

UNIVERSITY OF HAWAI‘I SYSTEM ANNUAL REPORT



REPORT TO THE 2011 LEGISLATURE

ANNUAL REPORT FROM THE
HAWAI‘I NATURAL ENERGY INSTITUTE

HRS 304A-1891

November 2010

Report to the 2011 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: Section 304A-1891 passed by the Hawai'i State Legislature in 2007 established the Hawai'i Natural Energy Institute (HNEI) in statute, defined duties of the institute and its director, and required 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. In 2010, ACT 73 established a barrel tax and authorized that 10 cents of the tax on each barrel be deposited into the energy systems development special fund to be managed by HNEI. However, 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). UH is working with DBEDT to determine means for UH to access the funds, consistent with legislative language. A summary of HNEI activities is appended.

Summary of Activities, 2010
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	15
	Other temporary staff (APT, RCUH)	9
	Training (a)	28

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

Summary of Activities and Contracts: Between 2001 and 2008, the Hawai‘i Natural Energy Institute (HNEI) experienced significant growth in its extramural funding from under \$2 million per year to over \$5 million per year. IN 2009, extramural funding for HNEI increased to over \$14 million and to over \$24 million in 2010. Major programs contributing to these increases include the National Marine Renewable Energy Center from the U.S. Department of Energy (USDOE), Phase 2 funding for the USDOE-funded Maui Smart Grid Demonstration Project, a significant expansion of activity for development of hydrogen infrastructure on the Big Island, and expansion of HNEI’s partnership with the Office of Naval Research (ONR) to utilize Hawai‘i as a site for alternative energy testing in the Pacific region.

HNEI is a nationally acknowledged leader in areas such as hydrogen, fuel cells, biofuels and ocean resources. In accordance with HRS 304A-1891, HNEI has undertaken a pivotal role within the state to reduce dependence on fossil fuels while contributing to the development of advanced energy technologies and systems aimed at finding solutions to energy shortage problems. While continuing efforts directed toward development of new renewable energy and ocean resource technologies, HNEI is also serving as the implementing partner for several major public/private partnerships to deploy and demonstrate renewable energy systems to meet Hawai‘i’s energy needs. In addition, HNEI has initiated two major efforts directed toward solving the technical issues associated with very high penetration of renewable energy technologies onto the electrical grid. These efforts support the goals of the Hawai‘i Clean Energy Initiative (HCEI).

A brief synopsis of select HNEI activities follows:

Hawai‘i Distributed Energy Resource Technologies for Energy Security: This program, managed by HNEI and conducted in partnership with GE Global Research, the Hawaiian Electric Company (HECO), Maui Electric Company (MECO) and the Hawaii Electric Light Company (HELCO), addresses technical issues associated with increased

penetration of intermittent renewable and distributed energy technologies in the electrical grid. Analytic models developed under this program are being used to identify near-term energy-transforming projects for implementation. To date, models have been developed and validated for the Big Island, Maui, and O‘ahu. These models are being used to examine utility practices to manage grid stability and reliability in the face of increased as-available renewable energy systems, including detailed studies of the proposed interisland connection in support of HCEI.

This program also supports the deployment and testing of emerging distributed energy technologies and solutions to end-use energy efficiency issues with the potential to identify cost-effective approaches to reduce electricity use in both the residential and commercial sectors. .

Hydrogen Energy System as a Grid Management Tool: With funding from the US DOE and project technical program management from the Naval Research Laboratory (NRL), HNEI is developing hydrogen production infrastructure at the Puna Geothermal Venture (PGV) electricity production plant on the Island of Hawaii. 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 hydrogen produced will be used to fuel two hydrogen-fueled and internal-combustion-engine-powered shuttle buses operated by the Island of Hawaii Mass Transit Agency as a feeder service to the main Hele-on bus line in the Puna district, and in support of hybrid electric fuel cell buses at Hawaii Volcanoes National Park (HAVO). The PGV hydrogen system is planned to be operational by the end of September 2011. The total budget is approximately \$2 million.

Marine Corps Base (MCB) Hawaii Hydrogen Fueling Station at Kaneohe Bay: The Office of Naval Research (ONR) is deploying five General Motors (GM) Equinox Fuel Cell Vehicles (FCVs) to enable the US Navy/Marine Corps to conduct technical evaluations and gain experience in the operation of FCVs utilizing direct hydrogen fuel. The first five vehicles were delivered in October 2010. HNEI is planning to reallocate the HAVO 350 bar (5,000 psi) fast-fill station, funded by the USDOE and State of Hawaii, to MCB Hawaii. Additional funding (approximately \$ 2 million) to upgrade the 350 bar station to 700 bar capacity is expected to be received from ONR in early 2011.

Hawai‘i Hydrogen Power Park: With funding from the USDOE and from the State's Hydrogen Investment Capital Special Fund through the Department of Business, Economic Development and Tourism (DBEDT), HNEI is the implementing partner for the installation of a hydrogen fueling station on the Big Island at Hawai‘i Volcanoes National Park (HAVO). In support of this effort, HNEI worked with HAVO to secure separate funding in the amount of \$1 million from the U.S. Department of Transportation to convert two conventional diesel shuttle buses into hydrogen-fueled plug-in hybrid electric vehicles (PHEV) to transport tourists at the park. Fuel for this effort will be provided by the newly funded PGV Hydrogen Infrastructure (see above).

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 four-year, \$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. The preliminary engineering design was completed in 2009. In 2010, the team completed detailed project design and continued product development for the advanced smart grid technologies. Installation of these new technologies on the MECO system is planned for 2011.

Energy Analysis for Renewable Portfolio Standards: As called for by Act 95, passed by the 2004 Hawai'i State Legislature, HNEI, under contract to the State of Hawai'i Public Utilities Commission (PUC), provided technical evaluations to the PUC to assess current renewable portfolio standards. HNEI submitted the draft final report to the PUC in October 2008 and this contract terminated in December 2008. Although HNEI subsequently offered our assistance (under other funding) to continue providing information to the PUC for determination of ways to enhance renewable portfolio standards, the PUC elected not to accept our offer.

Hawai'i Energy and Environmental Technologies Initiative (HEET): Initiated in 2001, the HEET Initiative, funded by the Office of Naval Research (ONR), focused on the development and testing of fuel cells and seabed methane hydrates. A key activity under HEET was the development of the Hawai'i Fuel Cell Test Facility (HFCTF) located on HECO property on Cooke Street. Today this facility has, in addition to ONR funding, several awards active or pending from the USDOE, the National Renewable Energy Laboratory, and various companies. In 2009, as part of the ONR effort to work in Hawai'i to validate alternate energy technologies for deployment in the Pacific region, HEET was expanded to include additional activities in biofuels and to support testing of critical heat exchanger technology in support of Ocean Thermal Energy Conversion (OTEC). We anticipate further expansion of these efforts in 2010, including new programs in energy efficiency technology and implementing technologies in support of high penetration of renewables on the electrical grid.

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. USDOE recently awarded \$2,333,379 for the second and third years of funding (September 2010 to September 2012). This is in addition to the first-year federal funding of \$978,048. The state's utilities and industrial partners are expected to provide in-kind cost-share matching.

Solar Initiatives: HNEI is the primary subcontractor to MVSystems, a mainland solar energy company, for development of technology for the solar production of hydrogen. HNEI has critical patents in this field and is currently negotiating with industry for licensing and further development. HNEI is also providing technical support, data acquisition, and analysis services to the Hawai‘i Department of Education for the installation of \$5 million in solar systems on selected schools.

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.

HNEI has developed a high-data-rate Data Acquisition System (DAS) to collect time-stamped data of weather and PV performance at a variety of sites. The high-data-rate time-stamped data provide the raw data to support analysis of the transient response characteristics due to the environmental conditions.

The initial test site, at Pu‘u Wa‘a Wa‘a Ranch on the Big Island of Hawai‘i was put into operation in 2010. Multiple sites and technologies are expected to become operational in 2011.

The Flash Carbonization™ process: Under this technology development effort, HNEI has developed a patented process for the rapid and efficient production of charcoal from biomass. Charcoal is a renewable replacement for coal, which 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 seeking permits to enable the commercial operation of the technology in Hawai‘i. HNEI also is active with an exploration of the use of this technology for producing charcoal from Honolulu sewage sludge. The most recent work involves a National Science Foundation-supported collaboration with Dow Chemical Company in production of charcoal to replace coke used to reduce silica to silicon for the manufacture of photovoltaic cells.

Algal Bio-Oils for Biodiesel Production: Under this technology development effort, HNEI is working with various industry partners to contribute to the development of technology for the production and extraction of oils from biomass. The UH Office of Technology Transfer and Economic Development (OTTED) has filed for a U.S. patent for technology developed at HNEI in this area. Two external funding streams have been secured. The first, funded through the Consortium for Plant Biotechnology Research links HNEI with a start-up mainland company that is seeking to exploit HNEI technology to extract bio-oil from biomass. The second, funded through the Center for Biomass Engineering Research and Development is aimed at fundamentally modeling the HNEI technology. Combined, these efforts focus on the production of biodiesel from waste streams and downstream separation processes which will be essential for cost-effective production of algal oils.

Microalgal Oil for Jet Fuel Production: HNEI is the subcontractor on a Navy Small Business Technology Transfer project for producing jet fuel. We are involved in wastewater treatment, reuse and management for microalgae cultures as well as production of value-added co-products from biomass.

Electrochemical Power Systems R&D: Researchers in HNEI's Electrochemical Power Systems Laboratory conduct testing and modeling to further understanding of the performance of advanced batteries for use in electric vehicles and renewable energy storage applications. Funding sources include the Idaho National Laboratory and the Hawai'i Center for Advanced Transportation Technologies..

Expenditures:
General Funds \$ 1,201,562
Tuition and Fees S Funds \$ 15,327
Research and Training Revolving \$ 205,832
Extramural Awards \$ 24,335,837

All funds were expended in support of research and training activities described above. We anticipate 2011 extramural funding levels to be comparable to that of 2010. As discussed in the opening summary, no funds specific to HB1003 HD3 SD1 CD1, SLH 2007, have been received or expended by HNEI.

Contracts Developed: Due to difficulty accessing funds appropriated into the Energy Systems Development Special Fund, no contracts specific to HB1003 HD3 SD1 CD1, SLH 2007, were developed. HNEI has contracted support services from various partners under federally funded programs, as summarized above. Planning has been initiated for use of the special funds and we expect to initiate agreements once access to the funds has been resolved.

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. HNEI has submitted patents on extraction of bio-oils from biomass to the U.S. Patent Office and these patents are pending review.

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 2010 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, is developing the State Hydrogen Plan as called for as part of the Hydrogen Investment Capital Special Fund. HNEI is working closely with DBEDT to insure that this plan is consistent with State objectives in this area.
- ***Marine Corps Base (MCB) Hawaii Hydrogen Fueling Station at Kaneohe Bay:*** HNEI is leveraging the State of Hawaii investment in the Hawaii Hydrogen Power Project by reallocating the hydrogen production and fueling station from Hawaii Volcanoes National Park to MCB Hawaii 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 Hawaii for the first commercial rollout of its FCV program.
- ***Hawai'i Bioenergy Master Plan:*** HNEI efforts to develop the Bioenergy Masterplan for the state were initiated in May 2008 with the first stakeholder workshop, held at the Capitol. Several drafts of the plan have been prepared and submitted to DBEDT and a broad group of stakeholders for review and comment. The final plan will be submitted to DBEDT no later than December 12, 2009 for subsequent submission to the State legislature.
- ***Utility Scale Clean Energy Capacity Project:*** HNEI provided substantive assistance to DBEDT in the development of this award from the USDOE. HNEI remains available to support this effort as it gets underway.
- ***National Marine Renewable Energy Center:*** DBEDT is a cost-share partner in the recently awarded 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.
- ***Hawaii-Okinawa Partnership on Clean and Efficient Energy Development and Deployment:*** HNEI has worked closely with DBEDT and HECO staff in scoping demonstration projects in Hawaii under this partnership between the U.S. and Japanese governments in the areas of smart grid, ocean energy, and energy efficiency technologies.

Recommendations for Proposed Legislation: Generally, HNEI does not initiate legislation, but HNEI does recommend funding the Energy Systems Development Special Fund. As high oil prices continue to pressure the consumer and energy providers, this fund would 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.