



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 2015

Executive Summary

Clean energy development continues to accelerate and transform Hawaii into a clean energy leader. The State has already exceeded, its 15% interim clean energy goals for 2015. Today, Hawaii obtains about 21 percent of its generation from renewable energy sources. More than 500 megawatts of generating capacity from wind, solar and biomass have been added since Hawaii Clean Energy Initiative (HCEI) was established in 2008.

Alternative energy technologies have advanced significantly in recent years, leading to an explosion of new markets, jobs, and local energy sources. Due to these and other advances, Hawaii is currently ahead of its timeline in reaching its goal of becoming forty per cent renewable by 2030. The Hawaii State Energy Office (HSEO) works to make sustainability a reality for Hawaii and drives energy innovation by aligning policies among government agencies and the private sector. HSEO also provides a policy framework and tools to attract energy developers and potential investors and assists with the creation of the necessary conditions to position and attract meaningful test-bed investments. It is also retooling its energy transportation road map, which is vitally important given that two-thirds of Hawaii's energy mix is associated with transportation.

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.

Since HSEO started the performance contracting program in 1996, there have been a total of over \$402M in performance contracts signed by state and local government agencies; these contracts will save in excess of an estimated \$989M over the life of the contracts. In 2015, Hawaii retained its top national ranking for energy performance contracting per capita with an investment of \$295.82 per capita, resulting in a fourth consecutive national *Race to the Top Award* from the Energy Services Coalition, a national organization focusing on energy performance contracting. State agency consumption in FY 2015 is 5.9% below the 2005 baseline levels, a savings of 40 million kWh. In 2015, Hawaii met its Clinton Global Initiative, Commitment to Action, by more than doubling the amount of performance contracts signed since 2013. As of 2015, electricity consumption in the State and private sector achieved a 16.8% reduction to our Energy Efficiency Portfolio Standard (EEPS) of 30% by the year 2030.

Another program is in the development of sustainable building design, construction and transformation through LEED. LEED-certified spaces use less energy and water resources, save money for families, businesses and taxpayers, reduce carbon emissions and create a healthier environment for residents, workers and the larger community. For 2015, Hawaii was ranked number 6, by the U.S. Green Building Council. The rankings are based on per-capita figures as a measure of the human element of green building, allowing for a fair comparison of the level of green building taking place among states with significant differences in population and, accordingly, number of overall buildings. See ranking chart on next page:

Rank	State	Projects certified in 2014	Square feet LEED certified in 2014	Per-capita square footage
1	Illinois	174	42,457,254	3.31
2	Colorado	102	15,816,498	3.15
3	Maryland	132	15,583,423	2.70
4	Virginia	150	18,617,712	2.33
5	Massachusetts	99	14,662,950	2.2
6	Hawaii	30	2,657,808	1.95
7	California	517	69,762,936	1.87
8	Georgia	87	17,748,781	1.83
9	Minnesota	39	9,511,684	1.79
10 (tied)	Arizona	82	11,152,201	1.74
10 (tied)	New York	250	33,691,209	1.74

Source: U.S. Green Building Council, February 5, 2015

Renewable Energy – Hawaii, A Proving Ground for Clean Energy

HSEO is reaching out to stakeholders on setting up another policy initiative, this one to accelerate the move toward renewable energy. Data and planning guidance will be critical to achieving the highest penetration of renewables at the lowest costs, while also ensuring energy infrastructure safety and reliability. State modeling of mitigation strategies for managing intermittent power and grid stability from the utilities' perspective will provide third-party objectivity while empowering resolution.

Progress in renewable energy is measured against Renewable Portfolio Standards (RPS). Hawaii has steadily increased in quantity and energy generation since 2008. For instance, Hawaiian Electric Companies and Kauai Island Utility Cooperative reported that as of December 31, 2013, on a cumulative statewide basis, they achieved a RPS of 21.14%³, which means Hawaii effectively surpassed the 2015 interim goal two years early.

Hawaii reset its RPS in 2015 to 100 percent by 2045. The challenge in reaching the 100 percent RPS is not only innovating ways to tap into Hawaii's plentiful natural, clean sources of power, but building the grids and interconnection infrastructure to make them accessible and affordable.

HSEO has also been focused on developing self-help tools and resources that empower users to better understand the regulatory requirements for individual renewable energy projects in Hawaii, which facilitates better project planning, design, and development. See the listing of some of these tools below:

- Developer & Investor Center (Center) (<http://energy.hawaii.gov/developer-investor>)
- Project Permitting Assistance and Resources (<http://energy.hawaii.gov/developer-investor/project-permitting-assistance-and-resources>)

³ Source: *Renewable Portfolio Standards Status Reports, 2008-2014* (Hawaii Public Utilities Commission)

- Self-Help Energy Suite (<http://energy.hawaii.gov/developer-investor>)
- EnerGIS Mapping Tool (EnerGIS) (<http://energy.hawaii.gov/resources/renewable-energis-map>)
- Hawaii Renewable Energy Projects Directory (Directory) (<https://energy.ehawaii.gov/epd/public/energy-projects-map.html>)

Currently, HSEO is able to track the visitation traffic for many of its resource websites, and provides additional metrics to measure the impact of each resource where available. For each resource, a brief summary of the following are provided:

- Tool Usage: Describes how the tool is being used by targeted stakeholders.
- Challenges/Issues Addressed: Describes the known challenges and issues the tool seeks to address.
- Impact: Quantifies, based on best data available to HSEO, the impact this tool has on facilitating the permitting and lowering the cost of renewable energy projects in Hawaii.

Energy Systems and Planning – Data and Planning Key Optimal Paths for Investments

The State is addressing Hawaii's entire energy landscape. Work continues to advance Hawaii's clean-energy agenda in the electricity sector with resource, demand and price analysis to improve interconnection and interoperability at the transmission and distribution level in support of grid modernization and micro grid development.

HSEO is also focusing on reducing petroleum-based fuels in transportation. In August, it released an in-depth analysis and roadmap by the International Council on Clean Transportation to guide Hawaii's efforts to cut the consumption of petroleum-based fuels in the transportation sector through projects and initiatives to advance and integrate electric and hydrogen-powered vehicles.

Use of alternative fuels such as natural gas is also being considered to replace petroleum-based fuels and drive down electricity rates; and to support higher rates of renewable penetration with quick start, efficient generators, while providing lower cost, cleaner options for marine and ground transportation.

Clean Energy Solutions – Hawaii, Developing Innovative Solutions

Now that the state is committed to even higher renewable portfolio targets, it is imperative that Hawaii attracts the investment needed to fund our clean-energy transformation. Hawaii needs to be innovative in coming up with technological solutions, as well as developing financing solutions to drive the investments in clean energy. Even as the groundwork is laid, efforts to build and deploy tomorrow's clean energy systems must already be in development. The state is working with partners in Hawaii and globally to gather expertise and finance, test, implement and refine programs that will advance the State towards its clean energy vision.

To help drive this energy evolution, HSEO is also leading with innovation, creating and supporting programs and bold policy solutions that will help make clean energy more accessible for Hawaii. HSEO supports the Energy Excelsior in its efforts to help innovative companies succeed with funding, development of relationships and overall success in Hawaii's energy ecosystem.

HSEO also has focused its efforts on supporting the financing of clean energy technologies through the Green Energy Market Securitization Program. HSEO supported DBEDT in the issuance of the

November 2014 Series A GEMS Bond issuance, rated AAA/Aaa/AAA by Standard & Poor's Ratings Services, Moody's Investors Service, and Fitch Ratings. It is the first AAA rated issuance by the State of Hawaii and is the lowest cost-capital accessible by the state in the bond markets at the time of issuance. HSEO is responsible for maintaining DBEDT's compliance with the bond covenants and requirements.

The bond issuance has received national and international recognition through the following awards:

- 2014 Council of Development Finance Agencies, Excellence in Energy Finance Award
- 2014 International Financing Review, North America Structured Finance Issue of the Year Award
- 2014 International Financing Review Americas, US Structured Finance Issue of the Year Award
- 2015 Bond Buyer's Deal of the Year: Non-Traditional Financing.

Introduction

This report is respectfully submitted by the Department of Business, Economic Development, and Tourism (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 Energy Security Special Fund (ESSF) and targeted markets;
2. The Hawaii State Energy Office (HSEO) budgeted spending plan; and
3. An analysis of the Environmental Response, Energy, and Food Security Tax (EREFST) allocation.

Overview

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. The 15 cents of the tax on each barrel of petroleum product sold by a distributor to any retail dealer or end user of petroleum product, other than a refiner yielded \$3,708,195 to the ESSF in Fiscal Year 2015 (FY15).

In the fiscal year ended June 30, 2015, a total of \$151,822,440 was expended on new and existing clean energy initiatives. \$4,611,839 of expenditures was funded by the ESSF. \$1,618,905 was funded by federal and other funds. \$145,591,696 is attributed to the Hawaii Green Infrastructure Special and Bond Funds.

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:

1. Report the status and progress of new and existing clean energy initiatives, which includes:
 - a. The spending plan of HCEI;
 - b. All expenditures of the ESSF moneys; and
 - c. 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.
2. Study and analyze the EREFST to include:
 - a. Its amount and allocation; and
 - b. 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:

1. To diversify the State's energy portfolio;
2. Connect the islands through integrated, modernized grids;
3. Balance technical, economic, environmental and cultural considerations;
4. Leverage Hawaii's position as a clean energy test bed; and
5. 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 the Act, are to design, implement, and administer activities, to include:

1. Strategic partnerships for the research, development, testing, deployment, and permitting of clean and renewable technologies;
2. Engineering and economic evaluations of Hawaii's potential for near-term project opportunities for the State's renewable energy resources;
3. Electric grid reliability and security projects that will enable the integration of a substantial increase of electricity from renewable-energy resources;

4. A statewide clean energy public education and outreach plan to be developed in coordination with Hawaii's institutions of public education;
5. Promotion of Hawaii's clean and renewable resources to potential partners and investors; and
6. 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:

1. Deploy clean energy infrastructure as a catalyst for economic growth;
2. Facilitate innovation sector development; and
3. Enhance energy security advancement.

To achieve this mission HSEO is undertaking the following tasks:

1. 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:
 - a. Meeting 15% Renewable Portfolio Standard (RPS) target for 2015,
 - b. Meeting 2015 Energy Efficiency Portfolio Standard (EEPS) target to be set by the PUC, and
 - c. Displacing 50 million gallons per year of oil in the transportation sector by 2015;
2. Growing Hawaii's clean energy innovation sector; and
3. Facilitating development of key infrastructure to harness Hawaii's rich portfolio of renewables.

HCEI 2.0 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 FY15 under HCEI are as follows:

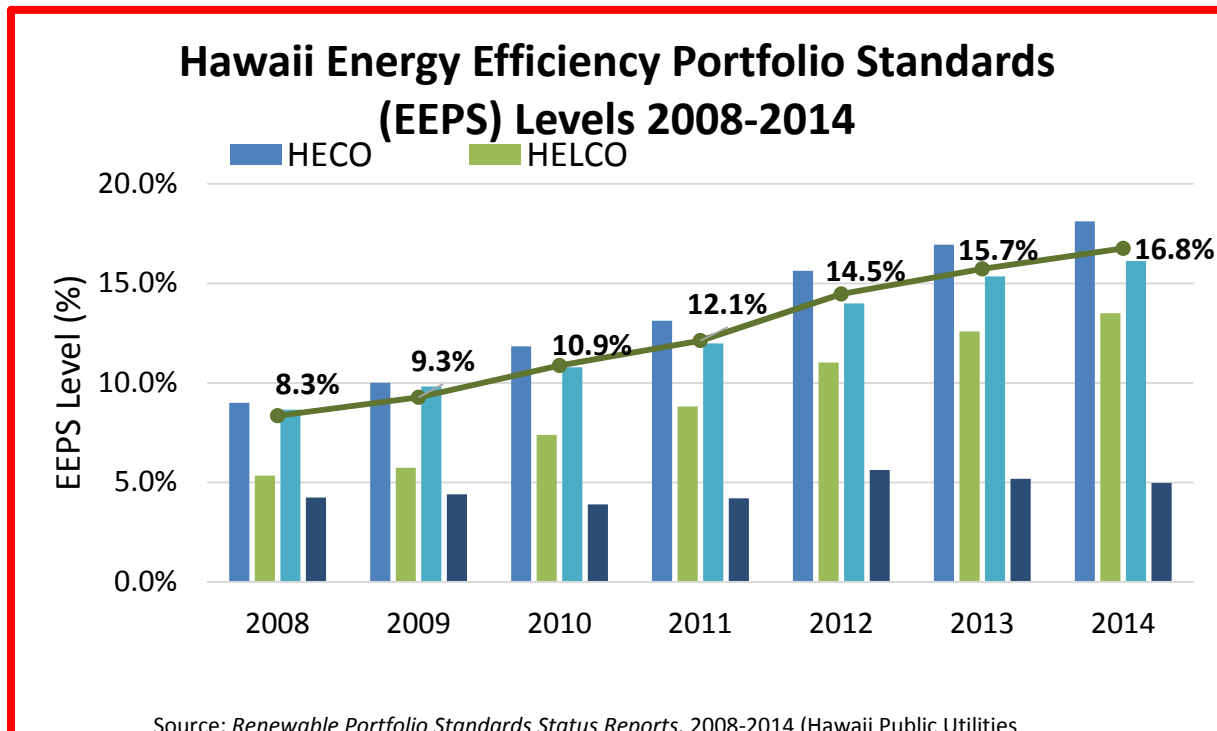
Energy Efficiency Demand Reductions

Hawaii's overall goal for energy efficiency is to meet the Energy Efficiency Portfolio Standard (EEPS) by reducing electricity demands by 30% by 2030. To meet this goal, the State continues to:

- Align the State's efficiency regulatory policy framework with clean energy goals;
- Support the retrofitting of existing residential and commercial buildings;
- Strengthen new construction policies and building codes;

- More than double energy efficiency within State and County buildings by implementing additional energy performance contracting with the private sector; and
- Identifying non-building related energy efficiency measures.

As a result of energy efficiency measures to date, Hawaii has already made great strides toward its 30% energy efficiency goal. The chart shows that for 2014 Hawaii, achieved a statewide EEPS level of 16.8%.



Also, State initiatives through the “Lead By Example” program are conserving energy and reducing energy consumption within government buildings, in vehicle fleet usage, and through personnel practices. Retrofitting existing buildings for energy efficiency and modifying operations strategies were the primary contributors to reducing electrical consumption and cost, but progress also was made in green building design, environmentally preferable purchasing, transportation and the adoption of renewable energy. Substantial progress has been made through this program, since its inception in 2006. State agency consumption in FY2015 is 5.9% below the 2005 baseline levels a savings of 40 million kWh.

1. Renewable Energy Development

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 -- causing the utility to delay the interconnection of new PV systems to the grid in certain areas.

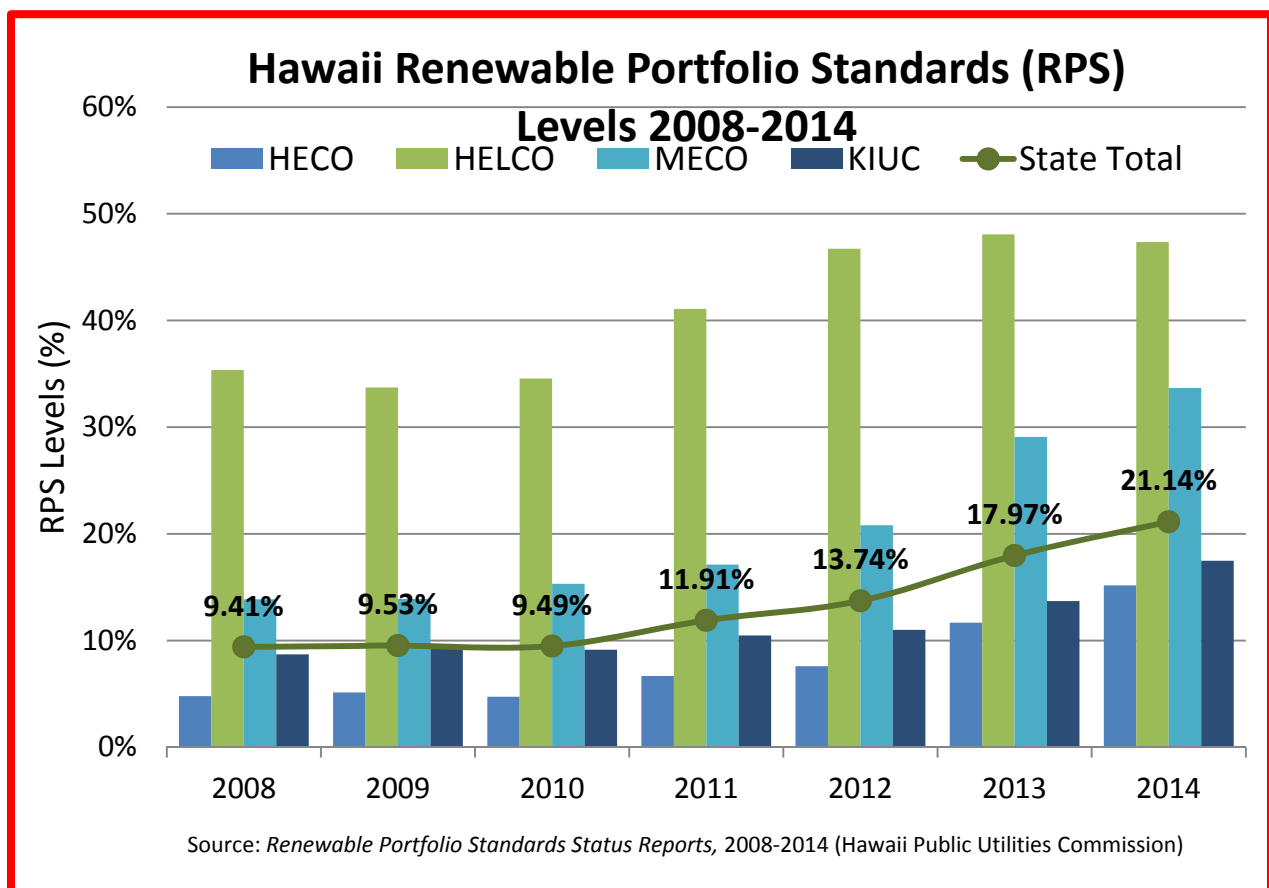
Interconnection is one of the priorities HSEO is focusing on in order to maintain momentum in the State’s clean energy transformation. Among the issues we are working on is understanding the relative costs of mitigation efforts – and how far does that take us beyond what’s in the queue today, including more aggressive strategies to incorporate demand response and greater consumer choice.

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.

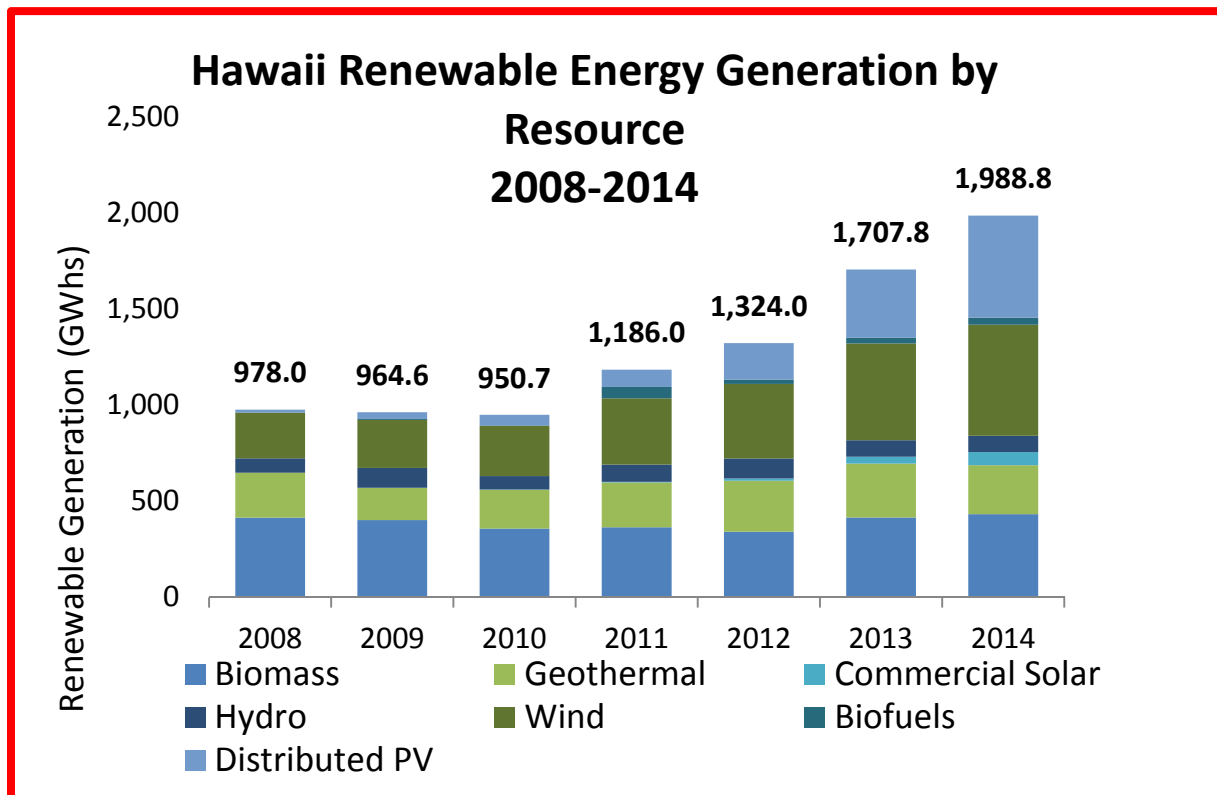
- Renewable energy generation in Hawaii continues to grow from approximately 14% in 2012 to 18% in 2013, and 21% in 2014.⁴
- Since 2006, net energy metering (NEM) system installations have increased rapidly and as of the end of 2014 there were a total of 49,570 NEM systems installed in the Hawaiian Electric Companies service territories, representing 307 MW of total capacity⁵.

As a result of renewable energy increases to date, Hawaii has effectively surpassed its interim 2015 RPS goal of 15%. The following chart shows that in 2014, Hawaii achieved a Statewide RPS level of 21.14%.



⁴ Source: Renewable Portfolio Standards Status Reports, 2008-2014 (Hawaii Public Utilities Commission)

⁵ Source: http://www.hawaiianelectric.com/heco/_hidden_Hidden/Community/Renewable-Energy?cpsextcurrchannel=1



Source: *Renewable Portfolio Standards Status Reports, 2008-2014* (Hawaii Public Utilities Commission)

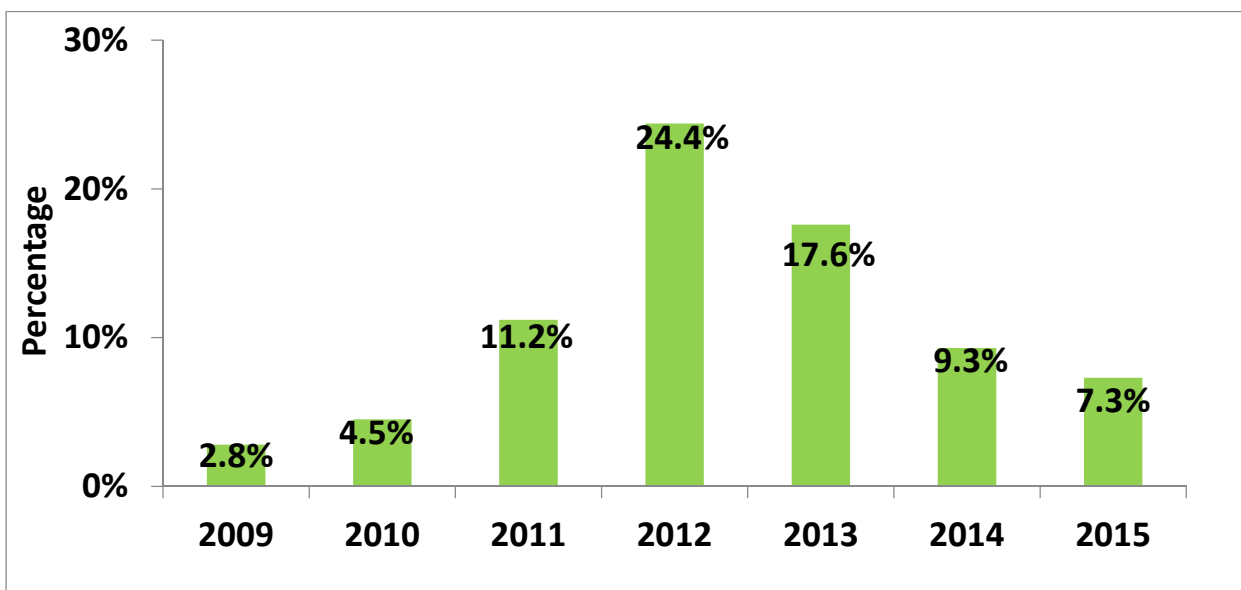
2. Energy and Economic Growth

HSEO is undertaking initiatives that provide sustainable and innovative strategies to address market issues to enable reducing Hawaii's dependence on imported oil. The intent is to expand, attract, and develop a critical mass of test-bed energy innovations which will advance clean energy solutions, bridge financial barriers, develop alternatives to transportation usage, add new clean energy infrastructure, and provide tools to foster development.

HCEI 2.0 is an initiative to help grow Hawaii's innovation sector. This new emphasis seeks to stimulate the deployment of clean energy infrastructure as a catalyst for economic growth, energy system innovation, and test bed investments. Hawaii's emergence as a clean energy test bed is a vital part of the growing clean energy economic cluster beyond tourism and military spending. Through continued collaborations with its HCEI stakeholders, international partners, and interested parties throughout the world, HSEO will continue to invest in efforts to scale energy innovation through the State's HI Growth Initiative economic development strategy to support late stage clean energy development in companies that are creating and demonstrating new technologies to meet Hawaii's technological challenges in clean energy deployment.

The solar industry is still a significant contributor to the construction sector, although construction spending from solar PV installations has slowed from unsustainable levels reached during the peak of Hawaii's solar boom in 2012, as shown in the chart on the next page..

Solar-Related Construction Expenditures
Solar projects (million dollars) as % of total building permit value



Source: Research & Economic Analysis Division, DBEDT

3. State and County Performance Contracting

Energy savings performance contracting enables more energy efficient operations, creates jobs, and avoids carbon emissions. These contracts are agreements between a building owner (or facilities manager) and a private energy services company (ESCO) that uses future energy and water savings to pay for and maintain energy efficiency improvements.

The State's aggressive approach to energy performance contracting has played a major role in energy use reductions that have made Hawaii a national leader for four straight years for the amount invested in energy performance contracts (EPC) on a per capita basis. HSEO provides technical assistance to state and county agencies, including analysis of energy saving measures, review of financing documents, and advice on agency-specific issues. See the chart below on EPC leadership.

Energy Services Coalition - Race to the Top						
State	Population	Performance Contracting	Dollars per Capita	Job Years Created	Source Energy Saved	Tons Carbon Avoided
Hawaii	1,360,301	\$402,400,424	\$295.82	4,374	3,339,119	57,356
Kentucky	4,339,367	\$750,000,000	\$172.84	8,152	6,223,500	106,901
Delaware	897,934	\$138,707,463	\$154.47	1,508	1,150,994	19,771
Ohio	11,536,504	\$1,252,683,627	\$108.58	13,616	10,394,769	178,551
Kansas	2,853,118	\$278,951,861	\$97.77	3,032	2,314,742	39,760

SOURCE: Energy Services Coalition, Performance Contracting Impacts - State Comparison 2014

4. Support for Innovative Solutions

Hawaii's Green Energy Market Securitization (GEMS) program paired an innovative bond issuance with a high impact strategy to deploy clean energy infrastructure and technologies. The GEMS program funds were raised through DBEDT's \$150 million bond issuance in November 2014. The 2014 Series A GEMS Bond issuance was rated AAA/Aaa/AAA by Standard & Poor's Ratings Services, Moody's Investors Service, and Fitch Ratings. It is the first AAA rated issuance by the State of Hawaii and is the lowest cost-capital accessible by the state in the bond markets at the time of issuance.

The bond issuance has received national and international recognition through the following awards:

- 2014 Council of Development Finance Agencies, Excellence in Energy Finance Award
- 2014 International Financing Review, North America Structured Finance Issue of the Year Award
- 2014 International Financing Review Americas, US Structured Finance Issue of the Year Award
- 2015 Bond Buyer's Deal of the Year: Non-Traditional Financing.

HSEO is responsible for maintaining DBEDT's compliance with the bond covenants and requirements. In 2015, this involved:

- Semi-annual true up filings in May 2015 and November 2015 to ensure the appropriate Green Infrastructure Fee is assessed.
- On-time debt service payment to bondholders on July 1, 2015.
- Semi-annual reporting to ratings agencies in August 2015.
- Procurement of a financial advisor, First Southwest Company, in September 2015.
- Audits of financial statements in December 2015.

In FY 2015, HSEO also supported the establishment of the Hawaii Green Infrastructure Authority (HGIA) and its initial deployment efforts. HGIA is tasked with effectively deploying the GEMS program capital into the clean energy market. In 2015, the GEMS program has focused on the necessary development to provide a financial product for PV for underserved markets: non-profit organizations, homeowners that lack access to capital, and renters. HGIA has developed processes, procedures and contractual obligations with qualified origination and loan servicers, solar installers and other service providers to make financing available for PV through loans to targeted GEMS customers. The loan products currently offered by the GEMS program are for two groups of customers: non-profit organizations, which opened for applications on March 27, 2015; and the consumer product, which opened for applications on June 30, 2015

The GEMS program has also been approved to finance PV for small businesses and expanded the technologies eligible for GEMS financing to include energy efficiency equipment for commercial use by nonprofits and small businesses. Both of these products are still under development by the HGIA. For more information about the performance of the GEMS program, please see the HGIA's annual plan and quarterly reports available on the HGIA website at gems.Hawaii.gov.

HSEO also uses ESSF to support the work of the Energy Excelerator in Hawaii:

Energy Excelerator is a startup program helping the world solve its energy challenges, starting in Hawaii. It is a dual-track program that takes the best from tech accelerators, government grant programs and investors to help innovative companies succeed with funding, strategic relationships and a vibrant ecosystem. The program is primarily funded by the U.S Department of Defense's Office of Naval Research, the USDOE, the State of Hawaii and corporate partners.

In late 2014, the State of Hawaii and Energy Excelerator formalized their partnership with funding from Hawaii State Energy Office in deploying demonstration projects and identifying problems that innovation can solve. The funding supports Energy Excelerator's core program: growing Hawaii's next generation of innovators and building a strong pipeline of companies, investors and corporates to Hawaii.

Overall Goals of the Partnership -

- To help Hawaii reach its HCEI goals by deploying innovation in key bottleneck areas
- Demonstrate advancement and commercialization of new energy technologies in HI\
- Position HI as the worlds' leading location for investment in clean energy innovation and economic growth opportunities.

Success to date –

- The Energy Excelerator team and its portfolio companies traveled to Silicon Valley for five days of programming to meet potential partners and investor, attend workshops, and participate in events to experience the start-up ecosystem first-hand. The trip was an important part of the Energy Excelerator's long-term strategy to develop meaningful relationships in Silicon Valley and to communicate Hawaii as a clean energy test bed.
- In an effort to ensure a strong pipeline of students and professionals into careers that support energy innovation in Hawaii, the Energy Excelerator developed a Training Program Strategy. The training program will help build the next generation of energy innovators who will support the achievement of HCEI goals and the public and private sector organizations who are seeking local expertise. The program will also support training for early-stage entrepreneurs in Hawaii and partner with others for energy-entrepreneur-focused training events such as energy-focused hackathons, startup weekends, pitch training events, business planning workshops, and other events for targeted training in this sector.
- The Energy Excelerator recruited five new mentors to mentor their early our early stage Go-to-Market portfolio companies.
- Developed a Strategic Communications Strategy which aims to position Hawaii as the world's leading location for investment in clean energy innovation and economic growth opportunities. The key goal in the Strategy is to define and increase the credibility, brand, and awareness of the Energy Excelerator brand.

5. Recommitment To Transportation Goals

HCEI 2.0, the next phase of the Hawaii Clean Energy Initiative involves a recommitment to transportation goals in order to confront the new challenge of going beyond 40 percent clean energy by 2030.

Transportation accounts for more than 60 percent of the energy consumed in Hawaii, and while air transportation uses the largest portion — nearly 40 percent — ground transportation via trucks, buses, and cars consume roughly 20 percent.

The overall goal for the transportation sector is to reduce the consumption of petroleum in ground transportation by 70% (or approximately 385 million gallons per year) by 2030. A transportation energy analysis by the International Council on Clean Transportation (conducted November 2014 through June 2015) for the HCEI transportation charrette produced 38 tactics in which 22 of these tactics serve as recommendations for a Hawaii road map, implementation framework, and action plan to guide our efforts to cut the consumption of petroleum-based fuels in the transportation sector.

One way to achieve this goal is by helping Hawaii residents mitigate the energy use by ground transportation, and thereby help Hawaii to achieve its clean energy goals.

Hawaii's leaders and stakeholders view the adoption and widespread deployment of electric and hydrogen vehicles, as a key approach towards the reduction of our fossil fuel dependency through the alternative use of clean energy generated electricity for transportation.

ChargePoint – the world's largest electric vehicle charging network – released a list of the top ten friendliest metropolitan areas for EV drivers; in which Honolulu was ranked number five (#5), as of December 31, 2014.

Hawaii's drivers have enthusiastically adopted EVs as their mode of transportation. The chart below shows the number of registered EVs in the four counties, as well as the number of publicly available charging stations statewide.

Registered Electric Vehicles and Publicly Available Charging Stations in Hawaii				
County	Electric Vehicles	Level 2 Charging Ports*	Level 3 Charging Ports**	Total Ports
Oahu	2680	244	5	249
Maui	627	68	22	90
Hawaii	166	51	2	53
Kauai	125	32	1	33
Total Statewide	3598	395	30	425

* Level 2 charging is at 240volts. All EVs are equipped for this type of charging. A "charger" can have one or more ports. The number of "ports" depends on how many vehicles each charger can service at one time. One "port" can service one vehicle.

6. Distributed Renewable Energy Infrastructure

Hawaii's electric utilities and consumers statewide are taking a "proactive approach" to activating more distributed energy systems onto the electric grid. In 2013, there were a total of 18,316 NEM systems installed statewide with a total capacity of over 115 MWs. See the chart on the following page.

Specifically, HSEO funded (through the U.S. Department of Energy SunShot Initiative grant) the study on the progress of the innovative Proactive Approach developed by Hawaiian Electric Company (HECO). The purpose of the study is to enhance the utilities' functions of interconnection, and transmission and distribution planning in order to anticipate and plan for higher penetration levels of Distributed Generation (DG) solar energy. The results could lead to faster, more efficient and cheaper evaluation of interconnection requests from renewable energy developers and homeowners wanting to install solar energy while remaining connected to the power grid. The Proactive Approach was recommended by the Hawaii Reliability Standards Working Group (RSWG), PV Sub-Group, which was convened to develop policy and technical recommendations to the PUC that will facilitate the increased use of renewable energy in the islands without compromising grid reliability.

The results of the Proactive Approach study were presented to both the RSWG PV Sub-Group as well as to the SunShot Initiative peer review team. They said, "This initiative is very important, not only for the benefits it can deliver to Hawaii, but also for the benefits it can deliver to the rest of the country. Since Hawaii is facing grid integration challenges before most other states, the work it does to improve interconnection processes and standards and to resolve reliability challenges as renewable energy penetration levels increase could be shared with other states and utilities in the future. Therefore, the potential impact of this initiative is very significant, assuming the results can be effectively disseminated and applied in other states. Engagement with many local stakeholders from industry, utility, and PUCs are strengths. Understanding the impact of high-penetration solar is a key step in the continued expansion of solar on the grid."

V. HSEO – Budgeted Spending

The HSEO is supported primarily by its Energy Security Special Fund (ESSF), established under section 201-12.8, HRS. The ESSF receives 15 cents of the tax on each barrel of petroleum product sold by a distributor to any retail dealer or end user of petroleum product, other than a refiner. In the fiscal year ended June 30, 2015, the ESSF revenues were \$3,708,195, down from \$3,719,218 in the preceding fiscal year. To address the reduced revenues from the Environmental Response, Energy, and Food Security Tax over the last several years, Act 185, SLH 2015 imposed the tax on fossil fuel, in addition to petroleum product. The ESSF will receive 14.3 percent of the tax on each one million British thermal units of fossil fuel sold by a distributor to any retail dealer or end user, other than a refiner, of fossil fuel.

In fiscal year 2015, DBEDT issued \$150 million in Green Energy Market Securitization Bonds 2014 Series A. The bonds are designated as "Green Bonds" because the proceeds are to be used to fund renewable energy and energy efficiency projects. Proceeds were deposited into the Hawaii Green Infrastructure Special Fund which was administered by the HSEO through June 30, 2015. As of July 1, 2015, this special fund is assigned to the Hawaii Green Infrastructure Authority.

Federal funding from the U.S. Department of Energy (USDOE) and other federal agencies supplements the HSEO's ESSF funding. The HSEO actively searches and pursues federal funding opportunities which align with its goals and objectives. The USDOE's State Energy Program provides an annual formula allocation of approximately \$280K. The current portfolio of federal grants supporting the State's energy program is detailed in the following chart:

Hawaii State Energy Office - Federal Grants

Funding Agency	Award Title	Award Amount	Grant Objective	Partners
USDA - Rural Development	Hawaii Energy Audit Program for Eligible Rural Small Businesses and Farmers in Oahu, Maui, Hawaii, and Kauai	\$ 100,000.00	To prepare Investment Grade Energy Audits (IGA) for rural small businesses and farmers. Term: Feb 2012 - Feb 2015.	GDS Associates Hawaii Energy County of Maui County of Hawaii
USEPA	Hawaii Growing Green Intern Development and Pollution Prevention Project	\$ 50,000.00	To establish an intern program that leverages the support and expertise of partners across the state with the purpose of expanding the Hawaii Green Business Program and Lead By Example Resource Efficiency Checklist Program, which focus on waste reduction, pollution prevention, and resource conservation. Term: Oct 2013 - Sep 2015.	Hawaii Dept. of Health City and County of Honolulu - Honolulu Board of Water Supply City and County of Honolulu - Refuse Division The Chamber of Commerce of Hawaii
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)	\$ 283,110.00	To design and carry out the Hawaii State Energy Office's energy efficiency and renewable energy programs. Term: Jul 2015 - Jun 2016.	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 - Sep 2016.	Hawaii Public Benefits Fee Administrator (SAIC/RW Beck) Hawaii Dept. of Accounting & General Services - Public Works Division Hawaii Energy
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New and on-going clean energy initiatives are now primarily funded by the Environmental Response, Energy, and Food Security Tax (EREFST) moneys through the Energy Security Special Fund (ESSF), or by awards from federal formula or competitive grants. The obligated and planned investments utilizing ESSF funds are shown in the following chart:

ENERGY SECURITY SPECIAL FUND - OBLIGATED & PLANNED INVESTMENTS		
INITIATIVE	FY15 OBLIGATED	FY16 PLANNED
Hawaii State Energy Office - Personnel Costs	3,375,010	3,852,677
Program Support - State Energy Office	186,924	179,530
Energy Education / Outreach - State Energy Office	33,622	30,250
Special Fund Assessments	181,361	180,000
Database Information, Databooks and Reports	94,834	50,000
Speakers and Facilitators	21,150	30,000
GEMS Project Management Services	80,000	
Energy Innovation - Energy Excelerator	500,000	
Geophysical Surveys for Geothermal Energy Resources - Hawaii Island	99,782	
Regulatory/Policy Support and Expert Witness-Related Technical Support	250,000	

Hawaii Science Bowl	7,000	
Hawaii Growing Green Intern Project	8,000	
Project Management Software Renewal	9,000	
Website for Solar Water Heater Variance Program	15,707	
Renewable Energy Permitting Wizard Software Upgrade	2,827	
Renewable Energy Projects Directory Website Software Upgrade	7,162	
Electric Load Shifting Study - County of Kauai	25,000	
Permitting Software Services	60,000	
Net Zero Technology Demonstration	625,000	
Innovation Center Content Design		200,000
VERGE Hawaii 2016 Asia Pacific Clean Energy Summit		100,000
Public Relations and Marketing Support		100,000
Network Assessment		20,000
Technical Assistance		50,000
TOTAL	5,582,379	4,792,457

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

Description	MOF	FY 2015	FY 2016
Personnel	A	-	-
Other Operating Expenses	A	-	222,974
Total	A	-	222,974

Personnel	B	3,649,525	3,852,677	**
Other Operating Expenses	B	52,989,780 *	51,689,780	
Total	B	56,639,305	55,542,457	
Personnel	N	-	-	
Other Operating Expenses	N	1,750,000	1,500,000	
Total	N	1,750,000	1,500,000	
Personnel	P	-	-	
Other Operating Expenses	P	1,514,192	-	
Total	P	1,514,192	-	
Personnel	V	-	-	
Other Operating Expenses	V	320,000	-	
Total	V	320,000	-	
TOTAL ALLOCATION		60,223,497	57,265,431	

Funding sources:

Method of Funding: A - General Fund

Method of Funding: B - Special Fund (Energy Security Special Fund)

Method of Funding: N - Federal Funds

Method of Funding: P - Other Federal Funds

Method of Funding: V - Federal Stimulus Funds

* Includes \$50M for the Hawaii Green Infrastructure Special Fund

** 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 HNEI⁶
- **Agricultural Development and Food Security Special Fund** – to be expended by HDOA⁷

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 (§42F) to the economic development boards and economic development agencies of each county to meet the stated objectives of HCEI.
- **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:

⁶ HNEI – Hawaii Natural Energy Institute of the University of Hawaii

⁷ HDOA – Hawaii Department of Agriculture

- 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, Ag Dev & 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 2030 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 FY 14 expended approximately \$3.9 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.

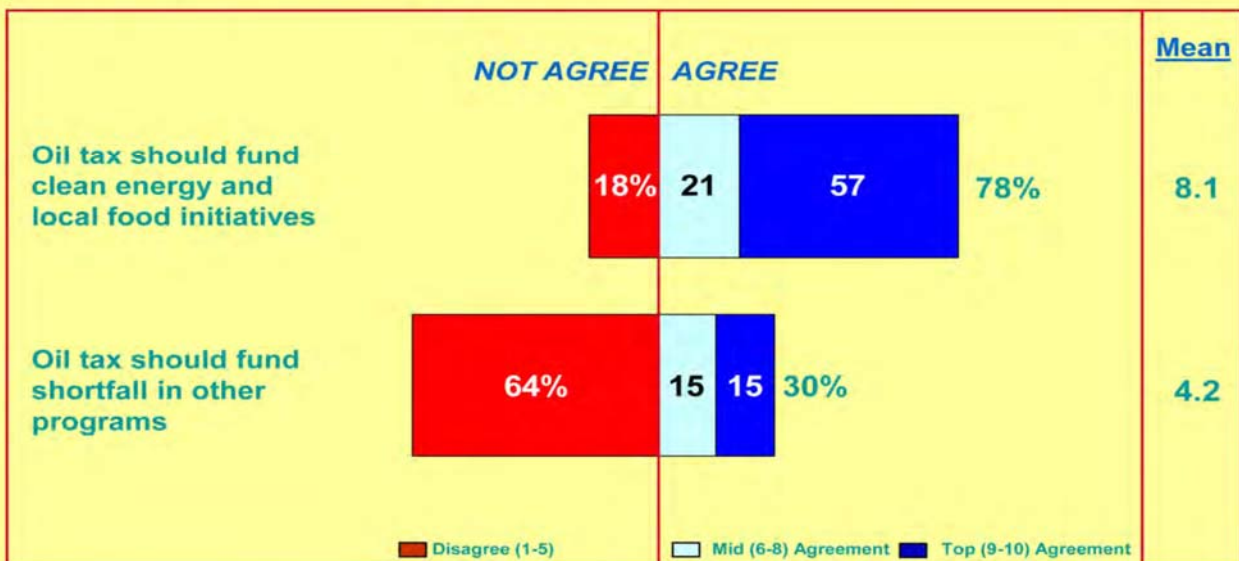
HEDTF DOA Expenditure – Encumbrance Update

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	\$ 344,639
Research	The conduct of research on and testing of agricultural products and markets	Anthurium Research; DNA Bar Coding	\$ 435,000
Marketing and Promotion	Promotion of marketing of agricultural products grown or raised in the state	"Buy Local it Matters" Multimedia Campaign; Logistics Workshop; Eat Local in Schools; Papaya Promotion in Asian Markets; Seal of Quality Campaign	\$ 520,000
Agricultural Support	Activities intended to increase agricultural production or processing and may lead to reduced importation of food, fodder or feed from outside of the State.	Invasive Species Response; Pesticides Database; Planner Position; Neighbor Island Support; Fire Ant Control; Galbraith Water Transmission, Biodigester, Kulani Agricultural Complex	\$ 2,605,489

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% 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.

Strong Support for Dedicated Funding of Energy and Food Sustainability Initiatives



Q: As you may know, in 2010 the legislature passed a \$1.05 tax on each barrel of oil imported into Hawaii, the purpose being three fold: first, to promote energy independence and clean energy alternatives; secondly, 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...?

- 1) 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
- 2) Most of the oil tax revenues should continue to fund the shortfall 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 next 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 are:
 - **100 Percent RPS – Act 97, SLH 2015**: Updates Hawaii's clean energy initiative and expand its renewable portfolio standards the Hawaii State Legislature increased Hawaii's renewable energy portfolio standard to 30 percent by December 31, 2020, 40 percent by December 31, 2030, 70 percent by December 31, 2040, and 100 percent renewable (electricity sector) by December 31, 2045.
 - **Community-Based Renewable Energy (CBRE) Tariff – Act 100, SLH 2015**: Requires utilities to file a CBRE tariff with the Public Utilities Commission by October 1, 2015. Authorizes ratepayer participation in eligible community-based renewable energy projects. Expands the market for eligible renewable energy resources to include residential and business renters, occupants of residential and commercial buildings with shaded or improperly oriented roofs, and other groups who are unable to access the benefits of onsite clean energy generation.
 - **Utility On-Bill Program – Act 201, SLH 2015**: In support of the GEMS program; exempts electric utilities acting as billing and collections agents for an on-bill program from various state taxes and state laws regulating financial institutions, escrow depositories, or collection agencies.

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 Hawaii Clean Energy Initiative.

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 on both our renewable portfolio standard and energy-efficiency portfolio standard. This success rightfully has prompted leaders in the public and private sector to call for even more aggressive clean-energy goals.

At the same time, we have to make sure that our success doesn't breed complacency. The problems solved first are often the easiest. We know that it will take a collective effort — backed up with focus and perseverance — to make Hawaii energy independent and create a vital growth area in our economy. 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.

ATTACHMENT 1. HCEI FEDERAL AND ESSF FUNDED INITIATIVES

Target Market	Method of Funding*	Reason For Selection	Persons Served	Program Objectives	Encumbered	Measurable Outcome
Regulatory	N, B	State Energy Planning, Regulatory Policy, and Energy Goals	Energy Program & Decision-makers	Expert Witness technical support services for potential and actual litigation of legal matters involving the State, its agencies, and its officers and employees, including administrative quasi-judicial proceedings	\$700,000.00	Assistance in pursuit of HCEI GOALS. Contingency activity.
Ground Transportation	N	Next phase of HCEI in reducing the consumption of petroleum in ground transportation.	Energy Program & Decision-makers	Analysis of HCEI transportation data and plans, evaluation of options, tactics, and tools for implementation	\$100,000.00	Progress towards TRANSPORTATION objective.
Electric Grid	V, B	Interconnecting the islands via electric transmission cable would provide increased energy security and system efficiencies and enable the islands to have backup power	Energy Program & Decision-makers	Technical assistance for cable research & development.	\$1,200,000.00	Progress towards RPS objective. In progress.
Regulatory	N	Grid regulatory and policy strategies for utility-scale energy self-reliance.	State, Utility, and Consumers	Hawaii Renewable Energy Grid Project	\$55,000.00	Progress towards RPS objective. In progress.
Underserved consumers	B	Provides low-cost financing to enable consumers in under-served markets to invest in clean energy installations.	Energy program and consumers	Project management services and Special Legal Counsel for the administration of the for Hawaii Green Infrastructure Market Securitization (GEMS) loan program.	\$1,392,500.00	Progress towards RPS objective. In progress.
Electric Grid	P, N	Continuing the advancement of energy-efficient measures in public buildings.	State and County government agencies	Technical assistance to state and local gov for energy code analysis & adoption, energy savings performance contracting and advancing energy efficiency measures in Hawaii public facilities	\$570,000.00	Progress towards EEPS objectives. In progress.
Public - Government Transparency	B	Facilitate government and public understanding of energy policies and programs.	Energy Program	Provide specialized public relations and other support services to DBEDT's Hawaii State Energy Office	\$200,000.00	Assistance in pursuit of HCEI GOALS.
Innovation	B	Innovation support and next step	Startup Companies	Support for energy innovation and the energy accelerator program and other avenues to grow energy innovations in Hawaii.	\$500,000.00	Clean Energy Technology Market Development
Geothermal	B	Potential Geothermal Development and Expansion	Energy Program & Decision-makers	Conduct Geophysical Surveys for Geothermal Energy Resources on Hawaii Island.	\$99,782.00	Progress towards RPS objective.
Mitigation	N	Energy Supply Disruption Planning	Energy Program & Decision-makers	Technical assistance to design, develop and implement emergency petroleum supply disruption assessment methodologies.	\$99,500.00	Progress in State Energy Emergency Preparedness.

UNIVERSITY OF HAWAI'I SYSTEM ANNUAL REPORT



**REPORT TO THE 2016
LEGISLATURE**

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

HRS 304A-1891

December 2015

Report to the 2016 Legislature

Annual Report on
The Hawai'i Natural Energy Institute

HRS 304A-1891

**Hawai'i Natural Energy Institute (HNEI) School of Ocean
and Earth Science and Technology
UH Mānoa**

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** – In June, the country's first grid-connected wave energy test site offshore from the Marine Corps Base in Kaneohe became fully operational with the deployment of the first wave energy conversion device. The sites three berths will soon be occupied, with others in a queue to take advantage of this unique facility.
- **Hydrogen Fueling Station** – 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.
- **Grid Modeling – RPS Study** – Independent electric utility system analyses were conducted to identify cost-effective solutions and practical strategies for increasing renewable energy generation; providing valuable information to the Public Utilities Commission and other stakeholders as we move toward the State's RPS targets.

- **Smart Inverter Deployment and Testing** – Smart inverters were 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.
- **Final Hawaii Clean Energy Programmatic Environmental Impact Statement** - Provides federal and local agencies, policymakers, energy developers, and the public with information and guidance on adhering to all laws and permitting requirements, implementing well-planned best management practices and mitigation measures, and consideration of community and cultural concerns that can be used to make decisions about renewable energy and energy efficiency deployment.

All of 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

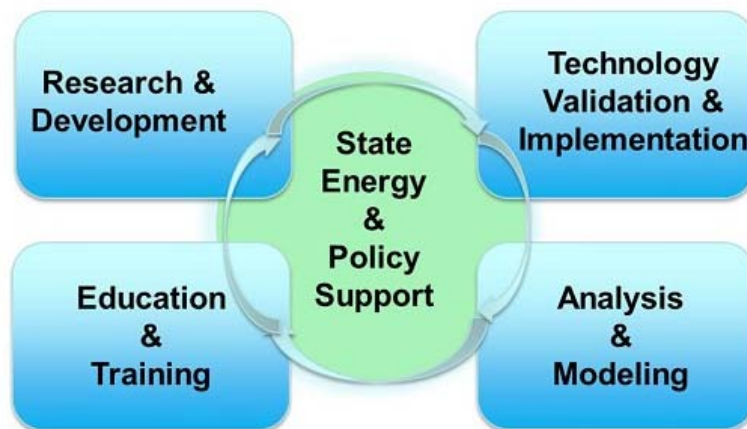


Figure 1. The schematic shows how these functions are inter-related and overlap by design to maximize collaboration and leverage resources.

State Energy & Policy Support

HNEI was established in 1974 to coordinate and undertake the development of natural energy sources for Hawai'i. In 2005, HNEI faculty developed a strategic plan which called for HNEI to be the UH and State focal point for multidisciplinary research and education on the energy supply for Hawai'i. In this plan, HNEI proposed to take a leadership role in the development of public-private partnerships for sustainable energy deployment and demonstration projects in Hawai'i.

The significance of HNEI's contributions to the State was recognized by the Hawai'i State Legislature which, in 2007, established HNEI in statute (ACT 253) 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.

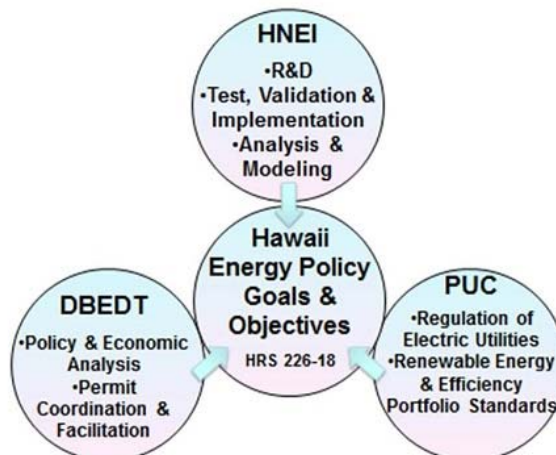
Act 253 also established the Energy Systems Development Special Fund (ESDSF) and directed that it be managed by HNEI. It went unfunded until 2010, when ACT 73 established a barrel tax and authorized that 10 cents of the tax on each barrel be deposited into the ESDSF. HNEI, in collaboration with the State 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.

HNEI Mission (from ACT 253)

To coordinate and undertake the development of Hawai'i's abundant natural energy sources, in order to:

- Diminish Hawai'i's dependence on imported fossil fuels;
- Meet the state's increasing energy demands with little or no environmental degradation;
- Contribute to the technology base for finding solutions to the national and global energy shortage;
- Coordinate with state and federal agencies; and,
- Demonstrate and deploy efficient end use technologies, including those that address peak electric demand issues.

In executing this 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 "Hawai'i Clean Energy Initiative, to achieve the goal of 70 percent clean energy by 2030, and the State's more recent 100% renewable portfolio standard. 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 UH labs to market is an important aspect of HNEI's TV&I mission. 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 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. Additionally, HNEI's state-of-the-art research facilities are used by UH research collaborators. HNEI also currently provides funding to Maui Community College, Kauai Community College and the College of Engineering (UH Mānoa) to support curricula and workforce development. Other funded projects include the Pacific Asian Center for Entrepreneurship and E-Business (PACE), which supports several fellowships at the UH College of Business to develop a workforce cross-trained in the business, legal and technical aspects of future energy systems. 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, 2015
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)	8
	Other permanent staff (APT)	3
	Temporary Faculty	26
	Other temporary staff (APT, RCUH)	21
	Training (a)	24

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

SUMMARY OF CONTRACTS AND ACTIVITIES: Due to new or expanded programs in ocean energy, hydrogen, smart grids, and 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 \$9.6 million for FY 2015 based on a 3 year rolling average).

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 is a continuation of the United States Department of Energy's (USDOE) Distributed Energy Resource Technologies for Energy Security program initiated in 2006. Under this program, managed by HNEI and conducted in partnership with GE Global Research, the Hawaiian Electric Company (HECO), Maui Electric Company (MECO) and the Hawai'i Electric Light Company (HELCO), HNEI has established a research and assessment program in integrated energy and systems analysis of electricity technologies. Through this program, HNEI conducts 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, and advanced power system monitoring, intelligent control, communications and enabling technologies. HNEI's program is 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 have included:

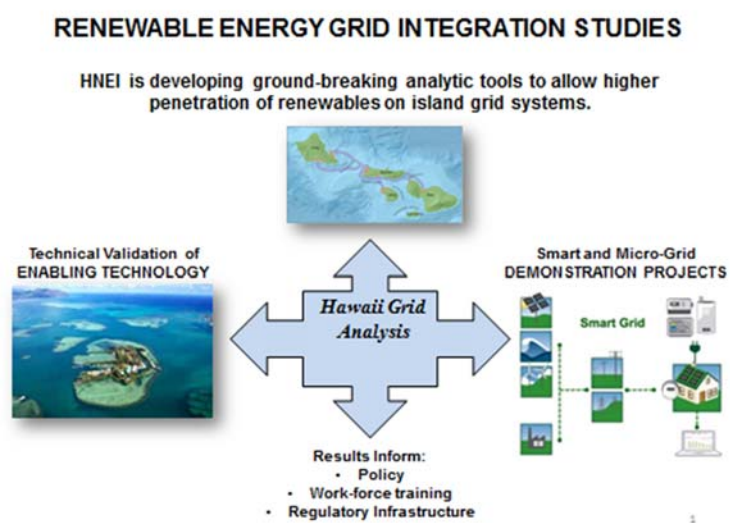


Figure 2. Renewable grid integration studies.

- *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)*

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

- *RPS II Study (2015 -)* This new phase of system modeling and analyses, is looking at even higher penetrations of renewable energy under the State's new 100% RPS law. It will evaluate 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.

HNEI has also committed resources from the Energy Systems Development Special Fund to support these efforts. This work is closely coordinated with the State Energy Office and the USDOE, and is cofunded by the ESDSF. This is described further in the section below on the ESDSF.

GridSTART: Building on its systems analysis experience and growing technical expertise in the area, HNEI established its Grid Systems Technologies Advanced Research Team (Grid**START**) 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. Grid**START** 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 four sections briefly describe a few of the projects Grid**START** is managing and/or supporting.

Hawai'i Naval Base Grid Modernization: In September, 2014, the Office of Naval Research, through a \$2.5 million contract with 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 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

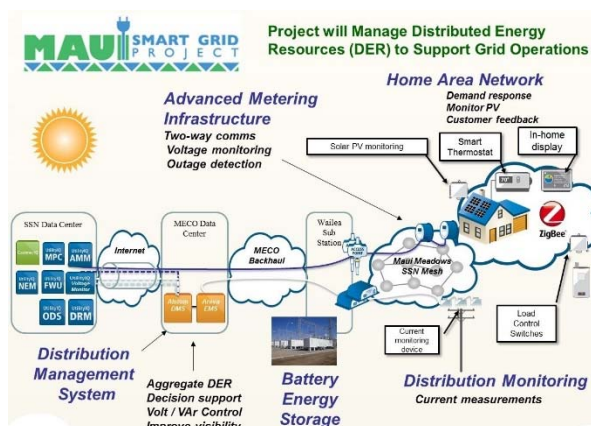


Figure 3. Maui Smart Grid Demonstration Project.

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. HNEI is also serving as one of the Hawai'i implementing organizations for the NEDO Smart Grid Initiative, also located on the south side of Maui.

DOE Smart PV Inverter Project. In a project that closely supported the Maui Smart Grid efforts, an HNEI-led team won a new project under the 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 mitigating the utility operations 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. Project partners include Fronius, which supplied the advanced PV inverters, and Silver Spring Networks, which integrated them into the smart grid network they developed. Maui Electric Company, Hawaiian Electric Company, and Pepco Holdings Inc. are the utility partners supporting the live demonstrations on their utility grids.

Under the USDOE funding the HNEI team completed development of the technology and purchased hardware for deployment and testing. Due to changes in the DOE program, continued testing of this hardware on the Maui grid is now supported by the Office of Naval Research.

Asia-Pacific Research Initiative for Sustainable Energy Systems: The APRISES initiative, formerly named the Hawai'i Energy and Environmental Technologies Initiative (HEET) was initiated in 2001 with funding from the Office of Naval Research (ONR), focused on the development and testing of fuel cells and seabed methane hydrates has been expanded to include biofuels and to support testing of critical heat exchanger technology in support of Ocean Thermal Energy Conversion (OTEC). The program was expanded to include deployment and testing of net energy neutral buildings, testing of grid scale Li-ion high power batteries for grid support, and support of various hydrogen infrastructure projects on the islands. In 2013 HNEI was awarded an additional \$15 million to continue the current activities and further expand to include 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 developed funding from various federal, state, and private sources to deploy hydrogen infrastructure at multiple sites on O'ahu and Hawai'i Island in support of both DOD and civilian transportation projects. These efforts, summarized in the following subsections, are budgeted at over \$8 million including approximately \$1,000,000 from the Energy Systems Development Special Fund to support a local bus service in the Hilo-Puna area on Hawai'i Island.

Hydrogen Energy System as a Grid Management Tool: This joint USDOE-DOD-HNEI project is intended to test and evaluate the dynamic operation of an electrolyzer to demonstrate its potential to provide frequency control in support of additional renewable generation, and to provide fuel for two transportation demonstration projects. The intended site at Puna Geothermal Ventures has been delayed due to continuing delays in executing a Memorandum of Agreement with PGV, and most recently the lava flow threatening Pahoa 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 May 2016. The total budget is approximately \$5 million.

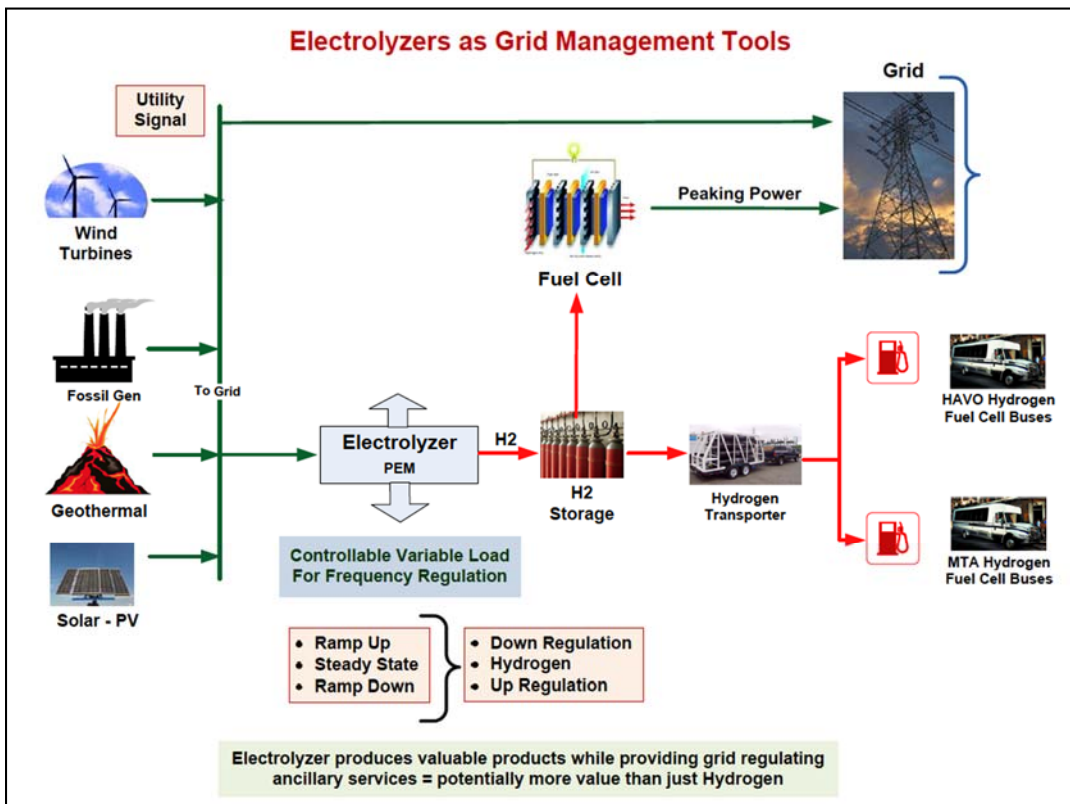


Figure 4: Batteries & Electrolyzers as Grid Management Tools

Hydrogen Fueling Tube Trailers: HNEI is also assisting with the purchase of two (2) 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 Hawai'i Island. The trailers were completed in May 2014 and are projected to be delivered in May 2015 with the hydrogen energy system equipment.

Marine Corps Base (MCB) Hawai'i Hydrogen Fueling Station at Kaneohe Bay: The Office of Naval Research (ONR) has leased and deployed five General Motors (GM) Equinox Fuel Cell Electric Vehicles (FCEVs) at MCB to enable the US Navy/Marine Corps to conduct technical evaluations and gain experience in the operation of FCEVs utilizing direct hydrogen fuel. HNEI has signed an MOA with MCB Hawai'i to provide rapid high-pressure refueling infrastructure in support of this work. The station has been commissioned and has been successfully fueling vehicles since November 2014. Vehicle fill times are under 5 minutes.

Hawai'i National Marine Renewable Energy Center (HINMREC): In March 2009, USDOE executed a five-year agreement with UH - HNEI to establish a new Center to facilitate the development and implementation of commercial wave energy converters (WECs) and to assist the private sector in developing Ocean Thermal Energy Conversion (OTEC) systems for use in Hawai'i and around the world. The HINMREC has established industry-driven partnerships between WECs and OTEC developers, utility companies, engineering and environmental support companies, university researchers, federal and state government agencies, and other non-government organizations (NGOs). 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 \$9 million contributed by the Naval Facilities Engineering Command (NAVFAC) in 2014, 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 site is now fully permitted with three berths at different depths. Northwest Energy Innovations deployed its Azura in June of 2015. A second WEC device will be deployed as soon as the weather permits, and a third is scheduled for deployment next year. HNEI is working with NAVFAC and USDOE to support the WETS efforts in

three key areas: 1) independent WEC device performance analysis; 2) environmental impact monitoring; and 3) ongoing 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.



Figure 5. Azura wave energy converter (WEC) deployed off of Marine Corps Base Hawai'i.

Solar Initiatives: HNEI is also working with USDOE and ONR to conduct high-fidelity resource assessments and testing of emerging solar technologies. The objectives are to characterize emerging photovoltaic (PV) technologies, to understand the performance of PV in differing environments, and to collect information to evaluate the effects of high PV generation on the grid. Multiple test sites became operational in 2012. 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.

EXPENDITURES: General Funds \$ 1,118,248
Tuition and Fees S Funds \$ 69,750
Research and Training Revolving \$ 390,842
Extramural Awards \$ 9,638,743

All of these funds support the research and training activities described above. We anticipate 2016 extramural funding levels to be comparable to those from 2015. The rate of expenditure is expected to be similar to that of 2015.

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 projects and continues to seek new opportunities and means to do so. Projects initiated or ongoing in 2014 which involve strong collaboration/coordination with DBEDT include the following:

- o ***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.
- o ***Hawai'i Hydrogen Plan:*** HNEI, via Kolohala Ventures developed the State Hydrogen Plan as called for as part of the Hydrogen Investment Capital Special Fund.
- o ***Marine Corps Base (MCB) Hawai'i Hydrogen Fueling Station at Kaneohe Bay:*** HNEI leveraged the State of Hawai'i investment in the Hawai'i Hydrogen Power Project to develop the fast-fill high pressure fueling station at MCB Hawai'i, in support of the deployment of the ONR/GM Equinox fuel cell vehicles. HNEI continues to work closely with HCATT, DBEDT and the state

legislature to attract national and international partners to support the roll-out of fuel cell electric vehicles in Hawai'i.



Figure 6. Fast-fill H2 fueling station at MCBH in Kaneohe.

- o **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.
- o **Hawai'i Clean Energy Programmatic Environmental Impact Statement (PEIS):** HNEI closely coordinated the PEIS effort with the Hawai'i State Energy Office and the USDOE. The recently completed PEIS will provide federal and local agencies, policymakers, and developers with information and guidance they can use to make decisions about actions that will support achieving HCEI goals.
- o **Hawai'i Public Utilities Commission support:** HNEI has been coordinating with the PUC on developing assumptions and scenarios for the RPS Study (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.

- o ***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

As described above, 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 tax on each barrel of oil 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.

The ESDSF statute (Sections 304A-1893, 1894, and 2169, HRS) was repealed (through a sunset provision) on June 30, 2013, and re-established on July 1, 2014. Thus, the ESDSF did not exist and thus received no barrel tax funding for fiscal year 2014.

Below is a description of projects that were supported by money committed from the Fund prior to its repeal and that continued or were completed in FY 2015, and projects newly initiated after the ESDSF was re-established.

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 May 2016. 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 Tube Trailers (\$555,000) ESDSF money was used to purchase two (2) 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 May 2016 with the hydrogen energy system equipment.

Hawai'i Clean Energy Programmatic Environmental Impact Statement:

(\$2,100,000) In 2010, DOE announced its intent to prepare a programmatic environmental impact statement (pursuant to the National Environmental Policy Act, or NEPA) with the State as a joint lead for wind energy development under the Hawai'i Interisland Renewable Energy Program. In response to public comments, as well as regulatory and policy developments, DOE broadened the scope of the analysis. In July 2012, in coordination with the USDOE and DBEDT, HNEI contracted New West Technologies to conduct a Programmatic Environmental Impact Study (PEIS). The PEIS analyzes, at a programmatic level, the potential environmental impacts of clean energy activities and technologies in the following clean energy categories: (1) Energy Efficiency, (2) Distributed Renewables, (3) Utility-Scale Renewables, (4) Alternative Transportation Fuels and Modes, and (5) Electrical Transmission and Distribution (including undersea cables). The draft PEIS was published in April, 2014, eight public hearings were held on the six major Hawaiian Islands, and the comment period closed in July 2014. The Final PEIS (completed in September 2015) considers and/or address all comments received on the draft.

The PEIS provides federal and local agencies and policymakers and energy developers with information and guidance on adhering to all laws and permitting requirements, implementing well-planned best management practices and mitigation measures, and consideration of community and cultural concerns they can use to make decisions about actions that support achieving HCEI goals. The PEIS also includes website references

of information that is routinely updated to ensure readers get the most up-to-date material.

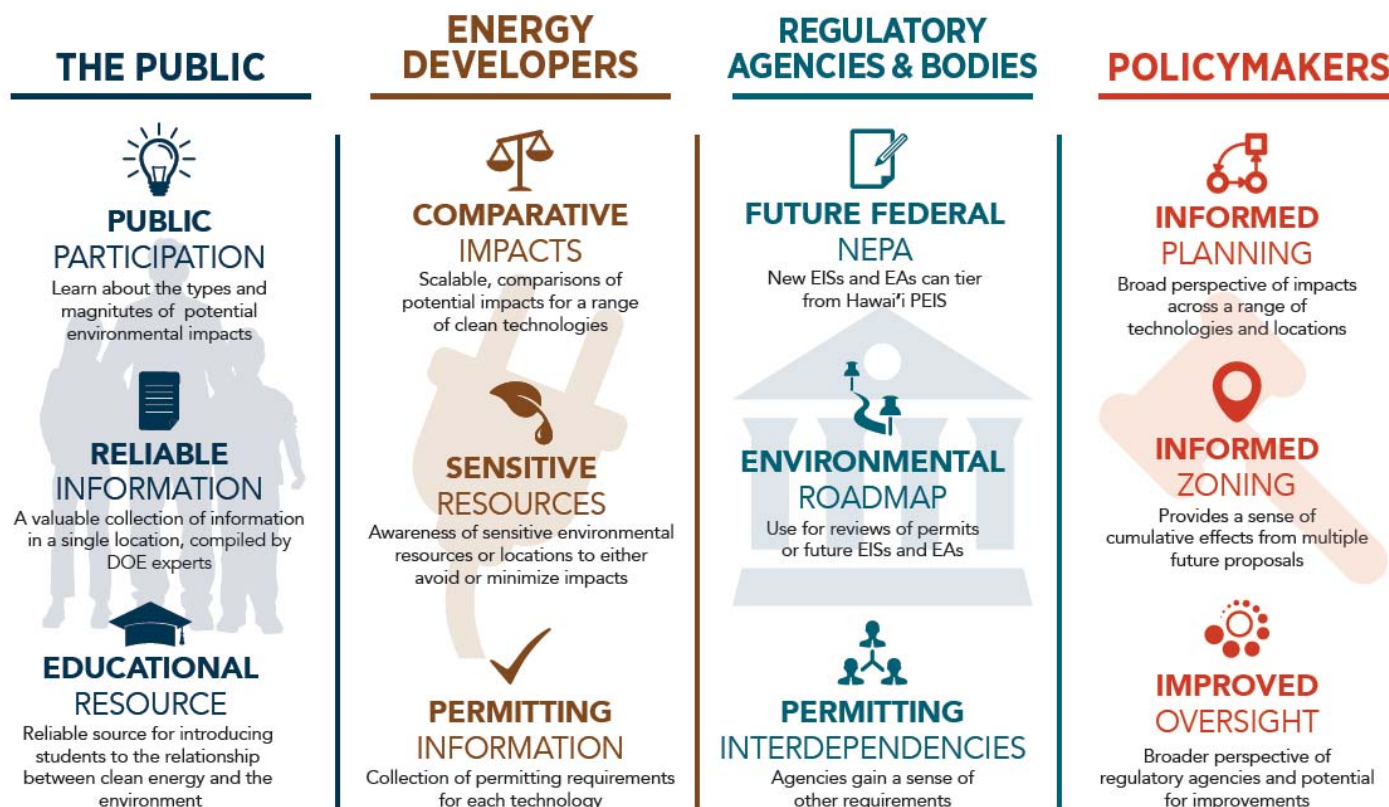


Figure 7. The Hawai'i Clean Energy PEIS -- Benefits to stakeholder groups

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.

Renewable Portfolio Standards Study (\$850,000) In May 2015 HNEI and partner General Electric Energy Consulting (GE) completed this study that built upon the modeling work done in several earlier studies and evaluated various mixes of renewable energy generation (primarily wind and solar), different island-interconnection strategies, and changes to utility operations to identify cost-effective pathways to meet the state's Renewable Portfolio Standards (RPS) targets. The U.S. DOE also provided funding for the Study. A variety of utility operational changes including reduced minimums on thermal units, thermal unit cycling, demand response, alternate fuels (e.g. Liquefied Natural Gas) and adjustments to ancillary service procurement were evaluated in the analysis.

The study showed that Hawai'i can cost-effectively achieve and even exceed the 30% goal for 2020 mandated by recent legislation. It provides a valuable tool to assess potential pathways to meet the State's goals while also maintaining a reliable system.

This type of modeling provides an independent look at the utility system and how changes to it and its operations can affect its costs and its ability to accept additional renewables. The report and additional analyses that build upon it will provide regulators and other stakeholders with valuable information as we continue reducing our dependence on fossil fuels.

Key findings of the study include:

- High levels of intermittent renewable energy generation with minimal curtailment can be achieved with modifications to electric system operations and infrastructure expected by 2020. With these changes, the islands of O'ahu and Maui can surpass the 2020 RPS goal while lowering electricity costs and increasing the reliability of the grid with or without island interconnection.
- Balanced growth of wind and utility-scale and distributed solar was shown to help reduce the aggregate variability and intermittency and the need for ancillary services on the grid relative to continued expansion of a single resource type.
- The use of natural gas as a transition fuel has the potential to substantially lower the cost of electricity, depending on cost projections for LNG and oil. The price

will be dependent on the volume of LNG consumed, hence any cost benefit decreases as renewable penetration increases.

- Increased use of energy efficiency, demand response, and storage will be needed to maintain grid reliability with fewer thermal generators on the system, as is projected by the utility.
- Inter-island transmission can facilitate more efficient use of resources, contribute to increased grid reliability, and enable increased renewable penetration by providing expanded siting options.

Hawai'i State Energy Office Support (\$1,125,000) 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 Systems Infrastructure Development – infrastructure planning may include LNG, fuels and/or smart grid.

Energy Efficiency Natural Ventilation Research (\$356,000) HNEI is conducting research and demonstration of three areas of energy efficient, emerging technology research that will enable natural ventilation to be integrated into building operation without sacrificing modern expectations of comfort. These technologies will be of interest to public facilities such as schools that are increasingly concerned about educational environments as they relate to student performance. Four areas using technologies being researched for Hawai'i-specific application are:

- 1) **Natural Ventilation and Comfort Mitigation:** HNEI is conducting research in collaboration with the UH School of Architecture Environmental Research and Design Laboratory on increasing comfort in extreme conditions in naturally ventilated spaces. Night flushing, ceiling fans and controls, and the use of

individual comfort devices are being assessed for applicability in non-air-conditioned environments in Hawai'i.

- 2) **Radiant Cooled Surfaces:** Radiant panels that can be retrofitted into standard T-bar ceiling grids, wall surfaces or work space cubicles can be used in conjunction with natural ventilation to provide a cooling effect at a much lower energy cost than conventional air conditioning. These are particularly applicable in buildings where natural ventilation provides sufficient airflow for much of the year, but where comfort is desired or required for the hotter, more humid portions of the year. The cooling benefits derive from an air conditioning compressor sized at a fraction of a standard compressor.
- 3) **Building Modeling and Simulation:** HNEI is conducting predictive modeling research using computational fluid dynamics (CFD) models to understand and validate heat transfer and comfort conditions within naturally ventilated spaces. In combination with building energy simulation tools, CFD can be used to predict the impact of external variables (adjacent structures, orientation, topography) on air movement into a building. Internal CFD models are being used to evaluate air flow within a space, including the effect of ceiling fans and radiant cooling surfaces. Modeling can be used as a predictive tool to determine the impact of comfort mitigating measures being considered by the State for schools and other unconditioned spaces.
- 4) **Energy Performance Dashboard:** HNEI is developing a classroom-based energy dashboard to provide real-time feedback to occupants as to how energy is being used in the facility, serving both as an energy management and an educational tool. The dashboard disaggregates energy consumption by end-use as well as the total load. The dashboard also displays energy generation (e.g., solar PV) in both real time, and year to date. The dashboard also integrates predictive modeling algorithms that compare annual usage-to-date with the predicted usage, providing feedback to users as to whether specific energy targets are being met. Based on the targets, recommendations are provided on-screen to help shape energy consuming behavior from day to day in order to meet annual energy targets. This dashboard is being designed specifically for Net Zero Energy facilities, but can also be used for conventional facilities as well.

New Projects

Renewable Portfolio Standards Study II (\$550,000) HNEI is continuing its modeling efforts with GE to provide independent assessments of issues critical to policy development and infrastructure investment. The analyses will build upon the recently completed RPS Study and further evaluate impacts of increasing renewables, system challenges, mitigations and the costs and benefits of various solutions. The study will also evaluate distribution level challenges and mitigations including distributed PV growth, frequency response, ride through capabilities and the ability of distributed resources (e.g. smart inverters, battery systems) to address these challenges.

The study is 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.

Economic Study of Hawai'i's Renewable Portfolio Standard (\$186,000)

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 will identify 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 (\$222,000) Also related to the RPS Study II, this assessment by the UH Department of Meteorology will analyze 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.

Federal Aviation Administration Alternative Jet Fuel Supply Chain Tropical Region Analysis (\$75,000) HNEI is partnering with other University of Hawaii departments and the FAA to develop information on regional supply chains for use in creating scenarios of future alternative jet fuel production in tropical regions, including the identification of the key barriers that must be overcome to produce significant quantities of alternative jet fuel in Hawaii and similar tropical regions.