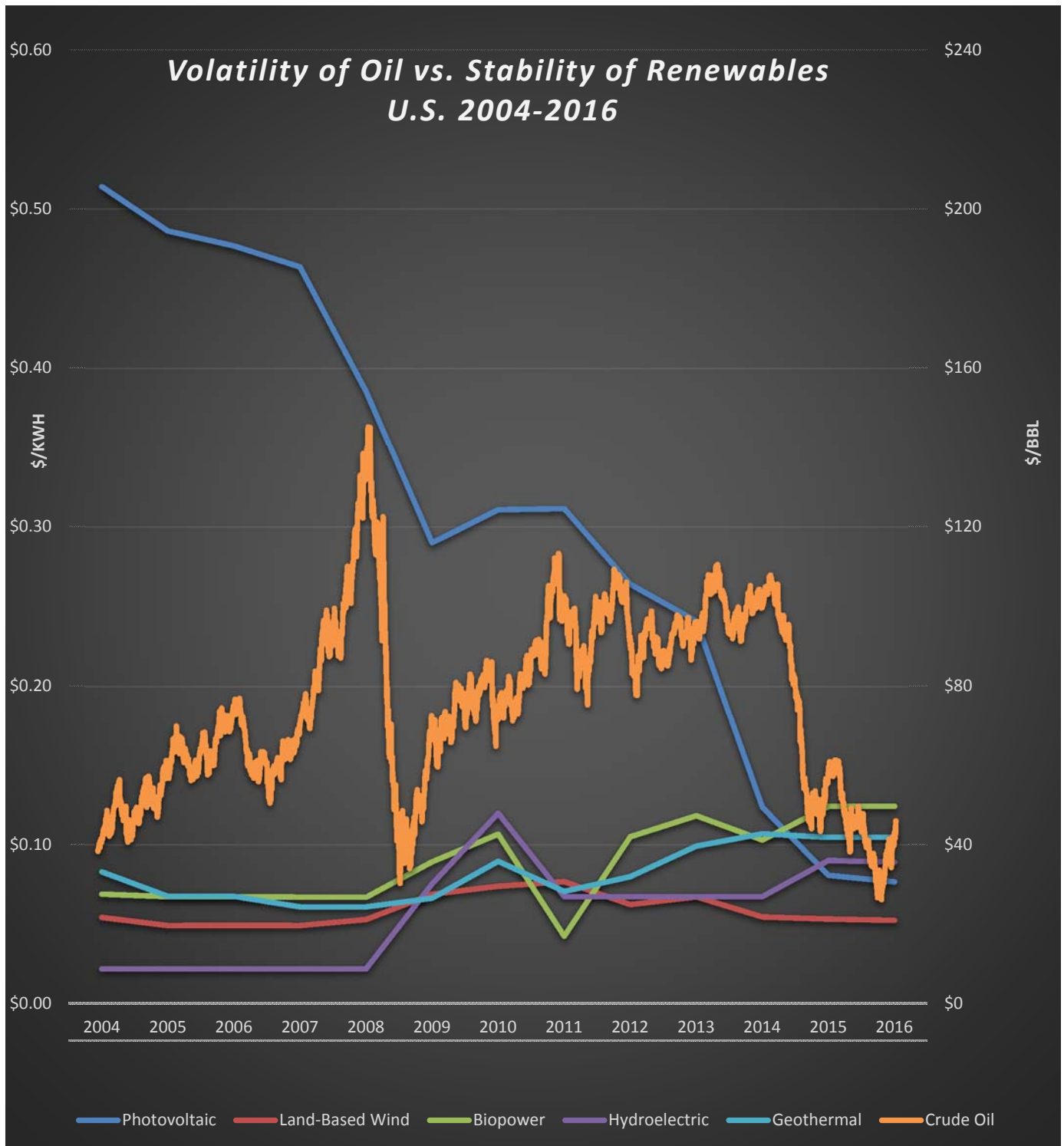
The value of solar-related construction spending is expected to total \$408 million in 2016, according to projections from the Department of Business, Economic Development and Tourism (DBEDT). Hawaii's emergence as a test bed for clean energy solutions continues to fuel innovation and attract investment. Japan's top public research institute spent \$55 million on its JumpSmart Maui project on the Valley Isle to develop technology for optimizing renewable energy use. The 42 portfolio companies participating in the Energy Excelsior, Hawaii's preeminent clean energy incubator, have raised \$342 million in follow-on funding as they showcase the innovation and ingenuity of today's start-up energy companies.

“Our drive to 100 percent renewable energy is very much driven by, not only saving the environment, but also the fact that it makes economic sense for Hawaii. Energy has ... been a huge driver of helping create this (Hawaii's) clean energy economy. Hawaii has very much the inside track on being the model for what a clean energy economy can be...”

Luis P. Salaveria, DBEDT Director

The Hawaii Clean Energy Initiative (HCEI) program was established to manage the state's transition to a clean energy economy. The Energy Security Special Fund (ESSF) supports the HCEI program, including DBEDT's Hawaii State Energy Office staff positions and projects that ensure dependable, efficient, and economical energy, promote energy self-sufficiency, and provide greater energy security for the State. The ESSF consists of a portion of the Environmental Response, Energy, and Food Security Tax (EREFST). The tax yielded \$3,863,897 to the ESSF in Fiscal Year 2016 (FY16). In FY16, a total of \$20,588,303 was expended on new and existing clean energy initiatives. \$4,471,867 of expenditures was funded by the ESSF. \$800,839 was funded by federal funds. \$15,315,598 is attributed to the Hawaii Green Infrastructure Special and Bond Funds.

Volatility of Oil vs. Stability of Renewables – U.S., 2004-2016 - The graph on the following page compares the volatile crude oil market versus the stable – and in some cases declining costs for the renewable energy market in the U.S. As the graph measures oil in dollars per barrel and renewables in dollars per kilowatt hour, it is meant to be directional and does not serve to compare prices against one another.



Sources: Renewable energy pricing 2004 to 2014 from Open Energy Information's Transparent Cost Database: en.openei.org/apps/TCDB/. Renewable energy pricing 2015 to 2016 from NREL's 2016 Annual Technology Baseline: nrel.gov/analysis/data_tech_baseline.html. Crude oil pricing from Energy Information Administration (EIA): eia.gov/dnav/pet/pet_pri_spt_s1_d.htm.

INTRODUCTION

This report is respectfully submitted by the DBEDT, pursuant to Act 73, Session Laws of Hawaii 2010. The sections to follow focus on reporting to the Legislature the following requested information:

1. The status and progress of clean energy initiatives funded by the ESSF and targeted markets;
2. The Hawaii State Energy Office (HSEO) budgeted spending plan; and
3. An analysis of the EREFST allocation.

OVERVIEW

With the establishment of HCEI, the State set a course for energy independence and embarked on a transformative journey that has brought us benefits and challenges in managing consumer costs, maximizing savings opportunities and maintaining utility security and system reliability. Our goal is to now achieve 100 percent renewable energy in the electricity sector by 2045. To get to this goal we will need to accommodate more intermittent renewables on increasingly saturated electric grids, develop the expertise to deliver technical solutions, attract the large amounts of capital necessary to finance the transformation and manage legacy issues such as stranded costs and long-term fossil fuel assets. Also, we are working on reducing the use of and providing alternatives to fossil fuels in the transportation sector.

I. DBEDT REPORTING PURSUANT TO ACT 73(10)

The Legislature in passing Act 73(10), determined that it is in the best interest of Hawaii's people to build the capacity needed to become self-sufficient in energy and food needs and to protect the health and function of the environment. Further, that Hawaii has all the necessary assets to significantly improve the State's energy and food sustainability and independence over the next twenty years if appropriate personnel resources and funding are judiciously used. To succeed, the State must ensure a long-term strategy, which is well-resourced, coordinated, and focused.

The Act specifies that DBEDT shall:

- A.** Report the status and progress of new and existing clean energy initiatives, which includes:
 1. The spending plan of HCEI;
 2. All expenditures of the ESSF moneys; and
 3. The targeted markets of the expenditures, including:
 - Reasons for selecting those markets,
 - The persons to be served,
 - Specific objectives of the program, and
 - Program expenditures, including measurable outcomes.
- B.** Study and analyze the EREFST to include:

1. Its amount and allocation; and
2. Its effectiveness in accomplishing the goals and objectives of the Act.

II. STATE ENERGY POLICY DIRECTIVES

Hawaii's energy policy commitment and objectives are to make cost-effective long-term investments in clean energy productivity and management for the purpose of promoting Hawaii's energy security. This supports the achievement of the HCEI goals to enable an integrated system based on clean energy resources. Key policy directives:

- A. To diversify the State's energy portfolio;
- B. Connect the islands through integrated, modernized grids;
- C. Balance technical, economic, environmental and cultural considerations;
- D. Leverage Hawaii's position as a clean energy test bed; and
- E. Allow the market to pick winners.

III. HCEI PROGRAM OBJECTIVES

HCEI was established to guide the State's transition to a clean energy economy. Its objectives, as established by Act 73(10), are to design, implement, and administer activities, to include:

- A. Strategic partnerships for the research, development, testing, deployment, and permitting of clean and renewable technologies;
- B. Engineering and economic evaluations of Hawaii's potential for near-term project opportunities for the State's renewable energy resources;
- C. Electric grid reliability and security projects that will enable the integration of a substantial increase of electricity from renewable-energy resources;
- D. A statewide clean energy public education and outreach plan to be developed in coordination with Hawaii's institutions of public education;
- E. Promotion of Hawaii's clean and renewable resources to potential partners and investors; and
- F. A plan, to be implemented from 2011 to 2030, to transition the State and each county to a clean energy economy.

These objectives were then used to refine an HCEI roadmap in which the overall mission of HSEO is to:

- A. Deploy clean energy infrastructure as a catalyst for economic growth;
- B. Facilitate innovation sector development; and
- C. Enhance energy security advancement.

To achieve this mission HSEO is undertaking the following tasks:

- A. Facilitating implementation of the clean energy objectives articulated in the HCEI road map and concentrating on immediate and near-term opportunities to accelerate renewable energy and energy efficiency deployment:
 - 1. Meeting Renewable Portfolio Standard (RPS) targets, and
 - 2. Reducing the use of oil in the transportation sector;
- B. Growing Hawaii's clean energy innovation sector; and
- C. Facilitating development of key infrastructure to harness Hawaii's rich portfolio of renewable energy resources.

HCEI MAX is intended to address the new ecosystem requiring grid modernization and interconnections, and bridging conventional to renewable energy sources with transitional fuels. As well as, the growing demands for energy efficiencies, and high impact innovative programs that advance the progress towards Hawaii's energy goals.

IV. STATUS & PROGRESS OF CLEAN ENERGY INITIATIVES

Key progress indicators and accomplishments for FY 16 under HCEI are as follows:

A. ENERGY EFFICIENCY – HAWAII A LEADER

Under HRS 196-4(3), the Energy Resource Coordinator shall formulate and recommend specific proposals, as necessary, for conserving energy resources; and shall assist public and private agencies in implementing energy conservation and efficiency programs. State energy policy is committed to maximizing cost-effective investments and fostering high impact programs. HSEO efficiency programs focus on delivery of cost-effective investments.

- ***Energy Performance Contracting (EPC)*** - finances energy and water efficiency improvements with the future savings from the energy and water conservation measures installed. Under an EPC, the energy service company contracted for the conservation measures will guarantee the savings or pay for the shortfall. EPC lets government agencies maximize their energy investments because they can include deferred maintenance and performance period maintenance services under a single contract with guaranteed savings measures. The economic impacts of performance contracting are significant, providing great value to the state.
- ***Race to the Top Award*** - For the fifth year in a row, the Energy Services Coalition ranked Hawaii first in the nation for per capita investment in government EPC for 2016. Hawaii's \$325.25 per capita investment beat out second place Kentucky (\$172.84), third place Delaware (\$154.47) and far outpaced the national average (\$53.93).

The award recognizes Hawaii for its outstanding achievements in energy efficiency, environmental stewardship and economic development through EPC. Since HSEO started the performance contracting program in 1996, state and local government agencies have signed a total of over \$442.4 million in performance contracts that are estimated to save in excess of \$1.1 billion over the life of the contracts. These savings are the equivalent of powering 368,426 homes for one year. The projects comprise over 96 million square feet in 225 buildings or facilities.

ENERGY SERVICES COALITION RANKING				
Rank	State	Population	Performance Contracting	Dollars per-Capita
1	Hawaii	1,360,301	\$442,432,189	\$325.25
2	Kentucky	4,339,367	\$750,000,000	\$172.84
3	Delaware	897,934	\$138,707,463	\$154.47
4	Massachusetts	6,547,629	\$865,349,091	\$132.16
5	Ohio	11,536,504	\$1,252,683,627	\$108.58

National Average Per Capita: \$53.93

Source: ESC is a national nonprofit network of experts working together to increase energy efficiency and building upgrades through energy performance contracting

- **State and County EPC Projects** - The chart on the following page illustrates the number of EPC projects conducted by state and county agencies from 1996 through 2016. In addition, over \$8 million in rebate incentives have been claimed from Hawaii Energy, reducing the cost of the energy efficiency improvements through performance contracting projects. Looking ahead, the state anticipates more EPC investments.

STATE AND COUNTY ENERGY PERFORMANCE CONTRACTS			
Agency	Year(s)	Contract Amount (\$)	Estimated Savings Over Life of Contract (\$)
UH-Hilo	1996-2012	\$6,402,695	\$14,630,066
County of Hawaii	1997-2026	\$2,215,546	\$8,157,880
County of Kauai	1998-2012	\$525,965	\$1,205,990
C&C of Honolulu	2001-2025	\$11,900,205	\$36,066,761
Hawaii Health Systems Corporation	2002-2022	\$21,936,997	\$55,766,364
Judiciary	2003-2012	\$1,474,406	\$9,785,036
Department of Accounting and General Services Phase I	2009-2029	\$36,873,266	\$72,580,767
Department of Public Safety	2010-2030	\$25,511,264	\$57,211,112
University of Hawaii Community Colleges	2012-2032	\$34,207,392	\$37,000,000
C&C Honolulu Kailua Wastewater Treatment Plant	2013-2033	\$6,054,178	\$13,693,910
Department of Accounting and General Services Phase II	2013-2033	\$17,400,000	\$28,000,000
Department of Transportation	2013-2035	\$244,804,877	\$730,027,690
Honolulu Board of Water Supply	2016-2036	\$33,125,398	\$56,173,154
Total		\$442,432,189	\$1,120,298,730

Source: Hawaii State Energy Office

- Building Better Buildings*** - On September 10, 2013, HSEO became a partner in the U.S. Department of Energy’s Better Buildings Initiative, a national leadership initiative calling on state and local officials to “make substantial commitments to improve the energy efficiency of their buildings and plants, save money, and increase competitiveness.” HSEO joined the Better Buildings Performance Contracting Accelerator “to significantly expand the use of performance contracting by state and local governments ... to catalyze public sector energy efficiency investments of \$2 billion from January 2013 to December 2016...” The partnership committed the state to executing \$300 million in performance contracting within the three-year period. As of summer 2016, HSEO had led Hawaii to nearly 95 percent of the target, working with agencies to sign over \$283.98 million in performance contracts. Since additional performance contract projects are under discussion, there is a good chance the state will exceed HSEO’s goal.

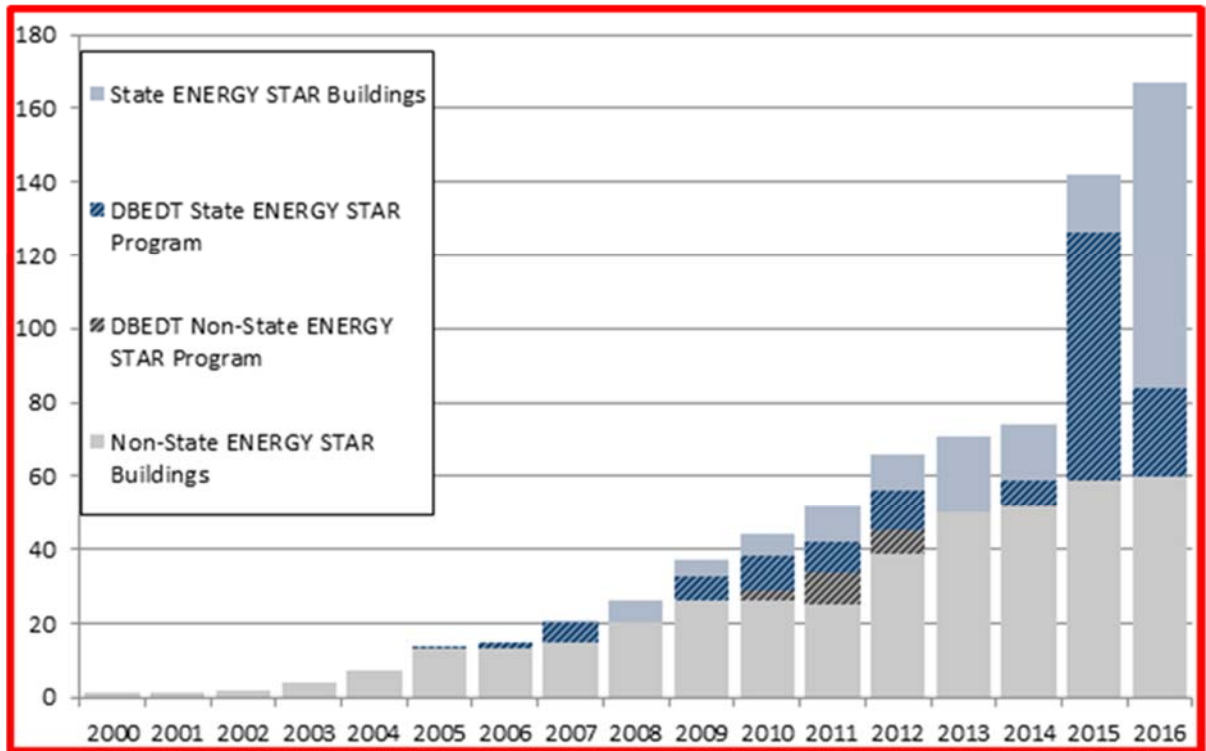
Hawaii Energy Building Code - On July 14, 2015, the State Building Code Council (SBCC) unanimously voted to adopt the International Energy Conservation Code (IECC) 2015, with the Tropical Climate Zone Code for residential dwellings and other amendments appropriate for Hawaii's climate.

HSEO serves on the SBCC, which was established by statute to update building codes. With the unanimous adoption of the IECC 2015, HSEO developed draft Hawaii Administrative Rules to codify the IECC 2015. HSEO provided IECC 2015 technical assistance and staff training for over 300 private and public sector design professionals and county building officials. HSEO will also testify in support of IECC 2015 when the county councils hold public hearings on their adoption.

ENERGY STAR® Buildings - To help identify energy efficiency investment priorities, 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. If a building's performance, as reflected in its ENERGY STAR score, ranks in the top 25 percent of all buildings of its type, it can be certified as an ENERGY STAR building.

In 2016, several Hawaii communities appeared in the U.S. Environmental Protection Agency's (EPA) ENERGY STAR Top Cities rankings. Honolulu ranked 22nd of the Top 25 Cities, with 69 buildings totaling over 9.6 million total square feet, saving \$23 million a year. Honolulu also ranked second among Top Mid-Size Cities. Among Top Small Cities, Hilo ranked 8th with 9 buildings and Kahului/Wailuku/Lahaina ranked 9th with 8 buildings.

The chart on below shows the rapidly increasing number of ENERGY STAR certified buildings in Hawaii. To qualify for certification, a building must meet ENERGY STAR requirements as verified by a licensed professional engineer or architect. The EPA then evaluates the verification submitted and, if approved, will officially certify the applicant as an ENERGY STAR building. Since 2000, 166 Hawaii buildings have received the ENERGY STAR certification, including 103 public and 63 private buildings. During this time, HSEO has helped benchmark 83 state facilities. Because energy use is constant, buildings should be verified and certified as ENERGY STAR annually to ensure optimum efficiency.



Sources: Hawaii State Energy Office, U.S. Environmental Protection Agency

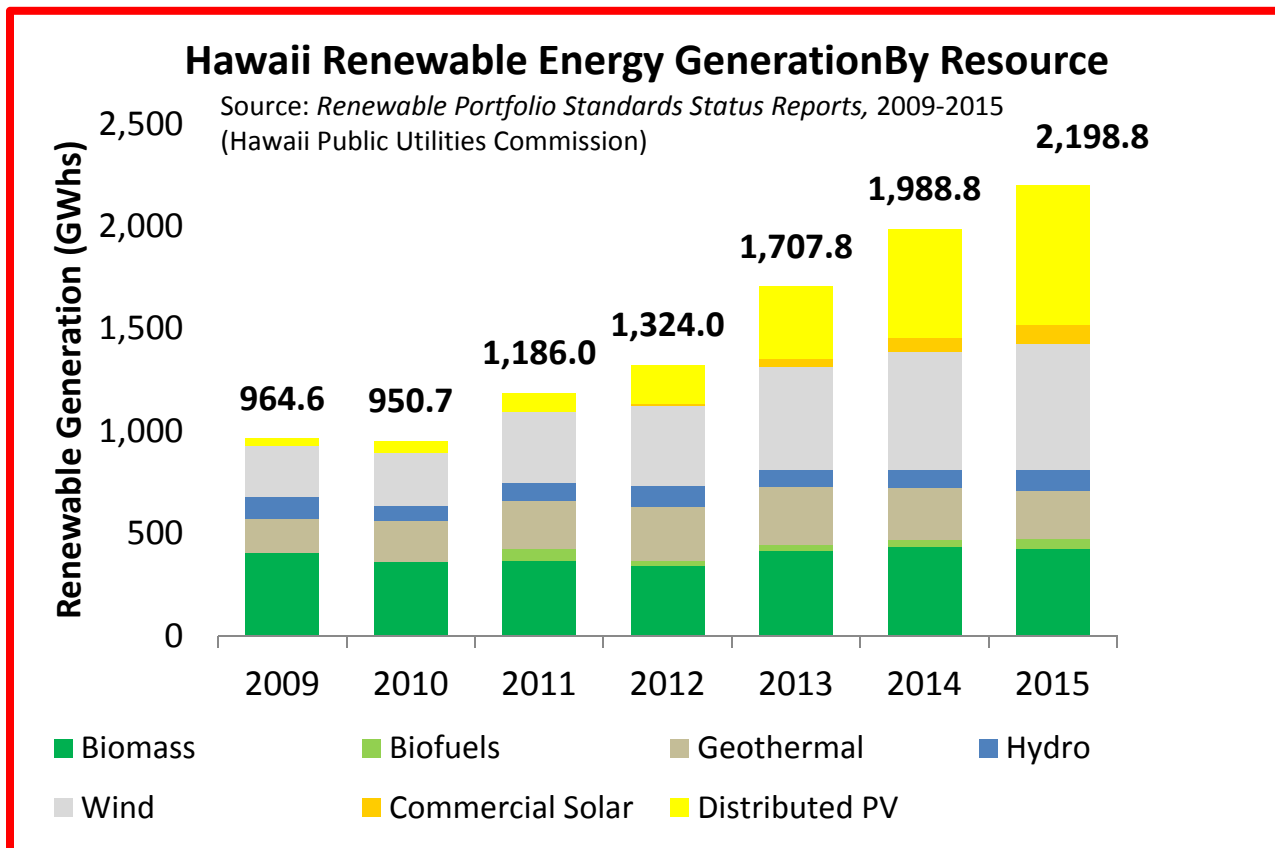
B. RENEWABLE ENERGY DEPLOYMENT

The explosion of PV is placing significant stress on the grid. On Oahu, a significant number of HECO's residential circuits are straining to manage increasing demand for distributed solar. The amount of solar energy being produced on many of HECO's circuits is at or above 100% of daytime minimum load prompting the utility to place a limit of PV systems that export to the grid.

Interconnection is one of the top priorities HSEO is focusing on in order to maintain momentum in the State's clean energy transformation. For example, HSEO is involved in a host of dockets currently before the Public Utilities Commission that are part of a broad effort to improve the planning process at Hawaiian Electric Company, so the utility will be better prepared to handle the rapid growth of distributed solar PV. Through its responses filed in the various dockets, HSEO is attempting to provide clarity on how to achieve a comprehensive solution to grid modernization.

Each year, Hawaii advances toward its clean energy goals set by HCEI. Renewable energy development is moving forward and an increasing amount of locally produced renewable energy is being utilized throughout the Islands.

- ***Renewable Energy Generation by Resource*** - Hawaii's mix of renewable energy in 2015 continued to favor distributed and commercial solar as well as wind, with gains more than offsetting declines in geothermal and biomass generation.



Source: Renewable Portfolio Standards Status Reports, 2009-2015 (Hawaii Public Utilities Commission)

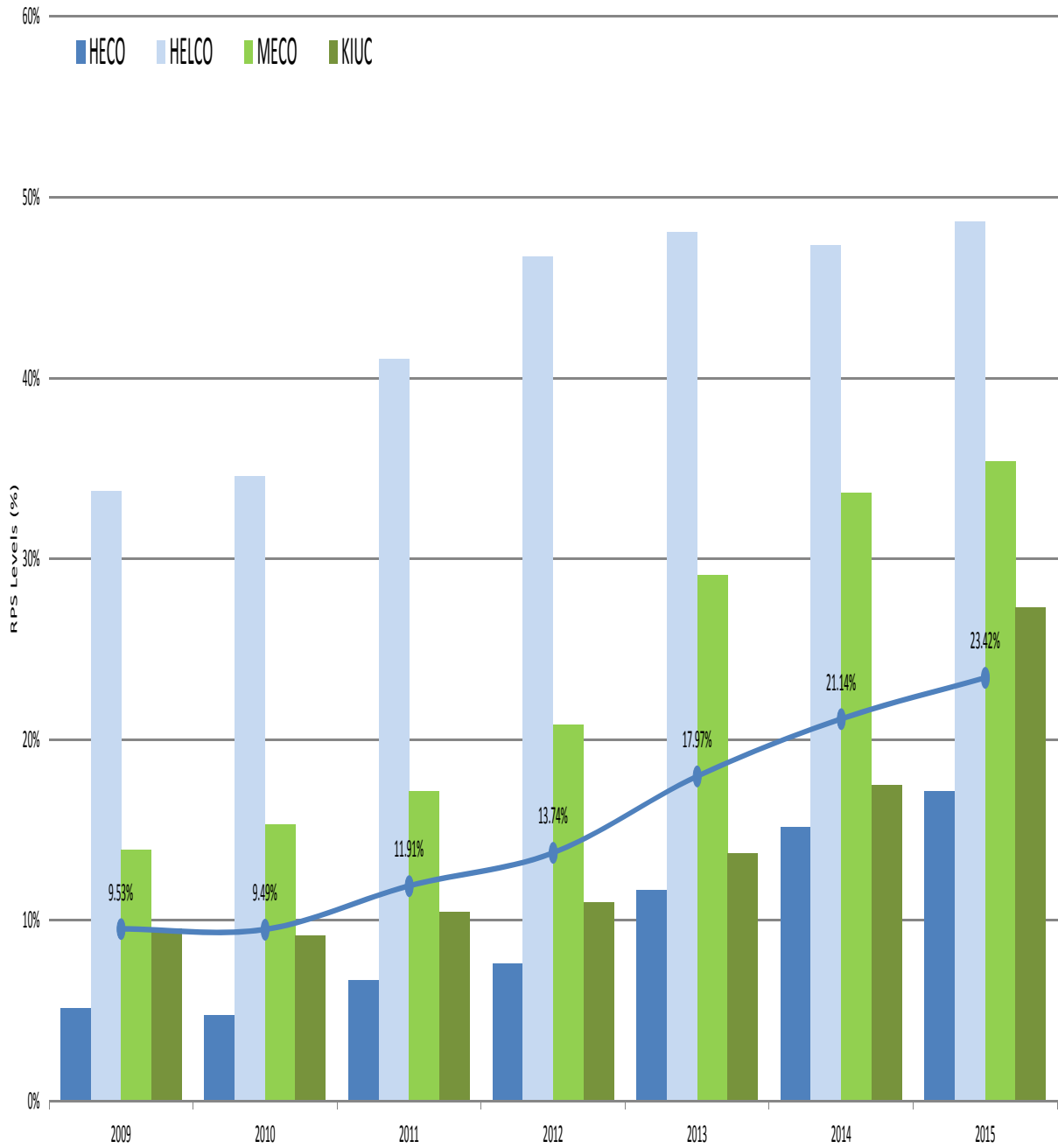
- Developer & Investor Center*** (<http://energy.hawaii.gov/developer-investor>)

The Developer & Investor Center informs users about contemporary issues and potential solutions when developing renewable energy in Hawaii today. The Center provides guidance on project permitting, local utility interconnection, Hawaii business registration, project financing and local incentives, local permitting consultants and site acquisition in Hawaii. It hosts the Guide to Renewable Energy Facility Permits in Hawaii and offers permit packets full of useful information about more than 160 federal, state and county permits, including process steps, estimated timelines and costs, agency contacts and relevant laws and references. Though developers and investors feature prominently in its name, the Center provides resources that are helpful to a wide range of stakeholders, including communities, the general public, regulatory agencies, policymakers, landowners and others interested in clean energy developments.

- ***Self-Help Energy Suite*** - HSEO created the Self-Help Energy Suite, available on the Developer & Investor Center's homepage, to advance impactful clean energy alternatives. The Suite's tools and resources for responsible project siting and design can help reduce project development soft costs and ultimately decrease local electricity costs and community impacts. Visitors can find important technical assistance, permitting tools and local connections to accelerate progress to the marketplace, expediting scalable benefits for the entire state. Highlights of the Suite include:
 - Renewable EnerGIS Map (energy.hawaii.gov/resources/renewable-energis-map) – Pulling from the Hawaii Statewide Geographic Information Systems (GIS) Program database, the EnerGIS map helps landowners, devel view location-specific siting and permitting requirements (e.g., slope, zoning, sensitive areas, other site restrictions, etc.). EnerGIS was developed in partnership with the Hawaii Office of Planning and the Hawaii Statewide GIS Program. HSEO is currently seeking to convert EnerGIS from Silverlight to a more contemporary platform (e.g., HTML5 JavaScript).
 - Renewable Energy Permitting Wizard (wizard.hawaiiicleanenergyinitiative.org) – Understanding the permits required helps developers better site and plan their renewable energy projects. It also provides other stakeholders (regulatory agencies, general public, policy makers, landowners, etc.) a bigger picture of all the approvals required for a given energy project. The Wizard covers prerequisites and processes for any county, state or federal permits that may be required for an individual project. Updated with current permitting requirements in 2015 with support from the DOE and local agencies, the Wizard is now available in an open source software environment with improved user functions.
 - Renewable Energy Projects Directory (energy.ehawaii.gov/epd/public/energy-projects-map.html) – The Hawaii Renewable Energy Projects Directory is an interactive map of existing and proposed renewable energy projects statewide, showcasing the variety of renewable energy resources that are moving the state closer to reaching energy independence. The Directory also serves to inform all stakeholders of planned and existing renewable energy projects of interest.
- ***Moving the Needle - Renewable Energy Portfolio Standards*** - Progress in renewable energy is measured against RPS with the ultimate goal of 100% by 2045. Renewable energy generation in Hawaii continues to grow from approximately 14% in 2012 to 18% in 2013, 21% in 2014, and over 23% in 2015.^[2] See chart on the following page:

^[2] Source: *Renewable Portfolio Standards Status Reports, 2009-2015* (Hawaii Public Utilities Commission)

Hawaii Renewable Portfolio Standards (RPS)

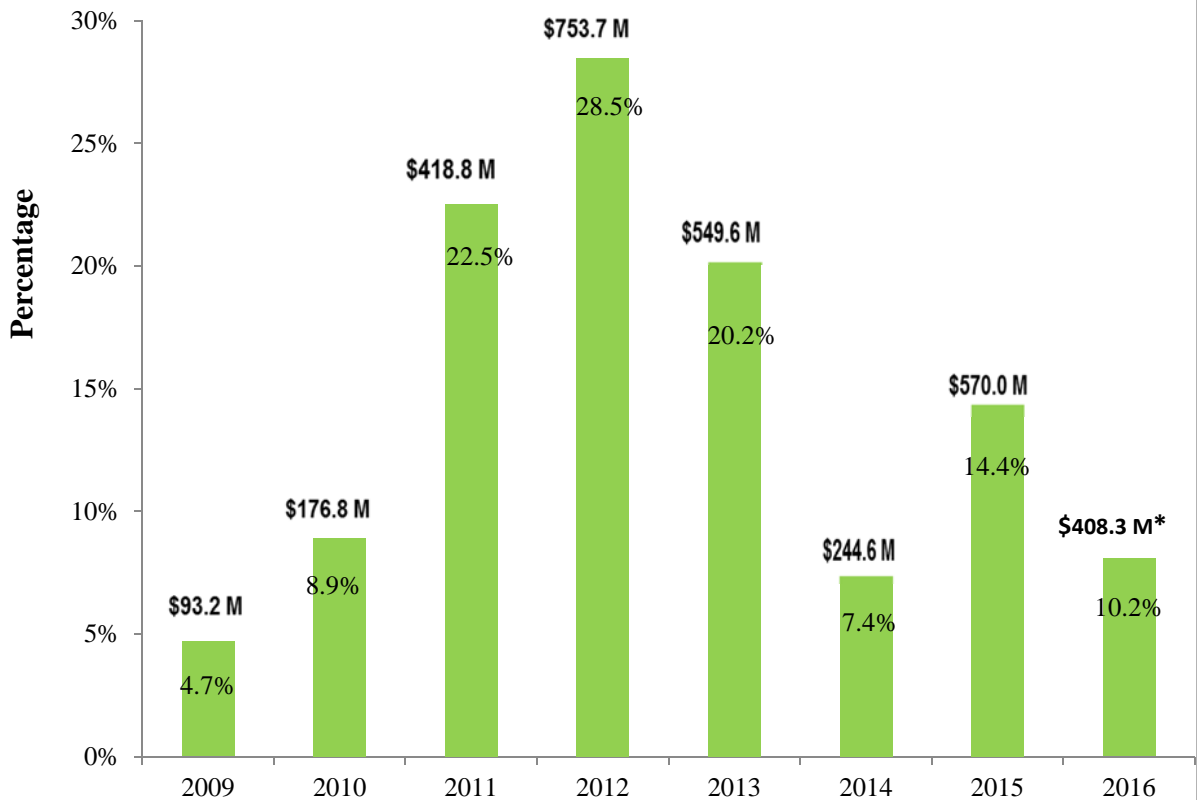


*Beginning January 1, 2015, electrical energy savings no longer count toward renewable energy portfolio standards.

Source: Renewable Portfolio Standards Status Reports, 2009-2015 (Hawaii Public Utilities Commission)

- **New Renewable Energy Projects** - The following utility-scale and pilot renewable energy projects became or are expected to become operational in 2016:
 - ❖ Kuia Solar Project, Maui (2.87 MW)
 - ❖ South Maui Renewable Resources Solar Project, Maui (2.87 MW)
 - ❖ EE Waianae Solar, Oahu (27.6 MW)
 - ❖ Hawaii American Water Wastewater Treatment Plant PV Array, Oahu (250 kW)
 - ❖ Waihonu North Solar Farm, Oahu (5 MW)
 - ❖ Waihonu South Solar Farm, Oahu (1.5 MW)
 - ❖ Hawaii Air National Guard (HCATT) Demonstration
 - ❖ Waste-to-Energy System, Oahu (200-300 kW)
- **Solar-Related Construction Expenditures** - Construction spending from solar photovoltaic installations has slowed from unsustainable levels reached during the peak of Hawaii's solar boom in 2012. Nonetheless, the solar industry is still a significant contributor to the construction sector.

SOLAR PROJECTS (MILLION DOLLARS) AS % OF TOTAL BUILDING PERMIT VALUE



Source: Research & Economic Analysis Division, DBEDT

* Projected

- ***Building a Policy and Regulatory Framework*** - HSEO contributed to the following renewable energy policy and regulatory advancements signed into law by Gov. David Ige in the ***2016 Legislative Session***:
 - i. **HB1170 (Act 220) RELATING TO LAND RESOURCES**. Provides for the lease of public lands for geothermal development without public auction as provided for other types of renewable energy.
 - ii. **HB2416 (Act 027) RELATING TO RENEWABLE ENERGY**. Repealed HRS 201N and related sections pertaining to the Renewable Energy Facility Siting Process (REFSP). Despite HSEO's efforts to implement the process dating back to its establishment in 2008, no renewable energy project has completed the REFSP, and HSEO agreed that the repeal of Chapter 201N was appropriate.
 - iii. **HB2569 (Act 176) RELATING TO ENERGY**. Established a Net-Zero energy goal for public school facilities.
 - iv. **SB2652 (Act 202) RELATING TO TAXATION**. Established a 5-year renewable fuels production tax credit, with an aggregate cap of \$3 million per year, to be administered by DBEDT and applicable to taxable years beginning after December 31, 2016. It also repealed the ethanol tax credit.

Regulatory Dockets - HSEO has intervened in the following regulatory proceedings affecting the deployment of renewable energy either directly or indirectly, in collaboration with various energy stakeholders, to advance Hawaii's clean energy goals:

- i. ***Merger Docket*** (No. 2015-0022) - HSEO testified that the application was not in accord with DBEDT's view that a change in control at the utility would advance the State's efforts to achieve its energy policy goals and directives. As an overarching issue, DBEDT was concerned with NextEra's inability to cite any concrete plan to support its claims about strengthening and accelerating HEI's clean energy transformation, the impact a merger would have on HSEO's mission, energy directives and goals, or the implications for the State as a whole. On July 15, 2016, the PUC dismissed without prejudice the proposed merger between HEI and NextEra.
- ii. ***Power Supply Improvement Plan*** (PSIP) Docket (No. 2014-0183) - Following the PUC's decision to reject the merger the PUC issued Order No. 33877 on August 16, 2016 requiring a revised PSIP to be submitted on December 1, 2016. The updated PSIP is to include additional analysis on inter-island cable, system security, customer exit economics and capital investment risks among other supplemental analysis. Statements of Positions on the revised PSIPs are due on January 13, 2017 with Reply Statement of Positions due on January 27, 2017.

- iii. ***Distributed Energy Resources*** (DER) Docket (No. 2014-0192) - Preliminary issues to be addressed in Phase 2 of this docket include: hosting capacity analysis, opportunities to enhance the value of DER to the grid, the Hawaiian Electric Companies' Integrated Interconnection Queue and revisions to applicable interconnection standards to enable advanced DER capabilities and improve the interconnection process, communications protocols between utilities and DER, advanced inverter functions and DER rate design and program structure.
- iv. ***Demand Response*** (DR) Docket (No. 2015-0412) - On December 30, 2015, the Hawaiian Electric Companies filed an application requesting approval for their demand response program portfolio structure, reporting schedule, and program cost recovery through the demand-side management surcharge. On July 28, 2016, the PUC filed an order announcing that they would hold a conference to receive feedback in determining a schedule for addressing the various issues.
- v. ***Smart Grid Foundation Project*** (No. 2016-0087) - On March 31, 2016, the Hawaiian Electric Companies proposed a \$340 million Smart Grid Foundation Project, which includes the installation of Advanced Metering Infrastructure (AMI) across the three companies. On June 28, 2016, this docket was suspended until further order of the (PUC).
- vi. ***Community-Based Renewable Energy*** (CBRE) ***Tariff*** SB1050 (Act 100, SLH 2015) - required the electric utilities to file a CBRE tariff with the PUC by October 1, 2015. DBEDT views the CBRE tariff as an attractive means to advance Hawaii's clean energy policy. A viable community-based renewable program will let the state extend the benefits of clean energy to underserved residents and allow for greater system penetration of renewable energy in support of RPS goals. On June 7, 2016, under Docket 2015-0389, the PUC issued Order No. 33751 that invited interveners to file comments to its CBRE Staff Proposal. DBEDT filed its comments to the PUC on June 30, 2016, and feedback in the areas of program structure, compensation, developer requirements and customer requirements. The CBRE tariff and related stakeholder comments are under PUC's review.

C. ENERGY SYSTEMS AND PLANNING SOLUTIONS

HSEO is examining solutions and alternatives for the design and implementation of the State's comprehensive energy ecosystem and energy assurance plans related to Hawaii's integrated utility grids, pipelines, fuels, and infrastructure. Also, HSEO is developing a statewide clean energy plan, and strategies for achieving the state's renewable energy goals, reducing petroleum use in the transportation sector, and ensuring energy security.

- ***Planning and Modeling for 100% Renewable Energy*** - The electricity sector in Hawaii is currently undergoing an extensive planning effort. With the issues in the energy sector becoming increasingly complicated, interdependent and impactful to customers, it is critical that stakeholders are engaged and decision-

makers are informed on the economic, environmental and energy security impacts of significant technical and policy decisions that must be made to transform the energy sector.

As required by law, HSEO plays a central role, assisting the Energy Resources Coordinator with “comprehensive strategic planning towards achieving full use of Hawaii’s energy resources and the most effective allocation of energy resources,” according Chapter 196, Hawaii Revised Statutes. Our duties include coordinating statewide industry and government energy interests and analyzing and evaluating energy resources, programs, systems and markets.

Modeling the energy sector – and its constituent integrated utility grids, pipelines, fuels, transportation and infrastructure – allows energy analysts to understand multifaceted issues. Crucially, modeling can illustrate how renewable energy penetration, energy efficiency measures, electricity demand and consumption, distributed energy resources, demand response programs and electricity generation interrelate in Hawaii’s complex energy ecosystem and result in the diversification of Hawaii’s energy mix.

HSEO utilizes modeling to inform statewide clean energy plans, policies and strategies for reducing petroleum use, to increase renewable penetration, and to ensure energy security. We have been intervening in dockets such as the Power Supply Improvement Plan at the PUC and working closely with utility companies, other public agencies and the private sector to properly analyze and coordinate programs and efforts in the energy sector.

- ***Energy Assurance and Security*** - Plans to achieve energy independence fail if they don’t also achieve energy security. Calamitous events, such as natural disasters or terrorist events make clear the critical value of disaster preparedness and energy resiliency. With the most isolated population concentration in the world, Hawaii’s energy resiliency and disaster recovery are a major concern. Ensuring a robust, secure and resilient energy infrastructure in the contemporary energy ecosystem is a primary function of the HSEO, in coordination with the Hawaii Emergency Management Agency, the U.S. Department of Energy, the Federal Emergency Management Agency (FEMA), County Civil Defense Agencies, partner government agencies, and energy industry emergency management and security counterparts.
- ***Revolutionizing Energy in the Transportation Sector*** - HSEO is working towards the decarbonization of the transportation sector, consistent with the energy planning objective amended by Act 38, 2015 to HRS 226-18 (a) (2). It is working towards this goal through the following initiatives:
 - Planning and coordination on the development of an energy in transportation roadmap in support of the State’s clean energy goals and in response to the HCEI transportation charrette and HCEI Transportation Energy Analysis in 2015, which identifies means by which petroleum consumption could be reduced based on economically feasible actions;

- Supporting the deployment of charging stations for electric vehicles (EV) and submitting a nomination for the designation of Alternative Fuel Corridors in Hawaii under the Fixing America’s Surface Transportation Act. As a result the Federal Highway Administration designated Hawaii’s nomination for electric vehicle and electric drive corridors within Oahu and Maui Counties.
- Participating in stakeholder discussions of the “Hawaii Sustainable Transportation Forum;” a Hawaii Department of Transportation initiated a forum which meets quarterly to address topics including; establishing statewide transportation goals, setting mode shift goals, strategies and measures, and discussing the importance of integrating land-use planning into transportation planning in support of a complete multi-modal system.
- Supported and facilitated a working group and prepared a final report on “Multi-unit Dwellings” (MUDs) based on Act164(15) to address the installation of EV charging systems within MUDs; and
- Investigating “Volkswagen Emissions Settlement” funding as an opportunity to invest in clean vehicle technology.

Registered Electric Vehicles and Publicly Available Charging Stations in Hawaii					
Island	Oahu	Maui	Hawaii	Kauai	Total
EVs	3,451	721	207	157	4,536
Level 2 Charging Ports	313	80	42	37	472
Fast Charging Ports	13	41	4	1	59
TOTAL EV CHARGING PORTS	326	121	46	38	531

Sources: DBEDT Monthly Energy Trends Report and DBEDT EV Stations Hawaii Data. Figures as of July 2016.

D. INNOVATION - EMPOWERING CLEANER POWER

Beyond supporting Hawaii’s clean energy goals, clean energy innovation has the potential to drive long-term economic prosperity by cultivating a world-class clean energy sector in Hawaii that develops new technologies and services. It is through clean energy innovations and collaboration that Hawaii will transform fossil fuel dependence into energy independence. Following are the steps we have taken to encourage high-impact, clean energy solutions and collaboration:

- **Green Energy Market Securitization Bonds (GEMS Bonds)** - is an innovative, sustainable green financing initiative designed by HSEO to make clean energy improvements more affordable and accessible for Hawaii consumers. A 2015 DOE report on state and local governments driving clean energy investment praised GEMS Bonds as an innovative clean energy financing program that engages capital markets to facilitate clean energy financing.

HSEO administers and supports the needs of the GEMS Bonds 2014 Series A (Taxable) issuance and the Green Infrastructure Fee, which is collected by the Hawaiian Electric Companies on behalf of DBEDT to pay bondholders. The sale of the GEMS Bonds provided low-cost capital to the GEMS Program run by Hawaii Green Infrastructure Authority. During fiscal year 2016, GEMS Bonds have maintained their Aaa, AAA and AAA ratings by Moody's Investors Service, Standard and Poor's and Fitch Ratings, respectively.

As part of its annual maintenance and reporting, HSEO assisted in:

- i. Ensuring payment of bondholders and ongoing costs on the semiannual payment dates of January 1 and July 1.
- ii. Completing the two required Green Infrastructure Fee filings setting the rate at an appropriate amount to ensure bondholders and ongoing costs are paid.
- iii. Filing semi-annual reports to rating agencies.
- iv. Filing an annual certification with the Municipal Securities Rulemaking Board
- v. Completing a fiscal audit for FY16 in accordance with the indenture and continuing disclosure requirements of the bonds.
- vi. General oversight of the bonds and their relationship to the GEMS Program
- vii. Any other needs related to the maintenance or new issuances of the GEMS Bonds
- viii. During FY16, HSEO has also procured and contracted for the services that support the ongoing maintenance of the GEMS bonds including:
 - a. A Financial Auditor, N&K CPAs, Inc.
 - b. A Financial Advisor, Hilltop Securities, Inc.
 - c. Bond Counsel, Katten Muchin Rosenman, LLP (procured through the Attorney General's office)

For more information about the Green Infrastructure Fee, visit:

energy.hawaii.gov/green-infrastructure-fee

For more information about the GEMS program, visit: ***gems.hawaii.gov***.

- ***Hawaii Innovation Center*** - HSEO contracted with the architecture firm Perkins + Will, Inc., to deliver conceptual plans. Work includes an assessment of space needs, a conceptual mock-up of the facility and preliminary budget estimations. HSEO also contracted with Cascadia Consulting Group, Inc., to develop a strategic plan for clean energy innovation. Cascadia will assess the clean energy ecosystem in Hawaii through research and stakeholder engagement and identify how HSEO and an energy innovation center can meet the needs of the clean energy ecosystem.
- ***Energy Excelsior*** - To encourage entrepreneurship in energy innovation, HSEO continues to provide the Energy Excelsior with funding throughout 2016 to support a training program, mentorship, outreach and connecting Energy Excelsior companies with Silicon Valley.
- ***Advanced Visualization and Collaboration Abilities*** - HSEO has been developing a visualization and collaboration platform that will:
 - i. Allow for HSEO to analyze and communicate the impacts of complex energy data sets.
 - ii. Serve as part-time collaborative workstations for HSEO energy modeling.
 - iii. Display modeling and energy ecosystem visualizations to energy stakeholders.
 - iv. Empower collaboration with other advanced visualization technologies at national labs, universities, utilities, etc.

We are exploring a partnership with the Laboratory for Advanced Visualization and Applications at the University of Hawaii to develop this platform.

- ***2016 Clinton Global Initiative Commitment*** - In 2016, HSEO partnered with Maui Electric and Hawaiian Electric to plan for the attainment of 100 percent renewable energy generation for the island of Molokai by 2030, 15 years ahead of the State's statutory requirement.

Currently, the partners have committed to:

- i. Deploy distributed, grid-connected energy storage and a grid-scale, fast response energy storage system on Molokai by December 2016. The deployment will increase levels of distributed, customer-sited photovoltaic systems, improve grid reliability and lower reliance on traditional fossil fuel generation.
- ii. Develop visualization tools to evaluate PSIPs for Molokai and updates or additions to the Molokai 5-year action plan by December 2017.

- ***JUMPSmart Maui Net Zero Microgrid*** - The JUMPSmart Maui project aims to improve distributed energy resource integration and prepare the electric system for widespread adoption of EVs. With an island-wide EV management system that increases the use of renewable energy, enables energy efficiency and creates a more stable energy infrastructure, the project will demonstrate that Smart Grid technology does not negatively impact daily life. As a collaboration between Japan and the United States, the project also improves government relations and promotes knowledge exchange between nations.
- ***Kalaeloa Community District Development*** – The Hawaii Community Development Authority (HCDA) is responsible for redeveloping the Kalaeloa Community District. After the Navy’s Base Realignment and Closure (BRAC) process, the area’s electrical infrastructure deteriorated, causing frequent blackouts.

The U.S. Department of Energy’s (USDOE’s) Office of Energy Efficiency and Renewable Energy has teamed with DBEDT, HSEO, HCDA, the U.S. Navy, and Sandia National Laboratories (Sandia) to present a four-day workshop and stakeholder meetings to identify ways to improve energy reliability and resiliency for Kalaeloa tenants and energy consumers. This workshop will be held as a part of the HCDA’s annual Kalaeloa Landowners Summit, an existing outreach effort of HCDA to seek perspectives and recommendations from landowners and key stakeholders within the district. With input from this workshop and meetings with tenants in Kalaeloa, Sandia will evaluate the potential of using microgrid technology and renewable energy to provide reliable power in Kalaeloa. Sandia’s findings will be documented in a subsequent publicly available report that will include the conceptual energy system designs and their rough (+/- 30%) cost estimates. These findings can be used as a basis by landowners and other stakeholders in order to:

- i. Create a Request for Information and/or a Request for Proposal for a microgrid,
- ii. Request funding for electrical infrastructure improvements, or
- iii. Pursue other efforts to provide reliable energy for the District.

- ***Hawaii-Okinawa Clean and Efficient Energy Cooperation*** - With the support of the DOE and Japan’s Ministry of Economy, Trade and Industry three areas of joint cooperation between Hawaii and Okinawa were identified: (1) continuation of the Ocean Energy Workshops with Kumejima Ocean Energy Consortium and Hawaii to advance Ocean Thermal Energy Conversion, (2) cooperation with Hawaii Electric Company and Okinawa Enetech Company on promoting power systems technical exchange and surveying renewable expansion and solutions, and (3) collaboration between Hawaii’s Pacific International Center for High Technology and Japan International Cooperation Agency to consider the possibility of overseas business expansion for Hawaii and Okinawa.

- ***Advancing the DBEDT-KETEP Partnership*** - In May 2016, DBEDT staff and Hawaii Korean Chamber of Commerce accompanied Hawaii legislators on a trade mission to Korea to meet with officials from the Korea Institute of Energy Technology Evaluation and Planning (KETEP). Several areas of cooperation were identified to pursue under the 2015 Memorandum of Understanding (MOU) between Hawaii and KETEP, with an agreement to continue regular policy dialogues through conferences and seminars to raise awareness by engaging a wide range of stakeholders. Hawaii and KETEP will continue to cooperate in pursuing new energy technologies and smart grid projects by partnering with key local partners, including the Hawaii Natural Energy Institute, Energy Excelerator and Seoul National University's Center for Energy and Environmental Law and Policy. Hawaii and KETEP also collaborated to develop future energy leaders by providing student exchanges and internships. This summer, HSEO hosted two interns from Seoul National University.
- ***Alliances with the Military*** - continues to be a vital contributor to the economic health of Hawaii. Both the State and the military are committed to energy security, reliability, and the maximum use of Hawaii's abundant indigenous resources to achieve energy independence. Also, it shares our responsibility to preserve the values of Hawaii while providing a secure, clean energy industry for future generations. Following are the steps this alliance has taken to encourage high-impact, clean energy solutions and collaboration:

 - i. ***Memorandum of Understanding with the Navy*** - On June 21, 2016, Gov. Ige and the Assistant Secretary of the Navy, Energy, Installations, and Environment, the Honorable Dennis McGinn, signed an MOU agreeing to collaborate on energy-related issues that support the aggressive clean energy directives of both parties. This MOU extends through December 31, 2020. The MOU initially establishes the following working groups.

 1. **Alternative Fuels in Ground Transportation**
Task: Develop and implement a strategy integrating alternative-fueled vehicles and fuel-saving technologies to cultivate an environment encouraging employees and organizations to adopt clean energy transportation solutions. Align with Hawaii statutes and federal and Department of Navy fossil fuel reduction goals.
 2. **Renewable Energy Project Development**
Task: Develop and sustain a collaborative team to accelerate renewable energy goals.

3. Grid Safety, Resiliency and Reliability

Task: Develop a collaborative team to identify Marine Corps Base Hawaii, Navy Region Hawaii and HSEO interests, plans and actions to promote energy resiliency for their respective installations, facilities and jurisdictions. Ensure a secure and reliable energy supply to support operating forces, their families and local communities by hosting critical infrastructure through the prudent development and management of efficient energy resources and infrastructure.

- ii. ***U.S. Pacific Command*** - Dialog is ongoing with U.S. Pacific Command (PACOM) regarding mutual areas of concern like energy security, energy management, disaster preparedness and response/ recovery. Critical infrastructure planning is imperative and collaboration with PACOM allows Hawaii to leverage expertise and resources to ensure energy security and rapid response to incidents. PACOM also remains an active participant in HCEI.
- iii. ***U.S. Army*** - HSEO has met with energy leadership from U.S. Garrison Hawaii to discuss collaboration on renewable energy projects. Both parties have agreed to continue open dialog around generation projects and lessons learned as we strive to achieve mutual clean energy goals.
- iv. ***SPIDERS JCTD*** – The Smart Power Infrastructure Demonstration for Energy Reliability and Security (SPIDERS) Joint Capability Technology Demonstration (JCTD) program increases cyber security and energy efficiency for U.S. military installations and transfers that expertise to non-military critical infrastructure. SPIDERS concluded a single-circuit demonstration of a cyber-secure microgrid for waste water treatment at Joint Base Pearl Harbor-Hickam and implemented the Department of Defense’s first installation-wide microgrid with cyber-attack defenses at Camp Smith, which allows full operation of the base during an extended electrical outage.
- v. ***HCATT/JPBPH*** – The Air Force Research Lab and the Hawaii Center for Advanced Transportation Technologies (HCATT) signed an agreement to develop a military microgrid at Joint Base Pearl Harbor-Hickam that will directly support the 154th Wing of the Hawaii Air National Guard. Developed by the Air Force, the microgrid will have electricity provided from renewable energy projects planned for the site and an existing Air Force-HCATT hydrogen fuel cell source.

V. BUDGETED HSEO SPENDING

The HSEO is supported primarily by its Energy Security Special Fund (ESSF), established under section 201-12.8, HRS. In the fiscal year ended June 30, 2016, the ESSF revenues were \$3,863,897, up 4.2% from \$3,708,195 in the preceding fiscal year. HSEO’s allocation of the EREFST to the ESSF is critical for supporting the HCEI, given Hawaii’s aggressive goal to reach 100 percent renewable energy by 2045. The obligated and planned investments utilizing ESSF funds are shown in the chart below:

ENERGY SECURITY SPECIAL FUND - OBLIGATED & PLANNED INVESTMENTS		
INITIATIVE	FY16 OBLIGATED	FY17 PLANNED
Hawaii State Energy Office - Personnel Costs	3,659,964	3,983,953
Program Support - State Energy Office	133,137	147,897
Energy Education / Outreach - State Energy Office	18,513	24,075
Special Fund Assessments	196,963	200,000
Database Information, Databooks and Reports	46,248	50,000
Speakers and Facilitators	1,500	15,000
Regulatory/Policy and Expert Witness-Related Technical	50,000	170,000
Project Management Software Renewal	4,500	-
Website for Solar Water Heater Variance Program	-	9,854
Renewable Energy Projects Directory Website Software	10,000	-
Innovation Center Content Design	149,100	-
VERGE Hawaii 2016 Asia Pacific Clean Energy Summit	100,000	50,000
Public Relations and Marketing Support	100,000	-
Network Assessment	-	15,000
Promotional Video	14,716	-
TOTAL	4,484,641	4,665,779

Federal funding from the U.S. Department of Energy and other federal agencies supplements the HSEO's ESSF funding. The USDOE's State Energy Program provides an annual formula allocation of approximately \$280,000 for increasing market transformation of energy efficiency and renewable energy technologies through policies, strategies, and public-private partnerships that facilitate their adoption and implementation. The formula grant may also be used for state-based activities, such as: financing mechanisms for institutional retrofit programs; loan program and management; energy savings performance contracting; comprehensive residential programs for homeowners; transportation programs that accelerate use of alternative fuels; and renewable programs that remove barriers and support supply side and distributed renewable energy. HSEO also actively pursues federal funding opportunities that align with its objectives. The current portfolio of federal grants supporting the State's energy program is detailed in the chart below:

Hawaii State Energy Office - Federal Grants				
Funding Agency	Award Title	Award Amount	Grant Objective	Partners
USDOE - EERE	State Energy Program (SEP) Formula (2010, 2011, 2012, 2013, 2014)	\$ 1,212,899.00	To design and carry out the Hawaii State Energy Office's energy efficiency and renewable energy programs. Term: Jul 2010 - Jun 2016.	Various
USDOE - EERE	State Energy Program (SEP) Formula (2015, 2016)	\$ 565,780.00	To design and carry out the Hawaii State Energy Office's energy efficiency and renewable energy programs. Term: Jul 2015 - Jun 2017.	Various
USDOE - EERE	Advancing Energy Efficiency in Hawaii Public Facilities	\$ 350,000.00	To strengthen, enhance, and expand the State's existing energy efficiency program by using Energy Star Portfolio Manager (PM) to benchmark appropriate State Executive Branch facilities and use the results to encourage state agencies to bundle facilities to pursue energy efficiency through energy savings performance contracts or other financing mechanisms. Term: Sep 2012 - Mar 2017.	Hawaii Public Benefits Fee Administrator (SAIC/RW Beck) Hawaii Dept. of Accounting & General Services - Public Works Division Hawaii Energy

In FY16, HSEO was responsible for a grant award pursuant to the provisions of Section 42F-103, HRS in the amount of \$211,825 to the Hawaii Community Action Program (HCAP). This grant is for HCAP to reduce energy consumption and costs in low-income households through energy education and installation of energy-efficient devices and appliances in low- to moderate-income households through its Residential Energy Solutions Initiative (RESI) program.

The Hawaii Green Infrastructure Bond Fund is a special fund outside the State Treasury into which all proceeds of the Green Infrastructure Fee established pursuant to section 269-F and any other proceeds of Green Infrastructure Property are paid. Money in the Green Infrastructure Bond Fund is to secure the payment of bonds, amounts payable to financing parties and bondholders, amounts payable under any ancillary agreement, and other financing costs.

The budgeted spending plan for HSEO utilizing all currently available sources of funding for HCEI is shown below:

Spend Plan For Fiscal Years ending June 30, 2016 and June 30, 2017					
Description	MOF	FY 2016		FY 2017	
Personal Services	A			-	
Other Current Expenses	A			1,200,000	
Total	A			1,200,000	
Personal Services	B	3,852,677		3,983,953	
Other Current Expenses	B	51,689,780	*	51,431,826	*
Total	B	55,542,457		55,415,779	
Personal Services	N			-	
Other Current Expenses	N	1,500,000		-	
Total	N	1,500,000		-	
TOTAL ALLOCATION		57,265,431		56,615,779	
Funding sources:					
Means of Financing: A - General Fund					
Means of Financing: B - Special Fund (Energy Security Special Fund)					
Means of Financing: N - Federal Funds					
* Includes \$50M for the Hawaii Green Infrastructure Bond Fund					

Initiatives supported by the spend plan reflect both HCEI program goals and areas targeted for achievement. Associated projects currently encumbered under contract are highlighted based on target market, method of funding, reason for selection, persons served, program objectives, amount encumbered, and measurable outcome in Attachment 1.

VI. EREFST TAX ANALYSIS

The amount and allocation of the EREFST as articulated in Act 73(10) is detailed in the following chart:

	Original
Environmental Response, Energy, and Food Security Tax	\$ 1.05
Environmental response fund	0.05
Energy security special fund	0.15
Energy systems development special fund	0.10
Agricultural development and food security special fund	0.15
Total	\$ 0.45
Balance to general fund	0.60

Under the Act three new funds were established in 2010:

- **Energy Security Special Fund** – to be expended by DBEDT
- **Energy Systems Development Special Fund** – to be expended by HNEI³
- **Agricultural Development and Food Security Special Fund** – to be expended by HDOA⁴

The allowable activities for funding from each fund (specified within the Act) are as follows:

- **Energy Security Special Fund**
 - Subject to appropriation, moneys from the fund may be expended by DBEDT for the following purposes and used for no other purposes, except:
 - a) To support HCEI and the Energy Division, including staffing positions;
 - b) To fund, to the extent possible, the Greenhouse Gas Emissions Reduction Task Force, climate change task force, grant-in-aids (Chapter 42F, HRS) to the economic development boards and economic development agencies of each county to meet the stated objectives of HCEI.

³ HNEI – Hawaii Natural Energy Institute of the University of Hawaii

⁴ HDOA – Hawaii Department of Agriculture

- **Energy Systems Development Special Fund**
 - Obtaining matching funds from federal and private sources for research, development, and demonstration of renewable energy sources;
 - Awarding contracts or grants to develop and deploy technologies that will reduce Hawaii's dependence on imported energy resources and imported oil. Projects may be commissioned that:
 - a. Balance the risk, benefits, and time horizons of the investment to ensure tangible benefits to the Hawaii consumer, with priority given to short- term technology development;
 - b. Emphasize innovative and renewable energy supply and energy efficient end use technologies focusing on environmental attributes, reliability, and affordability;
 - c. Enhance transmission and distribution capabilities of renewable energy supply for electricity;
 - d. Enhance reliability and storage capabilities of renewable energy for electricity;
 - e. Ensure that research, deployment, and demonstration efforts build on existing programs and resources and are not duplicated;
 - f. Address critical technical and scientific barriers to achieving energy self-sufficiency by reducing dependence on imported oil and imported energy resources;
 - g. Ensure that technology used and developed for renewable energy production and distribution will be commercially viable; and
 - h. Give priority to resources that are indigenous and unique to Hawaii; and
 - b) Managing the portfolio of projects commissioned under this subsection.
- **Agricultural Development and Food Security Special Fund**
 - Subject to appropriation, the Agriculture Development and Food Security Special Fund can fund:
 - a) Grants to farmers for agricultural production or processing activity;
 - b) Acquisition of real property for agricultural production or processing activity;
 - c) Improvement of real property, irrigation systems, and transportation networks necessary to promote agricultural production or processing activity;
 - d) Purchase of equipment necessary for agricultural production or processing activity;

- e) Research on and testing of agricultural products and markets;
- f) Funding of agricultural inspector positions within the department of agriculture;
- g) Promotion and marketing of agricultural products grown or raised in the state; and
- h) Any other activity intended to increase agricultural production or processing that may lead to reduced importation of food, fodder, or feed from outside the state.

The program's (DBEDT, HNEI, HDOA) effectiveness in accomplishing the goals and objectives of the Act are as follows:

- **Energy Security Special Fund**

HSEO has made significant and tangible progress towards achieving Hawaii's clean energy goals through HCEI, as evidenced by its national recognition, but we remain vigilant to adjusting and evolving in order to achieve Hawaii's clean energy goals.

HSEO is essentially dependent upon the ESSF to enable retaining the capacity, staff resources, and project funding to continue critical initiatives. This reliance on ESSF funds is documented by its obligations for FY15 in the chart on page 17-18.

An accounting of expenditures (obligations) in FY14 from the ESSF follows:

- In-line with the intent of the Act, HSEO funded staff positions within the Division (\$3,375,833). Remaining funds were expended in support of HSEO operations (\$1,236,006).

- **Energy Systems Development Special Fund**

See HNEI attached report, Attachment 2.

- **Agricultural Development and Food Security Special Fund**

The Department of Agriculture in 2016 expended approximately \$3.2 million from the Agricultural Development and Food Security Fund on initiatives targeting food self-sufficiency and security. These activities and programs are summarized in the following table.

HEDTF DOA 2016 Expenditures – Encumbrance Update

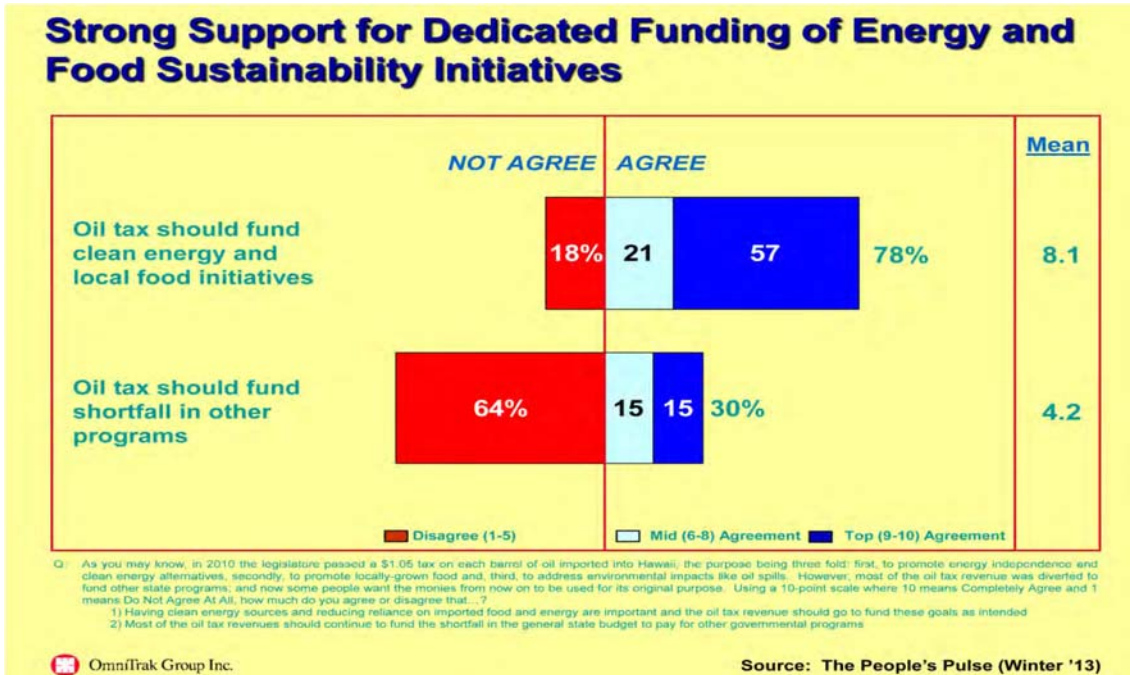
CATEGORY	PURPOSE	ACTIVITIES AND PROJECTS	EXPENDITURES
Irrigation Operations	Improvement of real property, irrigation systems, and transportation networks necessary to promote agricultural production or processing activity	Irrigation personnel and operating expenses; East Kauai Water Cooperative	\$ 598,311
Research	The conduct of research on and testing of agricultural products and markets	Macadamia Felted Coccid; Aquaculture feed development; Aquaculture metrics; Organics; Natural Farming	\$ 809,839
Marketing and Promotion	Promotion of marketing of agricultural products grown or raised in the state	"Eat Local" Campaign; Seal of Quality; Grants Roadshow	\$ 270,000
Agricultural Support	Activities that intended to increase agricultural production or processing may that may lead to reduced importation of food, fodder or feed from outside of the State.	Neighbor Island Support; Planner Position; Farm to School Program; Hawaii Association of Conservation Districts; IT System Development; Whitmore Agricultural Hub; Insectary Repairs	\$ 1,496,164

VII. EREFST ALLOCATION:

1. **Public Opinion** – In December 2012, public opinion was surveyed statewide on the issue of dedicated funding of energy and food sustainability initiatives. There was strong public support to return the barrel tax revenues to its original intended purposes. This survey by OmniTrak Group Inc. showed that 78 percent of Hawaii residents agreed that the barrel tax funds should be restored for the intended purposes of improving energy and food self-sufficiency. The question posed and the response results follow below:

- **Question** – In 2010 the legislature passed a \$1.05 tax on each barrel of oil imported into 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; and
- Most of the oil tax revenue should continue to fund shortfalls in the general state budget to pay for other governmental programs.



- **UHERO_Hawaii Free Press – February 13, 2014 stated:** “While in theory it [barrel tax] serves to discourage fossil fuels (internalizing the negative externality), its major impact has been as a funding source for energy and food security initiatives. ...Providing support for HCEI and the Greenhouse Gas Emissions Reduction Task Force, as well as instrumental research conducted by the Hawai‘i Natural Energy Institute (HNEI) are just several examples of how the barrel tax has contributed to advancing the State’s energy goals.”
2. **Legislative Session** – the Hawaii Legislature and the Governor approved Act 107, Session Laws of Hawaii (SLH) 2014, to enable the barrel tax to function as a resource strategy that is now aligned with the State’s 2045 clean energy goals to continue progress and plan development for clean energy infrastructure in Hawaii. This measure further provides support for the Departments of Agriculture and Health to respectively undertake food self-sufficiency and equip for an environmental response. And, the Legislature restored funding to the Energy Systems Development Special Fund, which had been repealed on June 30, 2012. Also, the Legislature via Act 185, SLH 2015 modified the taxation of petroleum by expanding the taxation to other fossil fuels. See the chart on the following page:

	Allocation as provided in Act 73, SLH 2010	Allocation as of July 1, 2012 and 2013	Restored Allocation as of July 1, 2014	Other Fossil Fuels Added Allocation as provided in Act 185, SLH 2015
“BARREL TAX”	\$ 1.05	\$ 1.05	\$ 1.05	
Environmental Response Revolving Fund	\$ 0.05	\$ 0.05	\$ 0.05	4.8% per 1 million BTU
Energy Security Special Fund	\$ 0.15	\$ 0.15	\$ 0.15	14.3% per 1 million BTU
Energy Systems Development Special Fund	\$ 0.10	----	\$ 0.10	9.5 % per 1 million BTU
Agricultural Development and Food Security Special Fund	\$ 0.15	\$ 0.15	\$ 0.15	14.3% per 1 million BTU
TOTAL ALLOCATED TO ENERGY, FOOD SECURITY & ENVIRONMENTAL RESPONSE	\$ 0.45	\$ 0.35	\$ 0.45	\$0.45 + 19 cents per 1 million BTU
BALANCE TO GENERAL FUND	\$ 0.60	\$ 0.70	\$ 0.60	\$0.60 + unexpended and unencumbered moneys each fiscal year in excess of \$1,250,000 from the ERRF

- Other notable legislative Acts, which were passed in 2016 are:
 - **Chapter 201N Repeal – Act 27, SLH 2016:** Repeals chapter 201N, HRS, relating to the Renewable Energy Facility Siting Process. Deposits proceeds in the renewable energy facility siting special fund into the general fund.
 - **Public Schools Energy Efficient AC – Act 47, SLH 2016:** Appropriates general revenues of \$100,000,000 or as may be necessary for fiscal year 2015-2016 for the purpose of funding capital improvement program equipment and installation costs for air conditioning, other heat abatement measures, energy efficient lighting, and other energy efficiency measures at public schools.
 - **HSEO Exemption From Civil Service – Act 79, SLH 2016:** Makes all energy program managers, energy program specialists, energy program assistants, and energy analysts positions within the state energy office exempt from civil service.

- **State Budget – Act 124, SLH 2016:** BED120 \$1,200,000 FY16-17 for a study to evaluate the alternative utility and regulatory models including, but not limited to, cooperative, municipal, and independent distribution system operators, and the ability of each model to: 1) achieve state energy goals; 2) maximize consumer cost savings; 3) enable a competitive distribution system in which independent agents can trade and combine evolving services to meet customer needs; 4) eliminate or reduce conflicts of interest in energy resource planning, delivery, and regulation; provided further that the study shall include a long-term cost-benefit analysis of each model and the steps required to carry out each scenario for each county.
- **Renewable Fuels Production Tax Credit – Act 202, SLH 2016:** Establishes a five-year renewable fuels production tax credit and repeals the ethanol facility tax credit. Allows qualifying taxpayers to claim a refundable income tax credit equal to 20 cents per seventy-six thousand British thermal units of renewable fuel, capped at \$3,000,000 per taxable year. Caps the credit at \$3,000,000 per year in aggregate. Requires DBEDT to certify all tax credits and submit a report regarding the production and sale of renewable fuels to the governor and legislature each year. Directs DOTAX to create forms for the tax credit. Applies to taxable years beginning after December 31, 2016. Repeals the tax credit on 12/31/2021.

CONCLUSION:

The EREFST serves as a self-sufficient fossil fueled based mechanism to fund clean energy solutions to Hawaii’s addiction to oil, through the HCEI.

There are many reasons to be optimistic about Hawaii’s progress and our ability to meet our ambitious goals. Most of the metrics are pointing in the right direction. We are ahead of schedule in our renewable portfolio standard. This success has prompted the goal to now achieve 100 percent renewable energy in the electricity sector by 2045. However, these clean-energy goals must be undertaken in a manner that benefits Hawaii's economy and all electric customers, maintains customer affordability, and does not induce renewable energy developers to artificially increase the price of renewable energy in Hawaii.

Progressive funding from the EREFST for HCEI, food security initiatives is imperative, towards developing solutions to complex technological challenges. EREFST progressive funding will enable program initiatives to provide positive contributions to economic development and jobs, and advance and achieve the State’s energy and food security goals and targeted timetable to achieve energy and food sustainability and independence.

“Our drive to 100 percent renewable energy is very much driven by, not only saving the environment, but also the fact that it makes economic sense for Hawaii. Energy has ... been a huge driver of helping create this (Hawaii’s) clean energy economy. Hawaii has very much the inside track on being the model for what a clean energy economy can be...” **Luis P. Salaveria, DBEDT Director**

**UNIVERSITY OF HAWAI‘I SYSTEM
ANNUAL REPORT**



**REPORT TO THE 2017
LEGISLATURE**

**ANNUAL REPORT FROM THE HAWAI'I
NATURAL ENERGY INSTITUTE**

HRS 304A-1891

December 2016

Hawaii Natural Energy Institute

School of Ocean and Earth Science and Technology

University of Hawaii at Manoa

Annual Report to the 2017 Legislature

HRS 304A-1891



SUBJECT: Annual Report on Activities, Expenditures, Contracts Developed, Advances in Technologies, Work in Coordination with State Agencies and Programs, and Recommendations for Proposed Legislation, required in accordance with HRS 304A-1891 (Act 253, SLH 2007).

HIGHLIGHTS:

The following key achievements were made possible in whole or part by contributions from the State's barrel tax:

- **Wave Energy Test Site** –Support from the barrel tax was instrumental in allowing the buildout of the country's first grid-connected wave energy test site offshore from the Marine Corps Base in Kaneohe. Under a combination of Navy, ONR, and USDOE funding, HNEI is conducting power performance assessments on deployed devices, collecting environmental data, and providing logistics support. This unique facility provides developers the necessary infrastructure to test devices and gather data to advance their designs toward commercial readiness.
- **Grid Modeling – System Stability** (RPS II Study) – Independent electric utility system analyses continue to be conducted to determine the effects of large amounts of distributed photovoltaic systems on the Oahu grid. In addition to ongoing work to address curtailment, these studies identify likely challenges, and assess the cost-effectiveness of strategies to maintain system stability and

reliability with increasing amounts of renewable energy generation. These analyses provide valuable information to the Public Utilities Commission and other stakeholders as we move toward the State's RPS targets.

- **Hydrogen Fueling Station** – Support from the barrel tax was instrumental in development of the State's first unattended fast-fill hydrogen fueling station on the Marine Corps Base in Kaneohe allows drivers to self-fill their cars just like they would at a gas station, and serves to demonstrate the capability of the technology to be user friendly. Over 400 successful fills were achieved.
- **Hydrogen Fuel Cell Shuttle Bus for the County of Hawaii Mass Transit Agency** – A hydrogen fuel cell electric bus to be operated by the County of Hawaii Mass Transit Agency was completed and is ready for shipment to Hawaii. It will be supported by a hydrogen fueling station being installed at the Natural Energy Laboratory Hawaii Authority (NELHA) and will be used by the Hele-On bus service to demonstrate the benefits of hydrogen buses to the Kailua-Kona community. This is the first hydrogen vehicle in Hawaii that will be available to the public.
- **Smart Inverter Deployment and Testing** – Support from the barrel tax was used to support development of smart inverters and communications protocols for better control of distributed PV. These smart inverters have been deployed in a Maui neighborhood to test and demonstrate their ability to manage rooftop PV generation and provide support to the distribution grid to enable higher penetrations of renewable energy on the system. Testing and data collection is ongoing using other funding sources.

These projects are described more fully later in this report.

SUMMARY:

The Hawai'i Natural Energy Institute (HNEI) conducts essential energy research relevant to Hawai'i 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 Hawai'i, while reducing our dependence on oil and other fossil fuel resources.

HNEI brings together people from a wide range of disciplines and different types of organizations to tackle the urgent and complex sustainable energy needs of the state and the nation. Analysis, research, engineering, economics, and policy are integrated to develop technology, strategies and policies that will have significant positive impact on the energy mix.

HNEI is committed to supporting the State, Federal agencies and industry in planning and implementing clean energy initiatives. HNEI's activities can be grouped into five core functions:

- Research & Development
- Technical Validation & Implementation
- Analysis & Modeling
- Education & Training
- State Energy & Policy Support

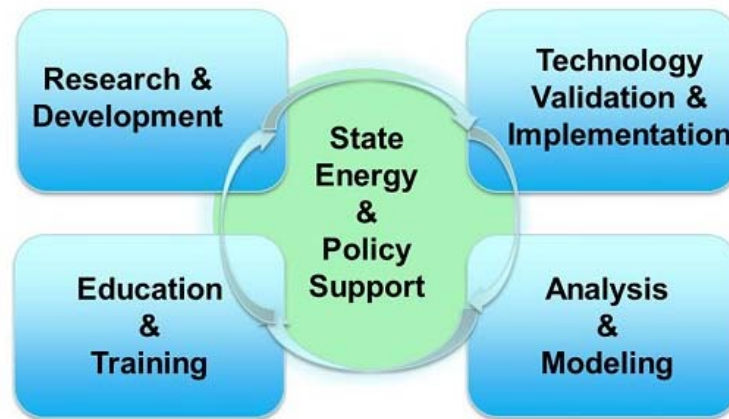


Figure 1. HNEI's inter-related functions used to maximize collaboration and leverage resources.

State Energy & Policy Support

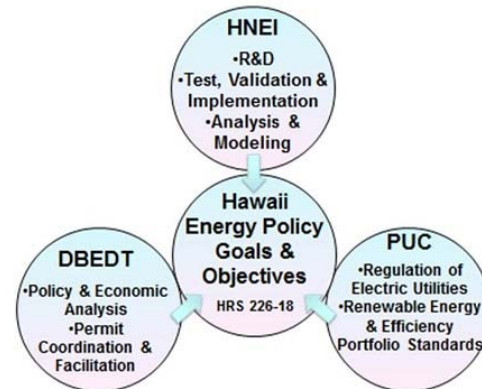
HNEI was established in 1974 to coordinate and undertake the development of natural energy sources for Hawai'i.

In 2007, ACT 253 established HNEI by statute and expanded its mandate to explicitly include coordination with state and federal agencies; and the demonstration and deployment of efficient end use technologies including those that address peak electric demand issues.

Act 253 also established the Energy Systems Development Special Fund (ESDSF) and directed that it be managed by HNEI. Three years later, in 2010, Act 73 authorized 10 cents of the \$1.05 tax imposed on each barrel of petroleum product imported into Hawaii be deposited into the ESDSF. HNEI, in collaboration with the State Energy Coordinator, develops expenditure plans for the ESDSF to maximize the value of these funds to meet needs and opportunities within the state, and to maximize matching funds from federal and private sources.

In executing its mandate, HNEI has assumed an important role within the state to reduce Hawai'i's dependence on fossil fuels, serving as the implementing organization for several large, public-private partnerships to develop, deploy and demonstrate renewable energy systems. HNEI continues to forge strong partnerships with industry, state and national organizations creating a thriving synergy that expands resources and accomplishments for all involved. HNEI works closely with federal funding agencies, industry, the State Energy Office, our State legislators, Public Utilities Commission and our Congressional delegation, providing stability and enhancing the benefits afforded to residents of Hawai'i and beyond.

HNEI has become recognized as an independent organization providing trustworthy and practical information to support the safe, reliable, and economically viable development of renewable energy technologies and systems. The foundation of HNEI's strength lies in its people and partners. The diversity of talents, education, experience, and the entrepreneurial spirit of this team creates flexibility in performing a range of renewable energy development responsibilities. HNEI also serves as a critical bridge between State and Federal initiatives, supporting for example the State's 100% renewable portfolio standard and clean transportation initiatives. In summary, HNEI's responsibilities go beyond traditional academic research, playing a significant role in public-private partnerships and supporting analysis for state energy policy.



Research & Development (R&D)

As an Organized Research Unit within the University of Hawai'i at Mānoa (UH), HNEI has maintained a strong core research effort. HNEI's faculty and staff are truly multidisciplinary, with a wide diversity of backgrounds. For efforts requiring additional expertise, HNEI also works closely with other units on campus, including the School of Ocean & Earth Science & Technology (SOEST), College of Engineering, College of Tropical Agriculture and Human Resources, and College of Social Sciences. This critical mass allows HNEI to conduct increasingly comprehensive and complex research. With a strategic focus on remaining flexible to support the dynamic needs of renewable energy development, HNEI's direction continues to evolve.

Technology Validation & Implementation (TV&I)

Moving R&D discovery from labs to market is an important aspect of HNEI's TV&I mission and supports the adoption of innovative solutions in Hawaii. HNEI faculty and staff have been successful in transferring patented HNEI technology in a variety of areas to demonstration scale, and even commercial implementation.

Additionally, there are many emerging technologies of potential significance to Hawai'i's energy needs developed elsewhere. Under our TV&I efforts, we identify and bring to Hawai'i technologies of interest, for validation and assessment for use in Hawai'i. These activities are frequently guided by our analysis and modeling efforts and supported by our R&D activities. HNEI's TV&I projects usually involve industrial partnerships and often include cost share. A good example is the ongoing effort to evaluate emerging grid scale and distributed battery energy storage technology as a solution to both transmission and distribution level issues associated with high penetration of intermittent renewable energy technologies.

Analysis & Modeling

HNEI conducts and supports analysis and modeling to analyze important forward looking scenarios for Hawai'i's energy mix. This analysis is critical to identifying optimal and realistic paths forward to meet Hawai'i's clean energy goals. Results from these studies are used as to guide state policy and help identify important validation projects in areas such as biofuels, grid integration, and hydrogen.

Education & Training

As a research institute, HNEI does not have its own academic program but has active partnerships throughout the university. Faculty members develop and present courses for academic units in SOEST, the College of Engineering, and the College of Tropical Agriculture and Human Resources. HNEI faculty support and supervise graduate students and post docs across these departments. HNEI also supports the Asia-Pacific Technology and Education Partnership (APTEP), funded by the Office of Navy Research (ONR).

The attached report summarizes HNEI's current research activities for the past fiscal year and provides a summary of the expenditure for the funds provided by the barrel tax to the ESDSF.

Summary of Activities, 2016
Hawai'i Natural Energy Institute
School of Ocean and Earth Science and
Technology
University of Hawai'i at Mānoa

Director: Richard E. Rocheleau

Staffing:	Permanent Faculty (FTE)	7
	Other permanent staff (APT)	3
	Temporary Faculty	28
	Other temporary staff (APT, RCUH)	16
	Training (a)	20

(a) Includes post-doctoral fellows, graduate and undergraduate students, and visiting scientists.

SUMMARY OF CONTRACTS AND ACTIVITIES:

HNEI is a nationally acknowledged research leader with major activities in areas such as hydrogen and fuel cells, biofuels, ocean resources, and grid integration. While continuing to conduct basic and applied research, HNEI has, in accordance with HRS 304A-1891, also undertaken a pivotal role within the state including identification, evaluation, and testing of advanced energy technologies and systems aimed at reducing Hawai'i's dependence on fossil fuels. HNEI serves as the implementing and/or managing partner for several major public/private partnerships to deploy and demonstrate renewable energy systems to meet Hawai'i's energy needs. These efforts support both the goals of the State of Hawai'i and our project partners.

A brief synopsis of select HNEI activities follows:

Hawai'i Energy Sustainability Program (HESP): HESP, funded by the United States Department of Energy's (USDOE), ended in September of 2016. During the 7 year period it was in place, HESP significantly boosted HNEI's partnerships and capabilities in many areas including system modeling, renewable integration, and mitigation technology analyses.

Under this program, in partnership with GE Global Research and the HECO utilities, HNEI established a research and assessment program in integrated energy and systems analysis of electricity technologies. This program provided essential research in areas of relevance

to Hawai'i and abroad including analysis and modeling of isolated grid systems with high amounts of renewable energy resources, power distribution and microgrid systems, advanced power system monitoring, intelligent control, communications and enabling technologies. The program focused on identifying

technically-sound cost effective solutions and practical strategies

that energy generators and grid operators can implement to deliver commercially viable renewable energy to achieve reduced dependence on oil and other fossil fuel resources. Major activities under this program included:

- *O'ahu Wind Integration Study (2008 - 2010)*
- *Hawai'i Solar Integration Study (2010 - 2012)*
- *O'ahu – Maui County Grid Interconnection (Stage 2) Study (2012 – 2013)*
- *O'ahu EV Charging Study (2012 – 2013)*
- *Renewable Portfolio Standards Study (2013-2015)*
- *Liquefied Natural Gas Study (2012)*
- *Evaluation of Alternative Ownership Options for Electric Utility Assets on the Islands of Oahu and Hawaii (2016)* – This assessment of municipal and cooperative ownership models included potential benefits and challenges associated with each and provided a roadmap of necessary steps and analyses necessary if these options are further pursued.
- *RPS II Study (2015 -)* HNEI's most recent and ongoing phase of system modeling and analyses, is looking at even higher penetrations of renewable

RENEWABLE ENERGY GRID INTEGRATION STUDIES

HNEI is developing ground-breaking analytic tools to allow higher penetration of renewables on island grid systems.

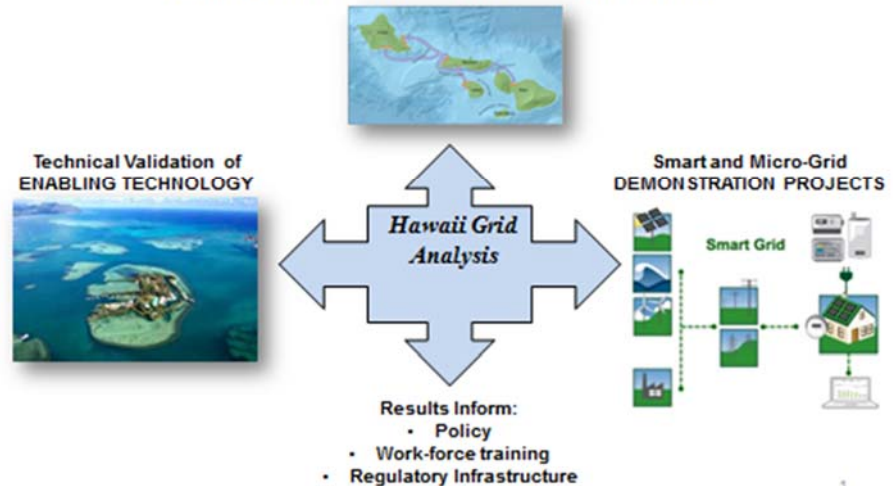


Figure 2. Renewable grid integration studies.

energy under the State's new 100% RPS law. It is evaluating likely system challenges, mitigations, and the costs and benefits associated with new equipment or modifications to operating practices including a more comprehensive review of energy storage.

* Descriptions and detailed reports of these studies can be found on the HNEI website.

This work has been closely coordinated with the State Energy Office and the USDOE, and HNEI has committed resources from the Energy Systems Development Special Fund to co-fund these efforts. Following the conclusion of the HESP program, additional work in these areas is being funded by the ESDSF and is described in more detail later in this report.

GridSTART: Building on its systems analysis experience and growing technical expertise in the area, HNEI established its Grid Systems Technologies Advanced Research Team (**GridSTART**) to develop, test and evaluate advanced grid architectures, enabling policies, and new technologies and methods for effective integration of renewable energy resources and power system optimization. **GridSTART** serves to integrate HNEI efforts across all its technology areas and has developed strong partnerships with state, federal, and international agencies, organizations and businesses, especially in the Asia-Pacific region. Its funding sources include the Office of Naval Research, NavFAC (via the Applied Research Laboratory at the University of Hawai'i – ARL-UH), USDOE, Hitachi, Nissan, and the State of Hawai'i. The following five sections briefly describe a few of the projects **GridSTART** is managing and/or supporting.

- **Hawai'i Naval Base Grid Modernization:** In September, 2014, the Office of Naval Research, through a \$2.5 million task order via ARL-UH, funded HNEI to develop a power grid modernization strategy and action plan to meet the future needs of the Navy in Hawai'i, with a special focus on the reliability and power quality demands of electrical service to the shipyard. As part of this task, a renewable energy integration action sub-plan will be developed to help the Navy meet its renewable energy goals in a manner that maintains electrical service reliability and stability, ensuring continuity of mission critical activities.

- Maui Smart Grid:**
 This very significant HNEI-led USDOE demonstration project was formally started on October 17, 2008, with partners that include General Electric, MECO, HECO, Sentech, and First Wind, among others. This \$15 million project was intended to

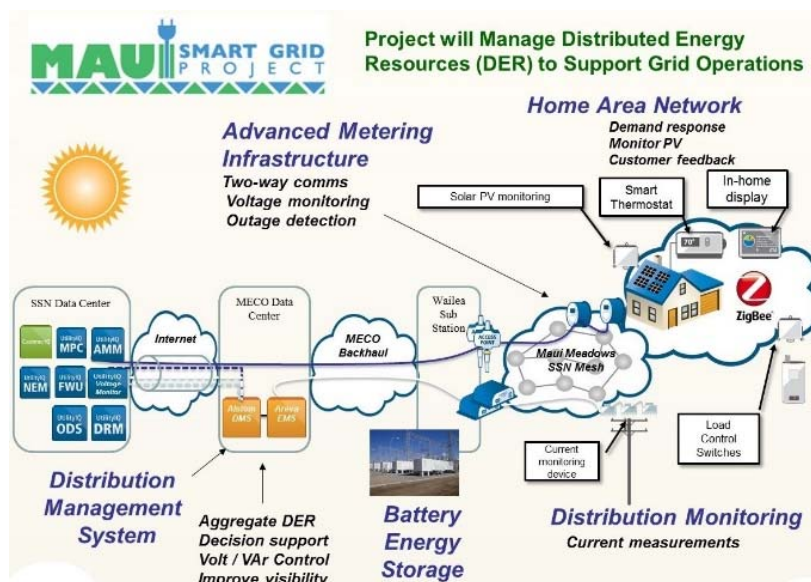


Figure 3. Maui Smart Grid Demonstration Project.

demonstrate reduction of peak electricity demand by at least 15% through the use of advanced smart grid and demand-side-management technologies, and to assist MECO in providing reliable and stable electricity with increasing percentages of as-available renewable resources. The equipment was installed, and the demonstration was conducted through 2014. A final report on this work was completed in December 2014. As a result of the collaborations established under this program, HNEI continues to serve as one of the Hawai'i implementing organizations for the NEDO Smart Grid Initiative, also located on the south side of Maui.

- Smart PV Inverter Project:** In a project that closely supported the Maui Smart Grid efforts, an HNEI-led team led this USDOE Sunshine Program to develop and demonstrate new "smart grid-enabled" PV inverters. This project, announced in September 2011, was intended to facilitate higher penetrations of solar PV systems by demonstrating technology to mitigate circuit level issues resulting from variability of PV systems. HNEI used \$400,000 from the Energy Systems Development Special Fund to meet a critical funding shortfall and to insure efforts to secure the federal funding. Original project partners include Fronius, which supplied the advanced PV inverters, Silver Spring Networks for advanced metering infrastructure; and Maui Electric Company and Hawaiian Electric Company as host sites.

Under the USDOE funding the HNEI team completed development of the technology and purchased hardware for deployment and testing. Continued testing of this hardware on the Maui grid is now supported by the Office of Naval Research.

- **Grid-Scale Battery Energy Storage System (BESS) Projects:** New projects on Molokai and at the Campbell Industrial Park (CIP) generating station on Oahu are joining the Hawi project on the Big Island in demonstrating and testing the capabilities of battery systems to provide services to the grid.

The 1MW Hawi BESS has been operating since 2013 to help regulate the energy output fluctuations of the Hawi wind farm and to regulate frequency on the Big Island electric grid.

On Molokai a 2MW BESS has been installed to help stabilize the grid which has a high proportion of PV generation. Innovative changes to control strategies are expected to enable this system to provide fast response operating reserves for disturbance management. The system may also be used for frequency regulation, power smoothing and peak shifting services.

The 1MW CIP BESS completed installation in September 2016, and is the first utility-scale system on Oahu. It will provide power smoothing, voltage support, and frequency regulation for an industrial circuit with a high penetration of PV.

These HNEI-BESS projects are allowing the testing of control algorithms and providing a wealth of data to determine the systems' safety, operating characteristics, and effectiveness in helping to integrate more renewable energy onto our island grids, while maintaining reliable service.

- **Micro-grid Projects:** HNEI's GridSTART team are participating in microgrid projects on Coconut Island in Kaneohe Bay, and the University of Hawaii at Manoa campus to demonstrate and test innovative technologies for the reliable operation of grids including operation of critical loads in isolation from the larger electric system.

Coconut Island, a UH owned island facility with a marine research laboratory will be used as a demonstration site for a high efficiency DC microgrid including the demonstration of innovative controls for critical loads with a need for high energy reliability. The facility has a large amount of rooftop PV. The persistent coastal wind and highly corrosive environment are typical of conditions in many island nations, and will provide an ideal test site for the testing of advanced clean energy technologies and integrated control strategies.



The UH Manoa project will be a 25MW microgrid to help support and demonstrate the value of using of on-site renewable energy generation. The objectives of the project include managing the high cost of electricity, improving the campus' grid reliability, quality of service and operations, and supporting the development and demonstration of advanced grid modernization.



Asia-Pacific Research Initiative for Sustainable Energy Systems: The APRISES initiative, funded by the Office of Naval Research (ONR), includes programs across a broad range of technologies, including electrochemical power systems (fuel cell and battery), seabed methane hydrates, technology for use of biofuels and hydrogen, ocean energy technologies (wave and Ocean Thermal Energy Conversion (OTEC), building efficiency, and grid integration. In 2016 HNEI was awarded an additional \$8.7 million to continue these activities with increasing emphasis on testing and evaluation of renewable generation and power system controls for smart and micro-grid applications. This program has provided substantial support for various smart and microgrid research activities with ongoing efforts on Moloka'i, Coconut Island, at the UH Manoa campus, and various projects on Maui.

Hawai'i Hydrogen Program: Since 2003, HNEI has conducted work to develop and deploy hydrogen infrastructure at multiple sites on O'ahu and Hawai'i Island in support of both DOD and civilian transportation projects. These efforts, have been supported from a variety of sources including USDOE, ONR, USAF (via HCATT), and the state of

Hawaii (via the Hydrogen Capital Investment fund and barrel tax). Specific activities are summarized below.

Hydrogen Energy System as a Grid Management Tool: This joint USDOE-DOD-HNEI project is intended to test the dynamic operation of an electrolyzer to evaluate its potential to provide frequency control in support of additional renewable generation, while also providing fuel for two transportation demonstration projects.. The system was delivered to the NELHA facility in Kona in November 2016 and will be installed and commissioned when site improvements have been completed. It is expected to be fully operational by May 2017. The total budget is approximately \$5 million.

County of Hawaii Fuel Cell Electric Bus and Hydrogen Transport Trailer: HNEI assisted with the purchase of one (1) hydrogen fuel cell electric bus that is being converted by



US Hybrid. The bus has been completed and will be shipped to Hawaii when the hydrogen fueling infrastructure has been installed and commissioned at NELHA in early 2017. The bus will be operated by the County of Hawaii Hele-on bus system and will be used to demonstrate hydrogen technologies to the public in Kailua-Kona. The bus leverages technology developed by HCATT. HNEI has also purchased three hydrogen transport trailers to support multiple fueling sites from the NELHA hydrogen production site. Current plans are to support refueling at Hawai'i Volcanoes National Park and NELHA.

Marine Corps Base Hawai'i (MCBH) Hydrogen Fueling Station at Kaneohe Bay: HNEI developed a rapid fill hydrogen fueling stations for MCBH in support of five General Motors (GM) Equinox Fuel Cell Electric Vehicles (FCEVs) leased by ONR. The station successfully completed over 400 fueling operations between November 2014 and August 2015 when GM recalled the vehicles back to CA. Efforts are underway to acquire or lease Toyota Mirai fuel cell electric vehicles to be supplied by Servco.

Hawai'i National Marine Renewable Energy Center (HINMREC): In 2009, USDOE executed a five-year agreement with UH - HNEI to establish HINMREC to facilitate the development and implementation of commercial wave energy converter (WEC) systems, and to advance Ocean Thermal Energy Conversion (OTEC) technology. The HINMREC coordinates engineering and science efforts to address industry needs and leverage U.S. Department of Defense (DOD) interest in Hawai'i energy projects. The USDOE awarded multiple year funding (2008-2015) to HINMREC of approximately \$8 million.

This USDOE funding and an additional \$12.8 million contributed by the Naval Facilities Engineering Command (NAVFAC) in 2014 and 2016, through the University of Hawai'i's Applied Research Laboratory, is being used to support testing activities at the United States' first grid-connected wave energy test site (WETS) at Marine Corps Base Hawai'i. The fully permitted site has three grid tied berths at different depths. Northwest Energy Innovations deployed its Azura in June of 2015. A second WEC device, the Fred.Olsen "Lifesaver," was deployed in March 2016 by Sound and Sea Technology.



Figure 5. Azura and Lifesaver wave energy converters deployed off of Marine Corps Base Hawai'i.



HNEI is working with NAVFAC and USDOE to support 1) independent WEC device performance analysis; 2) environmental impact monitoring including measurements and analyses of device acoustic signature, device and cabling electromagnetic fields (EMF) and changes in device/mooring-induced sediment transport, seawater chemistry, and ecological environment; and marine services support for the vendors which also serves to document system maintenance and reliability.

Figure 6. Acoustic device deployed at wave energy test site.

Solar Initiatives: HNEI is continuing work with USDOE and ONR to conduct high-fidelity resource forecasting and testing of emerging solar technologies, with the objective to understand the performance of PV in differing environments. Multiple test sites are operational, and additional test sites are being developed.

Fuel Cell and Battery Testing: HNEI researchers conduct testing and modeling to develop advanced battery system diagnostic and prognostic technology to further understanding of the performance of advanced fuel cells and batteries for use in electric vehicles and renewable energy storage applications. Funding sources include the US Department of Energy EERE Office and the Office of Naval Research. HNEI has recently initiated a major effort to conduct testing to better predict the lifetime of grid-scale battery energy storage technologies.

Ceiling Fan Selection and Controls Study: In a collaboration with contractor MKThink and UH affiliated Environmental Research and Design Laboratory, HNEI is conducting a detailed assessment of state-of-the-art ceiling fan technologies, evaluate design and performance, and provide a design, selection and application guidelines to be used by state agencies, including Department of Education, in selecting ceiling fans to maximize comfort in non-conditioned spaces.

Desiccant Dehumidification pilot: In 2016, HNEI prepared a report investigating the potential for the integration of desiccant dehumidification into mechanical cooling systems to reduce energy consumption. In phase 2 of this project HNEI will implement a pilot demonstration project selecting the most appropriate of desiccant technologies in conjunction with a small scale, free standing application such as a Project Frog site or Department of Education site.

Crissy Field Phase 2 Small Scale Wind Turbine Testing: Between 2010 and 2015, HNEI supported the implementation and monitoring of (5) 1 kW vertical axis wind turbines installed at Crissy Field in San Francisco. In 2016, HNEI funded a second phase with the replacement of previous turbines with four new turbines including new work to evaluate the impact of urban wind conditions (environment-induced turbulence) relative to idealized (laminar) wind conditions under which turbines are tested and rated.

Net Zero Buildings: Since 2010 HNEI has built five net zero test platforms for evaluation of advanced building technology. The final two, commissioned in September 2016 on the University of Hawaii at Manoa campus for the College of Education are the first two net energy neutral building on campus. HNEI will use these working classrooms as research platforms to develop and test energy technologies

including integrated PV-battery systems. These buildings are monitored for energy flows as well as environmental conditions, helping test design concepts that may be applied to other state facilities such as classrooms.

EXPENDITURES: **General Funds \$ 1,314,183**
Tuition and Fees S Funds \$ 41,885
Research and Training Revolving \$ 514,739
Extramural Awards \$ 7,096,945

Due to new or expanded programs in ocean energy, hydrogen, and grid integration, including interest by the Office of Naval Research (ONR) to utilize Hawai'i as a site for alternative energy testing in the Pacific region, HNEI has consistently been able to capture significant extramural funding (over \$7 million for FY 2016 based on a 3 year rolling average).

All of these funds support the research and training activities described above. We anticipate 2017 extramural funding levels to be comparable to those from 2016. The rate of expenditure is expected to be similar to that of 2016.

CONTRACTS DEVELOPED: HNEI has developed many subcontracts under its existing extramural federal funding. Contracts using the Energy Systems Development Special Fund are described in the section below on the specific projects funded by ESDSF. HNEI coordinated and planned for ESDSF expenditures with the State Energy Coordinator.

ADVANCES IN TECHNOLOGY: HNEI continues to conduct research to advance renewable energy technologies and system integration. HNEI has patent applications and/or patents in the areas of battery charging, conversion of biomass to charcoal, solar production of hydrogen, novel filtration for operation of fuel cells in harsh environments, and conversion of waste streams to valuable bioplastics in the processing of ethanol. Licensing discussions are ongoing in all of these areas.

COORDINATION WITH STATE AGENCIES: HNEI works closely with DBEDT and other agencies on a variety of renewable energy and energy efficiency projects and continues to seek new opportunities and means to do so. Projects initiated or ongoing in 2015 and 2016 which involve strong collaboration/coordination with state agencies include the following:

- **Hawai'i Hydrogen Power Park:** The hydrogen power park is funded in part by USDOE and in part by the Hydrogen Investment Capital Special Fund through DBEDT. HNEI is the implementing partner and works closely with DBEDT in the execution of this project. Associated projects, including development of the Hawaii Hydrogen Plan and development of Hydrogen Fueling infrastructure at MCBH also leveraged state partnerships.
- **National Marine Renewable Energy Center:** HNEI is working closely with DBEDT to attract technology providers to the state to participate in this project and to provide assistance in the permitting process.
- **Hawai'i Public Utilities Commission support:** HNEI has been coordinating with the PUC on developing assumptions and scenarios for the RPS Study II (described in the ESDSF section below) to support their need for independent modeling and analysis of utility systems and their capabilities, constraints and planning needs.
- **Hawai'i State Energy Office Support:** HNEI is working with the Hawai'i State Energy Office in DBEDT to support programs in energy efficiency, renewable energy, test bed development, and energy education and outreach.

RECOMMENDATIONS FOR PROPOSED LEGISLATION: Generally, HNEI does not initiate legislation, but is a member of the Hawai'i Energy Policy Forum and works closely with this group to review legislative initiatives in the energy area. Via federal funds and the ESDSF, HNEI also financially supports the University of Hawai'i's Hawai'i Energy Policy Forum for outreach and analysis efforts.

ENERGY SYSTEMS DEVELOPMENT SPECIAL FUND

The Energy Systems Development Special Fund (ESDSF) was established in 2007, but went unfunded until 2010, when the Hawai'i Legislature established a barrel tax and authorized that 10 cents of the \$1.05 tax on each barrel of petroleum product imported into Hawaii be deposited into the Fund. This has amounted to approximately \$2,300,000 per year of barrel tax funding for the ESDSF. HNEI works in collaboration with the State Energy Coordinator to develop an expenditure plan to maximize value of these funds to meet near term needs and opportunities within the state; and maximize leveraging of federal and private dollars.

Below is a description of projects that were supported by money committed from the ESDSF and were ongoing or completed in FY 2016, and newly initiated and planned projects.

Continuing/Completed Projects

Smart Inverter Deployment: (\$400,000) This US DOE funded project led by the University of Hawai'i, was intended to develop and commercialize smart grid-enabled PV inverters to mitigate grid reliability impacts of high penetrations of PV systems. This project was part of the ongoing smart grid demonstration projects on Maui. HNEI obligated \$400,000 from the Fund to match partner cost share. This cost share from the Fund resulted in an initial federal award of \$1.5 million with an additional \$4.5 million that was awarded upon successful demonstration of the go/no-go deliverables in early 2013. Due to changes to the DOE program, continued testing of this hardware on the Maui grid is now supported by the Office of Naval Research.

Hydrogen for Grid Management: (\$500,000) In 2011 HNEI was awarded \$ 1.7 million by the Naval Research Laboratory (funds provided to NRL by US DOE) to demonstrate the use of electrolyzer technology to simultaneously produce hydrogen for fuel and for grid management. This program leveraged other investment from the US Department of Energy, the Hawai'i Hydrogen Capital investment Fund, and in-kind cost share from Puna Geothermal Venture and County of Hawai'i Mass Transit Agency. The hydrogen system, originally intended to be located near PGV, has been delayed due to continuing delays in executing a Memorandum of Agreement with PGV, and most recently the lava flow threatening Pahoehoe and the main access road. Due to the continuing delays the project is conducting initial system dynamic testing at the Powertech Labs facilities in Vancouver, Canada, after which the system will be delivered to Hawai'i and installed at the NELHA facility in Kona. It is expected to be fully operational by early 2017. HNEI also contracted with the Hawai'i Center for Advanced

Transportation Technologies (HCATT) to procure a bus and convert it to operate on advanced fuel cells to for use in the county. Approximately \$500,000 from the ESDSF was committed for this work.

Hydrogen Fueling Transport Trailers (\$555,000) ESDSF money was used to purchase two hydrogen transport trailers to support multiple fueling sites from one production site. Current plans are to support refueling at Hawai'i Volcanoes National Park and the Island of Hawai'i Mass Transportation Agency. The trailers carry over 100 kilograms of hydrogen at a pressure of 450 bar (6,600 psi). The trailers support the development of critical hydrogen delivery infrastructure on the Island of Hawai'i. The trailers were completed in May 2014 and are projected to be delivered in 2017 with the hydrogen energy system equipment.

Hawai'i Energy Policy Forum Support, HCEI Metrics (\$350,000). HNEI continues to support the Hawai'i Energy Policy Forum and the Social Science Research Institute at the UH in their efforts to seek smart energy solutions for a clean and sustainable energy future through advocating policies and initiatives and promoting civic action. HNEI also specifically supported the Forum's effort to develop a set of metrics to measure the State's progress toward meeting the Hawai'i Clean Energy Initiative's requirements.

Wave Energy Test Site (\$500,000). UH/HNEI through the Hawai'i National Marine Renewable Energy Center was awarded a total of \$8 million by USDOE to support wave energy testing at the recently completed Wave Energy Test Site (WETS) at MCBH. This \$500,000 cost-share from the fund was critical to receipt of this award. These funds will support environmental and resource studies supporting the Navy sponsored plug-and-play facility. The Navy has committed approximately \$11 million for infrastructure at the WETS. Combined resources of the Navy, USDOE and the Fund have resulted the country's first grid-connected site where developers can test their wave energy conversion technology for proof of seaworthiness, functionality, system integrity, and technology viability.

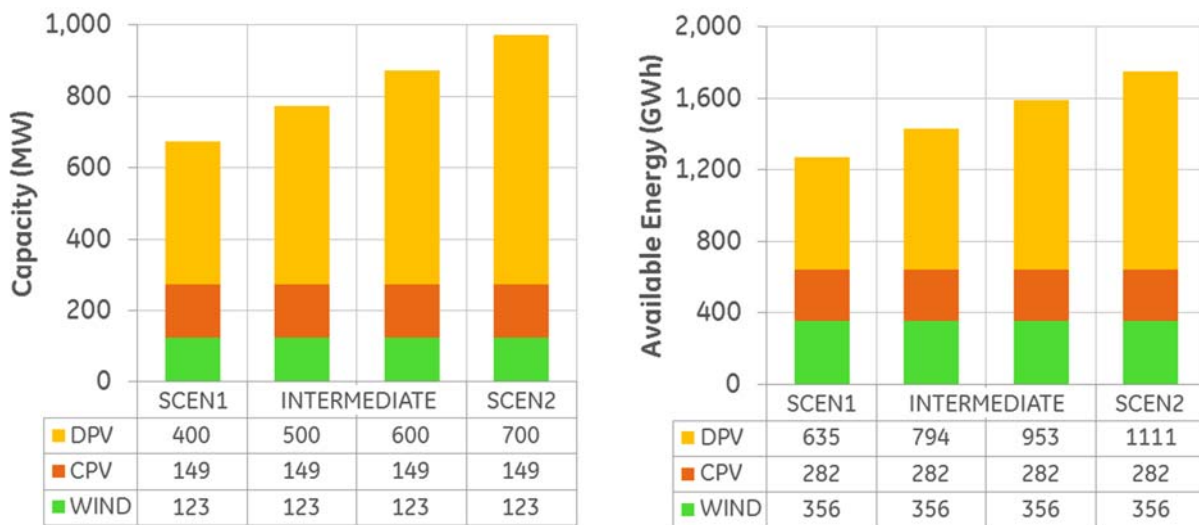
Hawai'i State Energy Office Support (\$1,095,000) HNEI continues working with the Hawai'i State Energy Office in DBEDT to support programs for:

- Hawai'i Test Bed Development and Energy Education and Outreach
 - Design Planning for Innovation Center for energy system commercialization testing, innovation, advancement, and energy venture acceleration
 - Energy Education and Outreach to generate awareness of Hawai'i's clean energy goals and their contribution to economic growth
- Energy Efficiency – Technical Assistance for High Performance Buildings

- Renewable Energy
 - Enhance EnerGIS Renewable Energy Resource Tool
 - Online Self-Help Investor Development Tools
 - Energy regulation analysis and Technical Services
 - Environmental Compliance.

New Projects

Renewable Portfolio Standards Study II (\$750,000) HNEI is continuing its modeling efforts with GE to provide independent assessments of issues critical to policy development and infrastructure investment. The analyses further evaluate impacts of increasing renewables, system challenges, mitigations and the costs and benefits of various solutions.



This study has been structured to be conducted in smaller pieces to provide results and findings on a more regular basis, and to allow enough flexibility to meet rapidly evolving state energy analysis needs in a timely way. Regular calls with stakeholders including the PUC, the State Energy Office, the Consumer Advocate, the utilities, the National Renewable Energy Labs, and independent industry experts help to guide the study, vet assumptions and methods, and review results.

In the study, production cost simulations, which are able to assess technical and economic impacts of hourly grid operation with high levels of renewables, are being run in conjunction with dynamic simulations, which look at the systems short-term (seconds, and fractions of a second) response to critical events, such as the loss of a

large generator. In an iterative process, challenges and potential mitigations found in the dynamic simulations are then run back through the production cost model to determine longer-term system and cost impacts.



In March and May of 2016, two reports were released describing the Oahu electric grids' ability to respond to large generator or load losses while operating with high amounts of distributed PV on the system. A third report on grid strength will be released soon. The study is also evaluating distribution level challenges and mitigations including further distributed PV growth, frequency response, ride through capabilities and the ability of distributed resources (e.g. smart inverters, battery systems) to address these challenges on Oahu and other island grids.

Economic Study of Hawai'i's Renewable Portfolio Standard (\$121,000)

In an effort related to the RPS Study II, HNEI is supporting the University of Hawai'i Economic Research Organization (UHERO) to assess the economic implications for the State of achieving high penetration levels of renewable energy focusing on policy mechanisms and economic outcomes. UHERO is identifying load profiles based on changes to factors such as rate design and storage capacity that may be used as inputs to GE modeling analyses, and will use results from GE modeling analyses to assess the broader economic impacts to the State under various scenarios.

Assessment of the Variability of the Energy Resource for Solar and Wind Power on Oahu (\$103,000) Also related to the RPS Study II, this assessment by the UH Department of Meteorology is analyzing the variability of the solar and wind energy resource on the Island of Oahu over periods of seconds, minutes, hours, days, months, years, and decades. Current models are based on wind and solar resource data from only one or two years. A clearer understanding of the actual variability of these resources over multiple timescales is critical for both accurate forecasting and planning.

Electric Vehicle Transportation Center Partnership (\$150,000) HNEI is a partner in the Electric Vehicle Transportation Center (EVTC), a four-year, \$9 million research effort to help create the nation's electric-vehicle transportation network, which is operated by the University of Central Florida's Florida Solar Energy Center

(FSEC). The vision for the EVTC is to transform the country's transportation network into a fully integrated 'smart' electric vehicle deployment coupled with a 'smart' electric grid, achieved with maximum efficiency and minimum time and disruption. HNEI is conducting research targeting the integration of electric vehicles into power grids characterized by high penetration of intermittent renewable energy.



Energy Efficiency Education and Training

Develop and deliver educational content on building performance and net-zero topics to the design community. Provide in-person and web-based training opportunities to educate building professionals and students to design for Hawaii's climate.

Project will result in a series of half-day workshops, evening courses and webinars for students and design professionals, covering topics such as net-zero design, energy efficient HVAC, passive cooling, comfort, lighting & daylighting design, relevant energy codes and design standards, building-integrated PV, designing buildings as grid assets.

Department of Education Support

Based on needs expressed by Department of Education, HNEI will work with DoEd to collect and utilize monitored school building data to develop high performance/ net-zero design recommendations for DoEd facilities that are not in existing heat-abatement contracts. HNEI and partners will also train staff of Maui non-profit, Ma Ka Hana Ka 'Ike, that collaborates with DoEd with at-risk youths, in building systems monitoring and data management in order to develop professional skill sets in energy monitoring and energy simulation and to provide design recommendations for high-performance / net-zero DoEd facilities. This initiative will provide STEM technology transfer from ERDL to DoEd initially through the Maui Ma Ka Hana Ka 'Ike, by training students and staff in building science and monitoring.

HNEI will also host a statewide database housing the data DoEd has collected from schools statewide.

Department of Hawaiian Homelands Support

HNEI and partners will provide the Department of Hawaiian Home Lands with guidelines and recommendations to improve comfort and reduce energy use, decrease electricity costs for occupants. This initiative will train UH System students and design professionals in energy monitoring and energy simulation; will result in

recommendations for design and operation of high-performance and net-zero site-built and packaged housing units; will quantify energy efficient and net zero options for 1,000 site built and packaged homes.

In-House Energy System Modeling

Leveraging its staff expertise, the GE grid-modeling projects, and other partnerships, HNEI is expanding its in-house modeling capabilities. Recently acquired PLEXOS modeling software will provide HNEI with a robust tool to supplement and expand on current modeling efforts. The model is being populated by utility data gathered for the GE modeling studies, and is capable of simulating detailed system operations and costs. It will provide HNEI with the capacity and flexibility to analyze additional renewable energy scenarios and sensitivities either to supplement existing projects, or do independent analyses.