

UNIVERSITY OF HAWAI‘I SYSTEM ANNUAL REPORT



REPORT TO THE 2013 LEGISLATURE

ANNUAL REPORT FROM THE HAWAI'I
NATURAL ENERGY INSTITUTE

HRS 304A-1891

December 2012

Report to the 2013 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, Its Work in Coordination with State Agencies and Programs, and Recommendations for Proposed Legislation, required in accordance with HRS 304A-1891 (Act 253, SLH 2007).

SUMMARY: Act 253 passed by the Hawai'i State Legislature in 2007 established the Hawai'i Natural Energy Institute (HNEI) in statute, defines the duties of the institute and its director, and requires an annual report to the legislature on its activities, expenditures, contracts developed, advances in technologies, coordination with State agencies and programs, and recommendations for proposed legislation. It also established the Energy Systems Development Special Fund (ESDSF) and directed that it be managed by HNEI. In 2010, ACT 73 established a barrel tax and authorized that 10 cents of the tax on each barrel be deposited into the ESDSF. The authorization to access those funds was included in the Budget Worksheets under Program ID#BED120, under the Department of Business, Economic Development and Tourism (DBEDT) until 2011, which delayed UH/HNEI access to those funds.

In June 2011, UH was able to access the funds. In the fall of 2011, in collaboration with the State Energy Coordinator, HNEI developed an expenditure plan to maximize value of these funds to meet near term needs and opportunities within the state. HNEI initiated actions on all but one of the original items. HNEI has recently, again in collaboration with DBEDT, expanded the project portfolio to include additional high priority projects. The attached report summarizes HNEI's current research activities for the past year and provides a detailed summary of the proposed expenditure for the currently available funds provided under ACT 73.

Summary of Activities, 2011
Hawai‘i Natural Energy Institute
School of Ocean and Earth Science and Technology
University of Hawai‘i at Mānoa

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Staffing:	Permanent Faculty (FTE)	7
	Other permanent staff (APT)	3
	Temporary Faculty	22
	Other temporary staff (APT, RCUH)	19
	Training (a)	45

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

SUMMARY OF CONTRACTS AND ACTIVITIES: Between 2001 and 2007, the Hawai‘i Natural Energy Institute (HNEI) experienced substantial growth in its extramural funding from under \$2 million per year to over \$5 million per year. 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 seen a dramatic increase in extramural funding since then from \$5.7 million in 2007, to over \$25 million for 2011 and 2012 (based on 3 year rolling averages).

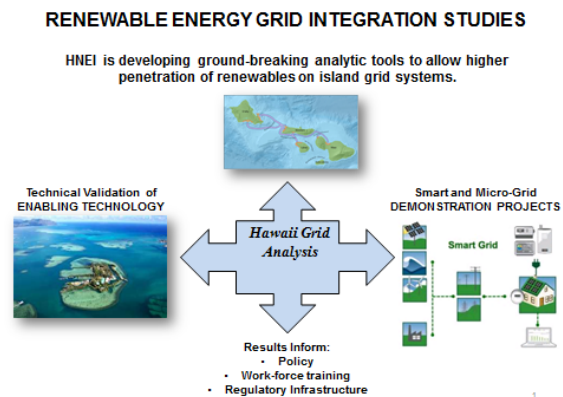
HNEI is a nationally acknowledged research leader with major activities in areas such as hydrogen, fuel cells, biofuels and ocean resources. While continuing to conduct basic and applied research, HNEI has, in accordance with HRS 304A-1891, also undertaken a pivotal role within the state to reduce dependence on fossil fuels 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 the goals of the Hawai‘i Clean Energy Initiative (HCEI).

A brief synopsis of select HNEI activities follows:

Hawai‘i Energy Sustainability Program (HESP): HESP is a continuation of the 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 an 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:

Oahu Wind Integration Study (2008 - 2010) – Utilizing a variety of modeling and grid simulation tools, this study evaluated the technical feasibility and economic viability of operational strategies, improvements to existing infrastructure, and new technologies to enable high penetrations of renewable energy in Hawai'i. A viable strategy was developed to integrate up to 500 MW of wind and 100 MW of solar energy on the isolated O'ahu power grid.



Hawaii Solar Integration Study (2010 - 2012): The just ending Hawaii Solar

Integration Study (HSIS) builds upon the knowledge gained in the Oahu Wind Integration Study (OWIS). The study examines very high penetration scenarios of solar and wind energy – up to 760 MW of distributed and utility scale solar PV and 300 MW of wind resources for Oahu, and up to 45 MW of distributed and utility scale solar PV and 72 MW of wind on Maui. Focusing on the operational impact on the O'ahu and Maui bulk power systems, the HSIS evaluates reserve strategies, impacts on thermal unit commitment and dispatch, utilization of energy storage, renewable energy curtailment, and other aspects of grid reliability, operations and costs. Study final reports are targeted for December, 2012, publication.

Oahu – Maui County Grid Interconnection Study (2012 – 2013): HNEI continues to drive, in partnership with Hawaiian Electric Company, a study that builds upon the work of both the OWIS and HSIS to examine the value proposition of prospective grid interconnection of the power systems on O'ahu to those in Maui county (Maui, Lāna'i and Moloka'i) via submarine power cables, advanced control systems and operational strategies. This study is of critical importance to the State of Hawai'i as high-cost investment decisions regarding the desirability and benefits of grid interconnections via submarine power cable systems progress. Study completion and report publication is targeted for February, 2013.

Oahu EV Charging Study (2012 – 2013): Leveraging the validated models of the O'ahu power grid refined in the OWIS and HSIS, the study's primary objectives are to quantify the impact of electric vehicle charging on O'ahu grid operations and to explore how different control techniques to manage EV charging profiles could further enhance the integration of wind and solar resources (e.g., by reducing curtailment and/or providing a new source of reserves). Study completion and report publication is targeted for March 2013.

In addition to the technical studies, HNEI has committed \$1million from the Energy Systems Development Special Fund to support the Hawaii Clean Energy Programmatic

EIS efforts. This is being closely coordinated with the State Energy Office, and is described in more detail below, in the section on the Energy Systems Development Special Fund.

Liquefied Natural Gas Study: In response to a request from the state, HNEI has retained FACTs Inc. to evaluate the potential importation of liquefied natural gas (LNG) to Hawai'i. The study will (1) assess the potential demand for LNG in Hawai'i, (2) evaluate the costs and benefits of LNG compared to other fossil fuels, (3) identify the potential impacts of LNG on Hawaii's economy and Hawaii's energy future, (4) identify and assess regulatory policies and practices that may be necessary or appropriate for Hawai'i to consider for the importation of LNG. The final report is due December 20, 2012 and HNEI will use approximately \$150,000 from this program to fund the study. In a separate body of work, HECO is contracting for studies to assess the technical feasibility of various import facility options and infrastructure requirements, and to assess different LNG supply options, including potential sources, pricing, security, and contracting options. Together the HNEI and HECO studies should begin to provide a foundation to assist in planning and decision making as the importation and use of LNG in Hawai'i is considered.

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 the Big 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 \$500,000 from the Energy Systems Development Special Fund to support a local bus service in the Hilo-Puna area on the Big Island.

Hydrogen Energy System as a Grid Management Tool: In a joint USDOE-DOD project HNEI is developing hydrogen production infrastructure at the Puna Geothermal Venture (PGV) electricity production plant on the Island of Hawai'i. The project objectives include 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 PGV hydrogen system has been delayed due to permitting and other agreements but is now expected to be operational by June 2013. The total budget is approximately \$5 million.

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 high pressure refueling infrastructure in support of this work. Completion is expected in first quarter 2013..

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 is 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 percentages of as-available renewable resources. We will finish installing equipment in 2012 and conduct the demonstration through 2013. HNEI is also serving as one of the Hawai'i implementing organizations for the recently announced NEDO Smart Grid Initiative, also located on the south side of Maui. In addition to general advice, HNEI is leading efforts to coordinate between the two smart grid projects

DOE Smart PV Inverter Project: In a project that closely supports the Maui Smart Grid efforts, an HNEI-led team won a new project to develop and demonstrate new "smart grid-enabled" PV inverters. This project, announced in September 2011, is intended to facilitate higher penetrations of solar PV systems by mitigating the utility operations issues resulting from variability of PV systems.

These new PV inverters will be tested as a part of the ongoing smart grid demonstration projects on Maui and another smart grid pilot project in Oklahoma. Project partners include Fronius, which is supplying the advanced PV inverters, and Silver Spring Networks, which will integrate them into the smart grid network they developed. Maui Electric Company, Hawaiian Electric Company, and Oklahoma Gas and Electric are the utility partners supporting the live demonstrations on their utility grids. HNEI used \$400,000 from the Energy Systems Development Special Fund to meet a critical funding shortfall and to insure timely and successful completion of this effort.

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). More recently the program was again expanded to include deployment and testing of net energy neutral buildings, testing of grid scale Li-ion high power batteries for grid support, and, as described above, support of various hydrogen infrastructure projects on the islands. In 2013 we will continue the current activities and with further expansion to include testing and evaluation of renewable generation and power system controls for smart and micro-grid applications.

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. In 2011, USDOE awarded \$2,333,379 for the second and third years of funding in addition to the first-year

federal funding of \$978,048. In 2012, HNEI was awarded an additional \$3 million to support development of a grid-connected wave energy test site at MCBH and to support industry testing at that site.

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 will be developed in 2013.

The Flash Carbonization™ process: Under this technology development effort, HNEI is scaling-up a UH patented process invented at the Institute for the rapid and efficient production of charcoal from biomass. Charcoal is the renewable replacement for coal that is burned in Hawai'i for power generation and is the biggest contributor to global warming. To assist licensees of our patents, HNEI is now developing emissions control technology that will facilitate the permitting process so that the technology can be operated in Hawai'i and on the Mainland. HNEI also is exploring the use of this technology to produce charcoal from Honolulu sewage sludge, and the production of charcoal to replace coke used to reduce silica to silicon for the manufacture of photovoltaic cells. The latter work is funded by the National Science Foundation and involves a collaboration with the Dow Corning Corporation.

Electrochemical Power Systems R&D: Researchers in HNEI's Electrochemical Power Systems Laboratory conduct testing and modeling to develop advanced battery system diagnostic and prognostic technology to further understanding of the performance of advanced batteries for use in electric vehicles and renewable energy storage applications. Funding sources include the US Department of Energy EERE Office through the Idaho National Laboratory, the Air Force Research Laboratory through the Hawai'i Center for Advanced Transportation Technologies, and Hawai'i Renewable Energy Development Venture funds through Better Place.

EXPENDITURES: General Funds \$ 1,074,351
Tuition and Fees S Funds \$ 31,390
Research and Training Revolving \$ 198,547
Extramural Awards \$ 21,588,319

All funds were expended in support of research and training activities described above. We anticipate 2013 extramural funding levels to be comparable to those from 2012. The rate of expenditure is expected to be similar to that of 2011.

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 coordinates and plans for ESDSF expenditures with the State Energy Coordinator and anticipates development of several additional contracts under the Special Fund during 2013.

ADVANCES IN TECHNOLOGY: HNEI continues to conduct research to advance renewable energy technologies. HNEI has patents in the areas of battery charging, conversion of biomass to charcoal, solar production of hydrogen, 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 2012 which involve strong collaboration/coordination with DBEDT include the following:

- ***Hawai'i Hydrogen Power Park:*** The hydrogen power park is funded in part by USDOE and in part by the Hydrogen Investment Capital Special Fund through DBEDT. HNEI is the implementing partner and works closely with DBEDT in the execution of this project.
- ***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. This work was completed in 2012.
- ***Marine Corps Base (MCB) Hawai'i Hydrogen Fueling Station at Kaneohe Bay:*** HNEI is leveraging the State of Hawai'i investment in the Hawai'i Hydrogen Power Project by reallocating the hydrogen production and fueling station from Hawai'i Volcanoes National Park to MCB Hawai'i, in support of the deployment of the ONR/GM Equinox fuel cell vehicles. HNEI has worked closely with DBEDT in coordinating this evolving project. This project is receiving global interest as a result of GM's commitment to target Hawai'i for the first commercial rollout of its FCEV program.
- ***Utility Scale Clean Energy Capacity Project:*** HNEI provided substantive assistance to DBEDT in the development of this award from the USDOE and was recently awarded funding from DBEDT to evaluate the impact of electric vehicles on the O'ahu grid system.
- ***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.
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RECOMMENDATIONS FOR PROPOSED LEGISLATION: Generally, HNEI does not initiate legislation, but HNEI does recommend the continuation of funding the Energy Systems Development Special Fund. As high oil prices continue to pressure the consumer and energy providers, this fund would help accelerate the acceptance and deployment of pre-commercial energy and energy-efficiency technologies expected to have near-term impact on Hawai'i's energy infrastructure.

HNEI 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, 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 was established in 2007 under ACT 273 but went unfunded until 2010, when, under ACT 73, 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. Due to account issues, UH/HNEI was unable to access these funds until June 2011. Between June 2011 and June 30, 2012, HNEI has received total funding in the amount \$4,960,000. Funds continue to accrue. HNEI has worked 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 dollars.

Below is a description of the existing commitments from the Fund, totaling \$3,278,000 and the proposed plans for expenditure of up to an additional \$2,550,000 million from the Fund for contract, research and support of renewable energy and energy efficiency technologies.

Current Commitments (Total to Date: \$3,278,000)

Geothermal Resource Assessment: (\$400,000) The US DOE is funding a project led by the University of Hawai'i to validate a new geophysical inversion and analysis procedure to map the subsurface structure of the geothermal resource and lower exploration costs. DOE funding is approximately \$1 million over two years with additional cost share from industry partners. HNEI committed \$400,000 from the Fund to purchase the relevant equipment and support one scientist to conduct the analysis to insure that the equipment and know-how developed under this effort will be available for additional resource studies with near-term target areas on both the Big Island and Maui. This work, initiated in Spring 2012 will allow initial site exploration on the Island of Maui.

Geothermal Strategic Development Study (\$115,000) HNEI has contracted to PICHTR to assess the current environment for geothermal development in the state, including the level of industry interest, and the identification of state and county agency needs to adequately perform the functions necessary for anticipated geothermal development. From this information PICHTR is preparing a geothermal strategic development plan that will help agencies be prepared for the complex planning, assessment, regulatory, and permitting activities required. This plan, to serve as a guide to DBEDT and other state agencies (e.g. DOH and DLNR) involved in geothermal development is expected to be completed in December 2012.

Smart Inverter Deployment: (\$400,000) The US DOE is funding a project led by the University of Hawai'i to develop and commercialize smart grid-enabled PV inverters to mitigate grid reliability impacts of high penetrations of PV systems, and demonstrating these systems at two sites, one on Maui and one on the mainland. This project is 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 to be awarded upon successful demonstration of the go/no-go deliverables in early 2013.

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 leverages 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 \$500,000 from the Fund has been identified support development of an advanced fuel cell bus for operation in the underserved Puna area. This work has not yet been contracted.

Hawai'i Clean Energy Programmatic Environmental Impact Statement: (\$1,000,000) A Programmatic EIS for the undersea cable was identified by USDOE and DBEDT as the next critical step in planning for the interconnection of the Hawaiian Islands via undersea cable - a critical step to meet HCEI goals. In July 2012, in coordination with the USDOE and DBEDT, HNEI contracted New West Technologies to conduct a Programmatic Environmental Impact Study for alternative scenarios for deployment of undersea electrical cables for interconnection of O'ahu, Maui, and Hawai'i Counties electrical grids. The PEIS is analyzing, 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 State of Hawai'i and the U.S. Department of the Interior's Bureau of Ocean Energy Management (BOEM) are cooperating agencies in preparing this PEIS. The PEIS will provide both federal and local agencies and policymakers with information and guidance they can use to make decisions about actions to support achieving HCEI goals. This work has been contracted and is underway.

The Pacific Asian Center for Entrepreneurship and E-Business: (\$50,000) PACE consists of an integrated set of leading-edge entrepreneurship programs at the University of Hawai'i Shidler College of Business with an innovative curriculum, research projects, and community outreach and involvement with Pacific and Asian entrepreneurs and entrepreneurial ventures. HNEI expended \$50,000 of the Fund to support several PACE fellowships to conduct technical and business analyses of critical energy issues. Support of this program is intended to provide future workforce cross-trained in both the business, legal and technical aspect of future energy systems.

HCEI Metrics (\$113,000). HNEI committed \$113,000 to support the Hawai'i Energy Policy Forum and the Social Science Research Institute at the UH in their development of a set of metrics to measure the State's progress toward meeting the Hawai'i Clean Energy Initiative's requirements. This effort is ongoing with completion expected in time for the 2013 legislative session.

Wave Energy Test Site (\$500,000) UH/HNEI through the National Marine Renewable Energy Center has been awarded an additional \$ 4.3 million by USDOE to support of wave energy testing at the to be constructed Wave Energy Test Site (WETS) at MCBH. This

\$500,000 cost-share from the fund was critical to receipt of this award and is in addition to \$3.8 million from the private sector. These funds will support environmental and resource studies supporting the Navy sponsored plug-and-play facility. Navy has committed approximately \$11 million for infrastructure at the WETS. Combined resources of Navy, USDOE and the Fund will result in a grid-connected site where developers can test their technology for proof of seaworthiness, functionality, system integrity and technology viability.

Sea Water Air Conditioning Monitoring (\$200,000) Seawater air conditioning has the potential to contribute significantly to the state's energy efficiency goals. HNEI has procured federal funding to develop high-fidelity plume models to assess the impacts of cold water return depth, a factor which has major impact on the capital cost of these projects. HNEI has also procured funding to initiate on-site monitoring before and during operation of the Honolulu SWAC system to assess impacts and validate models. HNEI will use \$200,000 from the barrel tax to conduct the long-term monitoring necessary to validate performance. Depth of discharge has major impact on the overall cost of the SWAC project. This work has the potential to save millions from future projects substantially increasing the likelihood of future SWAC development and resulting fuels savings.

Proposed New Projects (Total new expenditure: \$1,800,000 - \$2,550,000)

Based on community discussions and collaboration with DBEDT, the section below summarizes projects that have been identified for funding pending final detailed planning. The projects include new initiatives, and, where necessary, follow-on funding to commitments already made (see above). Cost for each are estimates based on similar work in the past. Total expenditures for these new and follow-on expenditures from the Fund are expected to range from \$1,800,000 to \$2,550,000. Projects shown below are planned but funds have not yet been committed.

Hawaii Clean Energy Programmatic EIS (\$500,000 - \$750,000) Based on discussions with the contractor and USDOE, it is anticipated that an additional \$500,000 to \$750,000 will be necessary to complete the work. These funds will only be committed after thorough review of progress under the initial funding and upon approval by DBEDT.

The Pacific Asian Center for Entrepreneurship and E-Business (\$100,000) HNEI plans to continue its support of the pace PACE program that will help provide a future workforce cross-trained in the business, legal and technical aspects of future energy systems. \$100,000 will support two fellowship teams to address business cases on interest to the renewable energy community. We intend to coordinate with DBEDT to identify projects of interest to the State.

Grid Modernization Projects (\$600,000-\$800,000) HNEI, with funding from USDOE and cost share from HECO has been funding GE to conduct detailed analyses of the various

island grids including high penetration solar studies for Maui and O'ahu, and studies to quantify the operational benefits of interconnecting O'ahu and Maui counties. These studies conclude in fall 2012. We anticipate the need for a limited number of well-defined follow-on studies to address unanswered issues important to HCEI. In addition to fuel cost savings, it is intended to identify and quantify the costs of necessary infrastructure and operational changes to implement the new systems, allowing assessment of the impact on electrical rates. These studies could also encompass a more detailed assessment of the potential for wind and solar electricity production on O'ahu necessary to make informed decisions on planning, including alternatives should technical or community issues limit deployment of the undersea cable interconnecting Maui and O'ahu counties. This latter effort would include an assessment of available wind and solar resource mapping data, GIS, and other data to determine the potential production of these resources on O'ahu.

National Fuel Cell Bus Program: (\$0 - \$200,000) HNEI is teaming with UTC Power on a proposal to the U. S. Federal Transit Administration (FTA) to deploy a state-of-the-art 40-foot fuel cell transit bus with the County of Hawai'i Mass Transit Agency (MTA) in Hilo to be operated on the Big Island on a variety of routes. If awarded, FTA and UTC cost share is expected to total \$ 2.2 million. The project will leverage hydrogen infrastructure installed at the PGV geothermal plant and MTA that was funded by the US DOE, Office of Naval Research, and State of Hawai'i. HNEI proposes to use \$200,000 from the Fund to meet the FTA cost share requirement only if the full award from FTA is approved.

Smart Meter Education (\$150,000 - \$250,000) Utilities need to effectively educate their consumers in order for them to gain the full benefit provided by smart meters. Failure to do so may have significant negative consequences on the utility's ability to modernize their grid systems. HNEI will work with local utilities and interest groups to develop a framework to guide utilities smart meter education efforts to effectively engage consumers, communities and advocates. The framework would identify best practices and successful techniques, and may include a sample education plan.

Maui County Load Management Assessment (\$200,000) HNEI proposes to fund an in-depth analysis of load management opportunities to evaluate the potential to reduce curtailed wind energy for Maui County. This assessment will include an evaluation of the ability of water utilities to time their use of electricity for pumping water to most benefit the island's grid and assist with the integration of intermittent renewable energy into the system without negatively impacting operations.

Energy Efficiency (\$250,000) While ceiling fans are an energy efficient alternative to mechanical air conditioning, current controls can't manage large banks of fans (more than 6), or respond to varying interior environmental conditions (temperature and humidity). HNEI proposed to partner with the UH School of Architecture's Environmental Research and Design Lab (ERDL), and Loisos + Ubbelohde (an architecture and engineering firm) to leverage current research initiated at Lawrence Livermore to develop ceiling fan controls hardware, and to prototype and test the controls in facilities currently monitored by HNEI.

The technology developed will be directly applicable to schools and other state facilities that need to improve comfort and reduce energy costs, and will allow more buildings to be naturally ventilated, thus advancing HCEI goals. We anticipate that this research would generate Intellectual Property that will derive residual revenue, a portion of which would flow back into the Energy Systems Development Special Fund.