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1 OBJECTIVES

The primary objective of the proposed National Marine Renewable Energy Center in Hawaii (Center) will be to facilitate the development and implementation of commercial wave energy systems for use in Hawaii and elsewhere in the world. For validation, the target is for one or more of these systems to be supplying power to the local grid at >50% availability before the end of the 5 year period of the Center's performance. The Center will assist in completing necessary environmental studies and help industrial partners acquire required permits. It will provide engineering support to developers and will work with industrial partners to monitor the performance of deployed systems. The Center also will coordinate information exchange among appropriate parties. Wave energy field test facilities developed under this program will offer opportunities for component optimization and testing of complete systems. National and international partnerships will be leveraged to assess the potential for the export of technologies to other markets.

A second objective of the Center will be to assist the private sector to move ocean thermal energy conversion (OTEC) systems beyond proof-of-concept to pre-commercialization through long-term testing of an OTEC plant with gross power generating capacity of at least 5 MWe. The timeline for construction of such a plant depends on the success of commercial developers to secure funding. The technical role of the Center in this endeavor will focus on system and component engineering and local and global environmental studies. Presuming that sufficient funding for a pre-commercial plant can be raised by developers, a reasonable target at the end of the 5 year period of performance would be to have completed or be in the process of finishing the final design of a plant, to have secured major permits, to have prepared, as required, either a draft Environmental Assessment (EA) or Environmental Impact Statement (EIS), and to have in place a power purchase agreement between the local utility company and the OTEC developer.

The Center proposes to achieve these objectives through: 1) partnerships it will promote between marine power system developers, utility companies, financing sources, engineering and environmental support companies, academia, local, state, and federal government agencies, and non-governmental organizations (NGO's); 2) the establishment of up to four field test facilities in the state of Hawaii for wave-power and OTEC systems; 3) the creation of a web-based virtual Center that will serve as a forum

to facilitate the international exchange of information, test data, and modeling results; and 4) hosting annual meetings of Center participants and other stakeholders.

Industry will be the driving force behind the proposed Center, as described in this narrative and evidenced by the letters of support from both potential power producers (developers) and their clients (the local utilities companies). While specific technical objectives and timelines will necessarily reflect the business plans of these partners, the overall intent of the project is to accelerate the development of marine renewable energy technologies in general and to address the needs and concerns of the public. Furthermore, the Center will be structured and managed to provide, to the greatest extent possible, open access to its facilities and expertise, and broad dissemination of non-proprietary information, for all credible wave power system developers and other stakeholders. This policy will not be determined nor diminished by the commercial agendas of the founding industrial partners.

2 MERIT REVIEW CRITERION DISCUSSION

This section provides a detailed description of the proposed Center, presents the Center's Implementation Plan and Demonstration & Commercialization Plan, and lists the qualifications of the participants and available resources. It addresses each of the three merit review criteria for Topic Area 3.

2.1 Criterion 1: Project Description and Implementation Plan

2.1.1 Project Description

A National Marine Renewable Energy Center will be established in Hawaii. The Center will be led by the Hawaii Natural Energy Institute (HNEI) of the School of Ocean and Earth Science and Technology (SOEST) of the University of Hawaii (UH), a Land, Sea, and Space Grant Institution. The Center will be a collaborative effort between academia, industry, government, and NGOs. Our partners include technology developers, the local electric utilities companies, a large engineering contracting company that can also provide financing opportunities for future commercialization efforts, and the State of Hawaii. International partners currently include groups from Norway, France, and the United Kingdom; additional partners from Asia are anticipated once the Center is established.

The primary focus of the Center will be the development and commercialization of wave energy devices. A secondary focus will be the pre-commercial validation of OTEC systems. Wave and OTEC were selected since Hawaii has exceptional resources and significant expertise in these areas and several major commercialization or demonstration projects in Hawaii are underway. Testing and demonstration will be conducted at up to four sites on the islands of Maui, Oahu, and Hawaii, and possibly also at facilities operated by our international partners in Norway, France, and the U.K. Permitting and adequate funding are potential major barriers to the successful development of wave energy projects. As described below and evidenced by our letters addressing these barriers is a major focus of the proposed Center. The team which has been assembled includes technology companies with a proven record of project development, and local industry and university personnel with considerable experience in permitting and environmental issues. A web-based virtual Center will be created to facilitate information and data sharing and to serve as a forum for stakeholders and the public. Regular stakeholder meetings will be organized to promote partnerships and to review and revise the Center's RD&D strategy.

Since tidal variations around Hawaii are relatively small at less than 1 m, and locales with significant ocean current velocities are limited, extensive field testing of devices that utilize these energy resources is unlikely to be undertaken in Hawaii but could be pursued via the Center's international partners in Europe. The Center will offer opportunities to developers of tidal and ocean current energy conversion devices to conduct laboratory, modeling, and environmental studies in cooperation with participating faculty and personnel from industry.

The Center will be strongly industry-driven and will be anchored by several ongoing projects in the state of Hawaii that propose to install wave energy systems which will feed electrical power to local

utility grids within the next 5 years. OTEC activities will also be coordinated with industry partners, although funding has yet to be secured for a proposed demonstration plant.

The state of Hawaii has a general coastline of over 1200 km, the fourth longest in the U.S., and an exclusive economic zone (EEZ) of about 2.4 million km^2. Previous studies have confirmed that Hawaii enjoys a superior wave energy resource and is, therefore, an excellent candidate market entry point for large-scale hydrokinetic energy conversion technologies. Wave systems have the potential to supply electrical power far in excess of current demand on all islands except Oahu, where about 75% of the state's population resides (SEASUN Power Systems, 1992). Even on Oahu, harnessing the wave resources off the north shore could meet almost two-thirds of the island's electricity demand.

Most of Hawaii's wave energy resource is produced by the northeasterly Trade Winds that blow throughout the year. These winds have monthly average velocities between 5 to 8 m/s and generate waves with a dominant period of 6-8 s and significant heights of 1-2 m. Smaller contributions to the resource come from long swells resulting from distant storms. Along coastlines with a northeastern exposure, the average wave power density along the 80 m depth contour lies between 10-15 kW/m, dropping by about 20%, due to refraction and shoaling, by the time the 5 m depth contour is reached (SEASUN Power Systems, 1992). At these power densities, the electricity demand of the counties of Hawaii, Maui, and Kauai could be satisfied by recovering a small percentage of the wave energy resource available on the outer shelf of the north coasts of these islands.

Although endowed with excellent solar, wind, geothermal, biomass, and ocean energy resources, over 92% of Hawaii's electrical power is derived from fossil fuels, primarily oil, making it particularly vulnerable to disruptions in supply. Prices of electricity and transportation fuel in Hawaii currently are among the highest in the nation.. Fossil fuel surcharges account for 60% or more of this price. While this imposes an economic burden on residents and businesses, it offers near-term opportunity for large-scale cost-effective deployment of renewable energy technologies such as wave and OTEC.

The State Government is actively promoting development of sustainable energy resources. It has enacted laws mandating that a minimum of 20% of the electricity supplied by the local utilities by 2020 come from these resources and improvements in energy efficiency. In addition, the State of Hawaii offers financial incentives through Hawaii Revised Statutes § 235-110.9 which allows for a non-refundable business tax credit of up to $2 million over 5 years for investments in a qualified high-technology business (Kaya *et al*., 2008). Research must constitute at least 50% of the activities of such a business and 75% of this "qualified" research must be conducted in the state. Non-fossil-fuel energy development is specifically identified in the statute as "qualified research." These state policies offer the opportunity for substantial leveraging of private and government investment in ocean energy technologies. Lastly, this past January, the State entered into an agreement with the U.S. Department of Energy (USDoE) for the Hawaii Clean Energy Initiative (HCEI), the objective of which is to have 70 percent of Hawaii's energy needs sourced from clean and renewable resources by 2030.

The isolation and relatively low installed generating capacities of the power grids on the various islands (about 1700 MWe for Oahu; 290 MWe for the county of Hawaii; 280 MWe for Maui; and 90 MWe for Kauai) present a unique challenge with respect to stability problems that can arise when conventional units that provide grid support are displaced by wave power. The utility on the island of Hawaii has been attempting to address these stability and reliability issues caused by a sharp increase in wind-generated power added to its grid over the past year. Experience gained from the grid-integration of wave power systems in Hawaii would particularly benefit the application of such technologies in other isolated communities and their export to small rural markets in the developing world.

Two wave energy projects have been initiated that may soon be delivering electricity to the power grids on Maui and Oahu. In February 2008, Oceanlinx, Ltd. of Australia in collaboration with Maui Electric Company (MECO) announced plans to provide up to 2.7 MWe from two or three floating platforms located about 1 km offshore of Pauwela Point on the northeast coast of Maui. Power will be generated using Oceanlinx's oscillating water column technology that has been tested previously at a facility in Port Kembla, NSW, Australia. Oceanlinx also is developing wave energy systems in Victoria, Australia; Cornwall, U.K.; Namibia; and Rhode Island. The $20 million privately-funded Maui venture

may be operational by the end of 2009. Oceanlinx currently is negotiating a power purchase agreement with MECO who will be seeking approval for this agreement from the Hawaii Public Utilities Commission (PUC) and who will provide the necessary transmission and interconnect infrastructure. MECO, Oceanlinx, and Planning Solution, Inc., a private environmental consulting firm located in Honolulu that has been engaged to prepare the EIS by Oceanlinx, are partnering with UH on the proposed National Marine Renewable Energy Center. As evidenced by a letter of commitment, MECO intends to provide substantial cost share, and the Pauwela Point site on Maui will be one of the field test locations operated by the Center. Center investment at this site would leverage and expand the Oceanlinx permitting efforts and in the later years, leverage the undersea power and instrumentation cabling provided by MECO. This would allow testing by other power providers. The Center would also conduct testing and obtain oceanographic data that would benefit wave power system development.

At a second site offshore of the Kaneohe Marine Corps Base Hawaii (KMCBH) on the windward (northeast) coast of the island of Oahu, Ocean Power Technologies (OPT) has been testing a single 40 kWe buoy in 30 m depth water. The up and down motion of the buoy is used to drive a generator which is connected to shore via an undersea cable. Commercial scale applications will require arrays of buoys. OPT has been collecting data since the first unit was deployed in June 2004 and has completed an extensive EA. This project, funded by the Office of Naval Research (ONR), is intended to demonstrate the feasibility of wave power for naval facilities worldwide. OPT also has projects in New Jersey and Spain.

Per the attached letters of endorsement and support from ONR and OPT, there is considerable interest in moving this project to larger systems in deeper water. This will require additional permitting, new buoy development, and the deployment of additional infrastructure. We propose to help reach these objectives by conducting oceanographic and environmental studies, and by directly supporting permitting efforts for the deep water experiments. Sea Engineering Inc., a Hawaii-based ocean engineering contractor that installed the OPT buoy and conducted much of the environmental field work will also be a Center partner. As in the case of the Maui project, this second test site at KMCBH takes advantage of the substantial leveraging offered by the OPT and ONR investment. .

Partnerships with the above two projects significantly enhance the probability of attaining our primary goal of facilitating the commercial implementation of wave power systems within 5 years. Moreover, these partnerships will make available to the Center valuable technical and capital equipment resources.

Hawaii arguably has the best OTEC resource in the U.S. The islands rise sharply from the seafloor, resulting in bathymetry that provides excellent nearshore access to deep, cold seawater. Annual sea surface temperatures around Hawaii typically are in excess of 25°C which is sufficient to provide the rule-of-thumb 20°C temperature differential (between the warm and cold sea water) required to ensure acceptable thermodynamic performance of an OTEC cycle. Over the past 30 years almost all major U.S. OTEC studies have taken place in Hawaii. In 1979, Mini-OTEC, the first successful floating closed-cycle OTEC system, was tested offshore of Keahole Point on the west coast of the island of Hawaii. This project, a joint effort between the State of Hawaii, Lockheed Missiles and Space Company, Alfa Laval Thermal, and the Dillingham Corporation, produced up to approximately 50 kWe gross power (10-17 kWe net) during its three month operation. The following year, USDOE funded TRW, Inc. to test titanium shell-and-tube closed cycle OTEC heat exchangers on OTEC-1, a converted navy tanker that was again moored off the west coast of the island of Hawaii

Since the late 1980's, other OTEC demonstrations and studies have been conducted at the Natural Energy Laboratory of Hawaii Authority (NELHA) facility at Keahole Point. NELHA was established in 1974 by the State of Hawaii to pursue OTEC and other ventures utilizing deep ocean water. Numerous sea water intake systems have been installed at NELHA including a recently completed 3.1 km long, 1.4 meter diameter. high density polyethylene (HDPE) pipe that extends to a depth of 915 m to supply cold seawater at 6°C at rates up to 1.8 m^3/s (27,000 gpm). Another 1.4 meter diameter. HDPE pipe is used to supply 2.56 m^3/s (40,500 gpm) of warm surface seawater from a depth of 24 m. Between 1992 and 1998, NELHA hosted the USDOE's Net-Power Producing Experiment (NPPE) in which an open cycle OTEC

system was constructed that produced a recorded maximum of 255 kWe of gross power (equivalent to >100 kWe net) as well as potable water from a second stage desalination unit. Two of the HNEI faculty who will participate in this Center were actively involved in the design, fabrication, and operation of the facility.

OTEC has the potential to produce a considerable amount of electricity at one site, as opposed to many renewable energy resource technologies. Given the exceptional OTEC resource around Hawaii, the extensive history of OTEC development in the state, and the OTEC technical expertise that can be found at the University of Hawaii, in government, and in the local private sector, HNEI proposes to pursue the commercial development of this marine renewable energy approach along with wave power systems. Following a strategy similar to our wave power initiative, the Center will team with Lockheed-Martin (LM), one of the partners in the early Mini-OTEC project. The objective is to undertake necessary environmental studies and component development testing to prepare for the long-term demonstration of a closed-cycle OTEC plant with a generating capacity of the order of 5 MWe or larger.

Regarding OTEC technologies, additional development is needed to reduce the capital costs and improve the performance of heat exchangers, address scale-up issues, and develop innovative approaches for deep water moorings and power transmission or energy carriers for far offshore floating systems. Questions about the environmental impacts of large OTEC systems also require attention, specifically, local and global impacts on biota due to the presence of large pipelines, the discharge of nutrient-rich deep seawater in the photic zone, and possible alterations of the thermocline resulting from sea water extraction and discharge by large floating OTEC plants.

In cooperation with LM and other OTEC developers who join the Center in the future, a test facility will be established to evaluate and characterize the performance of key OTEC components such as the heat exchangers. One possibility is to site this facility at NELHA which has hosted numerous earlier OTEC investigations and can provide large quantities of warm and cold sea water. HNEI has an established presence at NELHA.

The Center proposes to develop and operate a fourth field test facility at the Makai Research Pier to obtain long term data series on the wave energy resource and other environmental parameters, conduct research on corrosion and innovative materials, and provide an easily accessible site for the deployment and testing of small wave energy conversion devices and components. A multi-state survey of potential wave energy sites conducted by EPRI (EPRI, 2004) identified the Makai Research Pier, which is located west of Makapuu Point on the eastern tip of the island of Oahu, as offering a unique opportunity for a pilot wave power test facility due to the excellent wave climate and the existing research infrastructure. It is already permitted for a range of marine research activities. Two of the partner organizations of the proposed Center, the Hawaii Undersea Research Laboratory (HURL) and Sea Engineering, Inc., are primary tenants of the Makai Research Pier. HURL, a UH entity funded in part by the State of Hawaii has offered the Center space at its facilities and access to its skilled technical personnel there as cost share. Figure 1 shows the locations of the four test facilities.

The Center will be managed and led by HNEI personnel. While specific projects will be led and funded by industry, HNEI staff will closely coordinate with our industry partners to identify where Center investment and efforts can best help facilitate their efforts. This may include direct support for field and environmental studies, assistance with permitting, and leveraging of infrastructure to maximize the value of the sites for multiple users. In each case, newly proposed projects will require acceptance of the host site owners (e.g., MECO, KBCMH, and NELHA).

Colleagues from other departments of the School of Ocean and Earth Science and Technology of UH and from the College of Engineering with appropriate specialties and experience to provide value to the Center have been recruited to participate and their *curricula vitae* are included in the attached Resume file. In addition to supporting tasks that address specific needs of the industry partners, the faculty participants will also pursue independent research on critical technical issues related to performance,

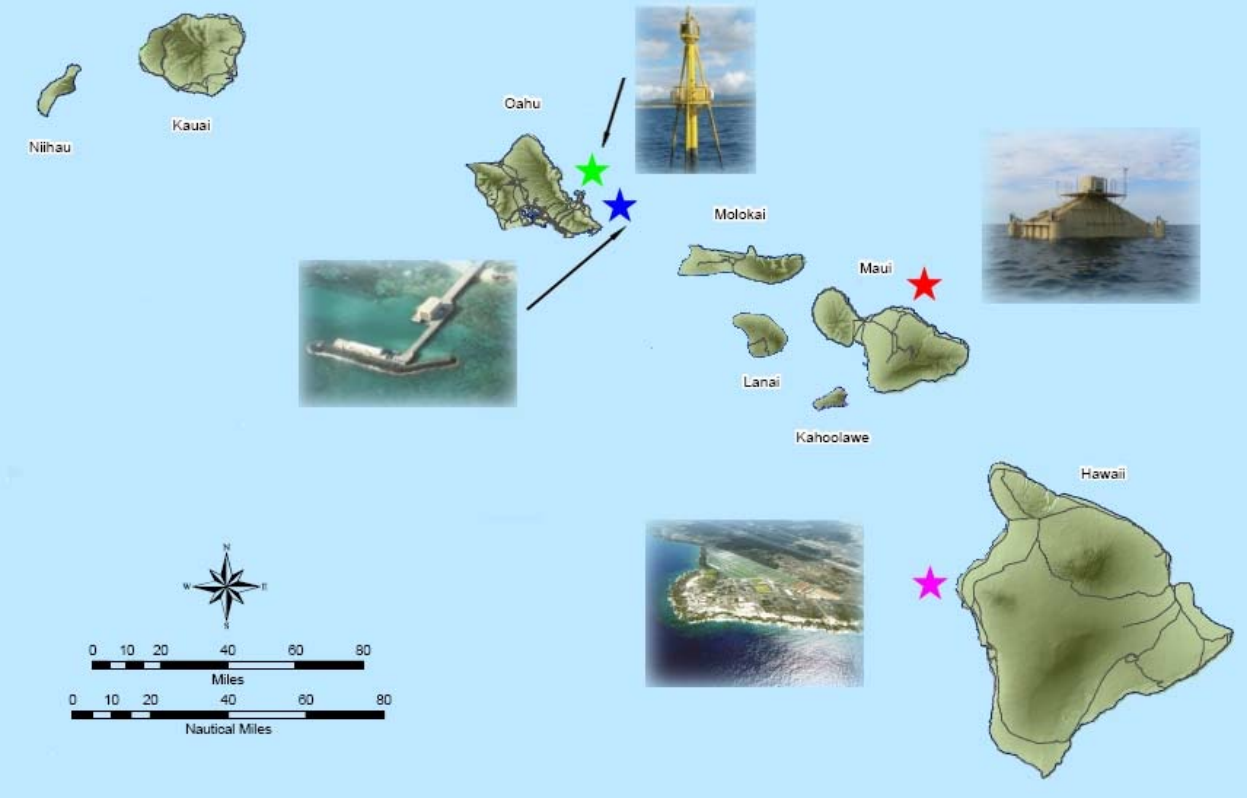


Figure 1. Locations of the four test facilities. The green star indicates the general location of the OPT project site offshore of the Kaneohe Marine Corps Base Hawaii; the OPT buoy is shown in the adjacent picture. The blue star is the location of the Makai Research Pier seen in the aerial photo. The red star is the planned site of the Oceanlinx oscillating water column device shown in the photo. NELHA on the west coast of the island of Hawaii is being considered as an OTEC component test site.

reliability, and environmental impacts of marine renewable resource power systems. There will be close and frequent interactions with industry partners to ensure that this research provides value to commercial development. Brief descriptions of research that will be performed over the 5 year period of performance on topics identified in the FAO (shown in *italics*) are provided below.

- *Perform research on advanced wave forecasting technologies.* The key objective of the research to be performed is to identify time windows and locations around the Hawaiian Islands that are most favorable for the operation of wave power systems and, in so doing, to identify and develop effective forecasting protocols and methods. This work will be led by participating faculty from the Departments of Ocean and Resources Engineering (ORE) and Oceanography (OCE). ORE has been operating a model system to provide 7.5-day experimental forecasts of wave conditions around the Hawaiian Islands at regional and island scales. The system includes the spectral wave models WaveWatch3 (WW3) and Simulation Wave Nearshore (SWAN) as well as the Coastal and Estuarine Circulation (ECOM) model. These models provide forecast runs every 6 hours for the Hawaiian Islands from Niihau to Hawaii at 6-km resolution and the individual islands at 600-m resolution. In each forecast run, the NOAA Global WaveWatch3 model and TPXO.6 global tidal database provide the wave and tide boundary conditions. The high-resolution atmospheric models (MM5/WRF) with proper depiction of terrain and land surface conditions operated by the UH Department of

Meteorology provide the wind forcing that accounts for the modification of large-scale flow by the Hawaiian Islands with heights ranging from 500 to 4100 m.

We propose to improve the accuracy of the wave forecast and to use the resulting system in hindcast mode to develop a wave atlas of the Hawaiian Islands. Improved wave forecasting accuracy will aid the deployment and operation of test devices, while the wave atlas will offer detailed information about the wave energy resource that will be of significant value for planning future commercial wave power systems and for related environmental studies. A key component of the proposed work is to enhance the Hawaii regional MM5/WRF, which provides the wind forcing to the spectral wave models, by assimilating satellite observations of ocean surface winds into the regional atmospheric model. Both WW3 and SWAN consider wave propagation, refraction, shoaling, and breaking under the influence of specified wind and current fields. Addition of diffraction will greatly enhance the spectral wave models in describing the wave conditions on the leeward side of islands. This enhanced model package provides a good opportunity to create a wave database for the Hawaiian Islands with high-resolution simulated winds diagnosed from atmospheric models using NCEP/NCAR (National Centers for Environmental Prediction/National Center for Atmospheric Research) reanalysis data for the past 5 years. The database allows better understanding of the seasonal wave climate around the Hawaiian Islands.

- *Conduct experimental and numerical modeling for optimization of marine energy conversion devices and arrays.* Faculty from the UH College of Engineering and SOEST will support the field testing as appropriate but will also undertake complementary laboratory studies and numerical modeling directed toward a wider range of applications. Two primary objectives will be pursued that relate to wave power systems: 1) refinement of numerical simulation packages to predict dynamic loads on floating and submerged structures and assess the performance of single wave power devices and interacting arrays of these devices; and 2) scale tests in an existing UH wave tank of prototype devices being investigated at the Center's field sites. Objective 2 will also involve improvements of laboratory facilities and protocols and will provide data to calibrate and validate the numerical simulation packages.

  ORE and HNEI personnel have developed codes to analyze wave-structure interactions (e.g., OTEC pipeline towing) and ORE has recruited a new faculty member with a specialty in ocean energy who is expected to start in August 2008. Six months per year of this person's time will be applied toward Objectives 1 (and 2) and is committed as a cost share.

  Laboratory experiments will leverage existing facilities at the UH Department of Civil and Environmental Engineering including a 15.2 m (l) x 1.2 m (w) x 0.9 m (d) wave tank/wave generator equipped with a towing carriage. A longer 1.8 m deep wave flume and towing carriage is being constructed with funding from ONR, the UH College of Engineering, and the Hawaii Department of Transportation. This facility will also be available for the wave energy experiments. The new wave flume will have an advanced computer controlled wave maker that can generate periodic waves, solitary waves, conoidal waves, breaking waves, and also irregular waves to better simulate the ocean wave field, as well as a self-circulation system that can produce currents up to 1 m/sec. Instrumentation include multiple wave gauges and data acquisition systems, a 3-D Laser Doppler Velocimeter (LDV) and a 3-D Particle Image Velocimeter (PIV), video cameras, high speed cameras, and flow meters.

  Experiments will be conducted under different wave conditions and will examine single devices and series of devices arranged in different patterns. An additional area of interest is the use of man-made wave focusing structures to enhance the performance of wave power devices. Previous research has determined that water waves can be focused to increase their amplitude by propagation over a submerged structure. In this project, we will conduct laboratory experiments to explore the possibility of developing practical wave focusing lenses that can be deployed with various wave power devices in the ocean.

- *Identify opportunities for cross-fertilization and development of economies of scale between other renewable sources and marine and hydrokinetic renewable energy sources.* Most renewable energy systems, including wave power, generate power intermittently, i.e., only when the resource is available. From the utility perspective, the inability to plan ahead with confidence makes economic dispatch of generating units difficult. If such intermittency occurs over a short time frame, then spinning and/or regulating reserve is necessary to ensure stability, further reducing the economic dispatch of the other generating units. In the extreme, such as with wind which can exhibit very significant short-period fluctuations, intermittency can lead to power quality issues that often results in the utility shedding the renewable energy generator from the grid system. While wave energy systems are expected to be more predictable and less transient than wind systems, there have not been, to our knowledge, any detailed assessments of the integration of large scale ocean energy systems into the grid.

  Under funding from the Department of Energy, HNEI, in partnership with GE Global Research Center (GE GRC) and the local utility companies, is developing detailed dispatch and dynamic models for the various Hawaiian Islands. These models, based on the GE GRC MAPS (dispatch) and PSLF (dynamic) models, are able to accurately evaluate the effect of intermittent energy sources on system stability and power quality.

  With their small and isolated grid systems and relatively high penetration of renewables including wind, geothermal, and biomass, the islands of Hawaii and Maui are excellent case studies to apply these validated models to investigate the effect of linking ocean energy systems with other renewable energy systems. By integrating wave power performance data from the planned field tests with high fidelity grid models and advanced wave forecasting techniques, we will be able to assess the value of grid-connected wave power facilities.

  A considerable amount of work is being undertaken to model the behavior of mixed portfolios of conventional and renewable power systems on Maui and the island of Hawaii. Ongoing modeling activities being led by HNEI are focusing on identifying technology systems or operating strategies (e.g., energy storage; advanced forecasting) that can respond to rapid grid frequency fluctuations caused by variations in wind turbine output. We intend to incorporate wave energy technologies into this analysis. This study will help the utility to properly site and size storage devices, address issues related to the interconnection of wave energy systems and the reliability of wave forecasting techniques, and provide comparative operational characteristics of different wave energy technologies.

  Unlike wave and wind power, OTEC does not suffer from intermittency problems and could help stabilize the grid. The effect of grid-connected OTEC systems on power quality management and unit dispatch, however, has never been evaluated. We propose to extend our modeling activities to identify strategies for the effective operation of portfolios of mixed conventional and wind, wave, and OTEC power systems. Results will benefit other renewables that may come online in Hawaii over the next ten years, such as additional geothermal, biomass combustion, and run-of-the-river hydro.

  On Oahu, which has an installed capacity of more than five times that of any other island, very little of the electricity comes from renewable sources. This situation may soon change, however, if plans to expand the use of biofuels for electricity production are realized. Wave power could provide additional electricity to the Oahu grid without disrupting stability and could be linked to the new bio-diesel systems. A grid modeling effort by HNEI for Oahu is planned to start by the end of 2008 and could incorporate the Kaneohe OPT facility.

  Testing ocean power systems on three different islands, each with unique grid characteristics, allows an evaluation of the operation of these technologies under different energy regimes. The proposed grid modeling will provide vital information to facilitate the successful integration of these power systems into a range of potential markets with different stability considerations.

- *Study the compatibility of marine and hydrokinetic technologies and systems with the environment, fisheries and other marine resources.* This study will include three components: 1) evaluation of chemical and biogeochemical threats posed by various discharges associated with wave energy devices; 2) a general assessment of the impacts of ocean energy installations on marine life; and 3) the effects of OTEC sea water removal and discharge on the food web and the potential for degradation of the thermal resource. These issues can profoundly influence the permitting process and commercialization of marine renewable energy conversion technologies. The study will be conducted by faculty from OCE, HNEI, and the International Pacific Research Center (IPRC) of SOEST.

  Chemical and biogeochemical impacts of OTEC operations have been studied previously (e.g., Sansone & Kearney, 1984, 1985; Sansone & Smith, 1986; Quinby-Hunt *et al*., 1986). Potential impacts of non-OTEC marine renewable energy systems such as hydrokinetic devices are less understood, particularly with respect to tropical and island environments. Possible chemical and biogeochemical environmental effects may include: release of anti-biofouling agents; disposal of removed biofouling; lubricants and surfactants released during operations and inadvertent spills; nutrient-rich groundwater released from electrical-cable shore crossings; and particulate matter released during the installation of moorings and shore crossings. As a specific test case, the Oceanlinx wave power facility planned for deployment off Maui will be analyzed to determine and rank the significance of these possible effects and to assess the sensitivity of the specific site to these effects. Methods to eliminate or mitigate significant impacts will be explored. This study will serve as a template for similar assessments of other types of wave power devices.

  On the second topic, different types of ocean energy installations (e.g., buoy arrays; floating platforms; OTEC suspended pipelines) will be analyzed to identify the full spectrum of possible impacts on marine animals. For example, objects placed in the ocean frequently attract and aggregate fish, sharks and other organisms. Installations may cause entanglement of whales, seals, turtles, birds and other animals or may be used as haul-outs and resting sites by seals and birds. The noises created by ocean installations can alter the acoustic environment and impact whales and other acoustically sensitive animals. Electromagnetic signatures of ocean energy installations may be picked up by animals that use such signals for navigation and positioning. Migration routes and timing can be altered as a result. In order to understand, predict, and mitigate the impacts of ocean energy installations on animals, it is necessary to understand whether they will be attracted, repelled or unaffected by a particular device, and to evaluate how different designs affect these responses. Siting decisions must also consider how specific areas are used by different species. Since the literature contains a significant body of information on animal responses to marine structures and anthropogenic disturbances, this study will apply these results in its analyses. Additional information will be collected during the field tests.

  The effects of OTEC will be investigated through numerical modeling. The Regional Ocean Model System (ROMS) will be applied to characterize local environmental impacts of an isolated OTEC plant. The large OTEC sea water flow rates will be idealized as point sinks and point sources in this model. Results will provide useful information to select the depth and type of OTEC effluent discharge that produce minimal perturbations. Since there is concern that release of highly concentrated nutrients (e.g., phosphates and nitrates) from the deep ocean within the photic layer can alter primary production (Nihous, 2006; 2007a), this phenomenon will also be explored by incorporating a nitrate-phytoplankton-zooplankton-detritus (NPZD) submodel within ROMS.

  A second theme that will be studied addresses the issue of degradation and global sustainability of the OTEC resource. It has been recognized that closely spaced commercial OTEC systems can interfere and alter the ocean temperature profile with a resulting drop in performance and possible negative environmental consequences. The modeling methodology developed for a single system will be extended to arrays of OTEC plants within a selected region, probably the area around the main Hawaiian islands and also the Gulf of Mexico. Finally, General Circulation Models (GCMs) will be employed to determine whether global OTEC resources are limited by the rate of deep cold seawater

formation in polar regions, as suggested by simple one-dimensional analyses (Nihous, 2005 ; 2007b). Further limitations from the effects of global warming on the ocean thermohaline circulation (Nihous, 2007c) may be investigated as well. Collaborations with the developers of GCMs other than ROMS, such as the U.S. Navy's NCOM (NRL) and France's MERCATOR OCEAN, will be actively pursued.

- *Increased reliability and survivability of marine and hydrokinetic renewable energy technologies, including development of corrosive-resistant materials.* The proposed research on this topic will focus on corrosion. The viability of ocean power generating technologies will be affected by their ability to resist corrosion in the harsh marine environment. General corrosion, pitting, crevice corrosion, and galvanic corrosion may occur depending on various factors. In addition to the ubiquitous chloride ion, sulfuric acid exposure by the reaction between sulfur dioxide and water is a growing concern in Hawaii due to emissions from the Kilauea volcano that have recently increased approximately five fold from a normal output of 150 - 200 metric tonnes/day. Above-water structures are subject to aggressive attack when exposed to volcanic smog that can be advected across the entire state by occasional southeasterly winds. Conventional marine corrosion data found in the literature may underestimate the speed and extent of material degradation in the Hawaiian environment.

  Marine installations also are vulnerable to biocorrosion which is a serious problem for power generation facilities and the offshore oil and gas industry (Scotto *et al*., 1986; Acuna *et al*., 2006; Bermont-Bouis *et al*., 2007). Microbial-influenced corrosion (MIC) alone accounts for 20-30% of all corrosion losses (about $30-50 billions per year). Biocorrosion occurs when complex microbial consortia interact with metallic surfaces through the establishment of multispecies biofilms (Fenchel, 2002). Biofilms mediate interactions between metal surfaces and the liquid environment, leading to major modifications of the metal-solution interface by drastically changing the types and concentrations of irons, pH, and oxygen levels. The mechanism of biocorrosion is complex and insufficiently understood (Videla and Herrera, 2005). While application of biocides and surfactants has been successful in mitigating biocorrosion (Lechavallier *et al*., 1988; Al-Darbi *et al*., 2002; Tsai *et al*., 2003; Aleman *et al*., 2006), effects are generally temporary and may not be acceptable for use in sensitive marine habitats.

  The corrosion studies that will be undertaken will leverage facilities at the Hawaii Corrosion Laboratory (HCL) at UH. HCL was established with $8 million of funding provided by the U.S. Army Corrosion Office since 2003 for its Pacific Rim Corrosion Research Program and Pacific Rim Environmental Degradation of Materials Research Program. HCL has established eight atmospheric test sites (including two in marine settings) at different locations in Hawaii that take advantage of the state's diverse micro-climates and environments (Hihara *et al*., 2008). It also operates a state-of-the-art corrosion, electrochemistry, and materials characterization facility for investigating corrosion mechanisms and determining the relationship between microstructure and corrosion behavior. The HCL specializes in synthesizing hybrid ceramic-polymer (ceramer) coatings for corrosion protection. Several novel coatings have been developed for aluminum and zinc that have shown exceptional promise for use in marine environments.

  Test facilities will be set up at the Center's four field test sites to investigate corrosion in the splash-spray zone, surface waters, and deep ocean water. Vulnerable materials used in wave energy devices and OTEC components will be identified and standard sample coupons and ceramer coatings will be prepared and tested. The exposed samples will be analyzed in the laboratory to determine corrosion mechanisms and results will be applied to develop second-generation ceramer coatings.

  Biocorrosion of sample coupons and actual hydrokinetic devices and OTEC components will also be explored using molecular methods to identify the composition of fouling communities (e.g., 16S or 18S rRNA library construction), classical taxonomic approaches, and Scanning Electron Microscopy. Innovative marine coatings, containing natural compounds extracted from algae and sponges and conductive polymers, will be tested in laboratory to determine if they are effective in providing protection from biocorrosion to ferrous and non-ferrous metals.

In addition to the above research topics required by the FAO, cradle-to-grave carbon footprinting of wave power and OTEC systems will also be conducted to assess the relative merits of these systems with regard to net greenhouse gas emissions.

2.1.2 Implementation/Management Plan

The Center will be managed and led by HNEI personnel. While specific projects will be led and funded by industry, HNEI staff will closely coordinate with our industry partners to identify where Center investment and efforts can best help facilitate their efforts. This may include direct support for field and environmental studies, assistance with permitting, and leveraging of infrastructure to maximize the value of the sites for multiple users. In each case, newly proposed projects will require acceptance of the host site owners (e.g., MECO, KBCMH, and NELHA).

HNEI staff will also be responsible for the development and maintenance of the web-based virtual Center for data and information exchanges between domestic and international stakeholders. Appropriate data security and access levels will be established allowing broadest access to that data intended for public dissemination but also careful protection of any shared data considered confidential by our industrial partners.

As discussed in the preceding project description, four primary tasks will be undertaken by the proposed National Marine Renewable Energy Center in Hawaii to advance the commercial availability and application of marine renewable energy:

- Funding of activities that directly support our industry partners (e.g. permitting, infrastructure development) to accelerate the deployment of wave energy devices supplying electricity to the utility grid to within a 5 year time horizon; and the design and permitting of a pre-commercial OTEC plant.
- Establishment and operation of up to three permitted field test facilities for hydrokinetic systems and one for OTEC component development at various sites in Hawaii.
- The conduct of broad based research on critical issues related to performance, reliability, and environmental impacts that will complement the industry-driven commercialization projects.
- Creation and operation of a web-based virtual center to facilitate the exchange of information and data between stakeholders and to apprise the public of developments in the area of marine renewable energy conversion.

Regular stakeholder meetings will be held to promote partnering, review progress, and update objectives and strategies. Although HNEI will administer and lead the Center, we propose to create a Steering Committee comprising 3-5 impartial representatives from industry and government (with appropriate expertise), to review technical progress and to provide external oversight regarding the Center's goals, strategies, and policies. Members of this Committee will be offered travel funds to attend an annual stakeholders meeting.

During the critical 1st year, the administrative structure of the Center will be implemented and memoranda of understanding (MOUs) and intellectual property (IP) agreements with all key participants will be negotiated and executed. Preliminary work plans for the joint projects with industry will be developed and the supporting science and engineering studies by the cooperating faculty will be initiated. HNEI will work with DOE and our partners to formalize decision making and establish agreed upon procedures for conflict resolution. The virtual Center website will be designed and brought online by month 6 of Year 1.

A comprehensive review of existing permits and infrastructure will be performed for all of the proposed field test facilities. Based on this review, a development plan will be prepared for some or all of the sites. Any required permitting activities for the selected sites will commence immediately on completion of the development plan.

At the end of Year 1, the scope of the technical activities will be reviewed and refined and detailed work plans and timelines put in place for years 2-5.

A project timetable showing major administrative and technical activities and critical milestones and decision points is presented in Section 3.

2.1.3 Potential Environmental Impacts

Neither the supporting laboratory and numerical investigations that will be conducted by participating UH faculty, nor the operation of the virtual Center are anticipated to result in any significant environmental impacts. Demonstration projects, such as the Maui Oceanlinx oscillating water column facility and the OPT buoy system offshore of the Kaneohe Marine Corps Base Hawaii, as well as the in-water testing that will be conducted at those sites and at the Makai Research Pier, will be subject to thorough environmental reviews required to secure necessary permits, and to subsequent regular monitoring. On-shore OTEC component testing at NELHA (or the HECO Kahe power station) will be similar to earlier OTEC studies conducted there. The associated impacts of those studies have been documented and appropriate mitigation techniques are known.

As discussed in the preceding section, wave power devices can affect the chemistry and biogeochemistry of the surrounding marine habitat through coatings containing anti-biofouling agents or leakage of lubricants and surfactants. Nutrient-rich groundwater may be released from electrical-cable shore crossings. Cables and moorings can release particulate matter and may cause mechanical damage to the reef. The floating structures may have positive or negative impacts on a host of marine animals spanning the entire food chain. Since objects in the ocean tend to aggregate fish, problems may arise with fishermen, sports divers, and boaters if access is restricted. Visual impacts may also pose problems as may marine safety issues. Finally, in locales such as Hawaii with a large and vocal surfing community, concerns over possible changes in the near shore wave characteristics have been articulated and could prove to be a significant hurdle during the permitting process.

As discussed previously, the proposed portfolio of broad-based, complementary scientific and engineering projects places great emphasis on studies to elucidate the aforementioned impacts and to develop means and strategies to reduce or mitigate negative consequences. These investments should yield valuable information that will help advance the commercialization of hydrokinetic technologies and address concerns of the public.

A substantial portion of the Center's budget and resources, particularly in the critical early years, will be applied to secure permits and to conduct required environmental assessments of the field test sites. Center participants, particularly partners from industry, have significant experience with permitting marine facilities in Hawaii. Sea Engineering, Inc. has performed much of the environmental work for previous phases of the OPT buoy project and Planning Solutions, Inc. has been engaged to prepare the EIS for the Oceanlinx installation off Maui and to secure permits for a planned OTEC project by LM.

The Department of Business, Economic Development and Tourism of the State of Hawaii has already prepared a comprehensive roadmap for permitting wave power projects in Hawaii (DBEDT, 2006) and a similar study of federal permitting requirements is available from the Ocean Renewable Energy Coalition (OREC), an industry trade association, and can be downloaded from their website. Our permitting plans will utilize the OREC recommendations and the DBEDT roadmap. Additional considerations related to cultural issues unique to Hawaii are discussed in a report prepared by the Hawaii Energy Policy Forum (2007). Those suggestions also will be incorporated into the Center's permitting strategy. Based on Center personnel's past experiences with permitting ocean field experiments in Hawaii (e.g., de Figueiredo, 2003), we estimate, barring any major complications, that all permits and permissions to proceed can be secured during Year 2. This is shown in the project Timetable in Section 3.

Finally, we have proposed to conduct cradle-to-grave carbon footprint analyses of the devices that the Center will test. Results will allow us to confirm and quantify frequently touted benefits of these technologies with respect to greenhouse gas emissions and climate change.

2.2 Criterion 2: Demonstration/Commercialization Plan

The proposed Center will be strongly industry-driven. It will initially be anchored by two wave power demonstration projects that are expected to be delivering electricity to the local utility grid—in one case accounting for about 1% of total installed capacity—before the end of the Center's 5 year period of performance. There also exists the possibility of bringing a multi-megawatt, pre-commercial OTEC plant online within a 5-10 year time horizon by one of our industry partners (LM). Center activities will focus on facilitating demonstration and commercialization of these and other private sector projects. Evidence of commitments by industry to test and evaluate advanced marine renewable energy technologies in cooperation with the Center is provided in the attached letters of support. One of our partners, AECOM has established an entity specifically to develop third-party financing for its customers. AECOM will give the National Marine Renewable Energy Center in Hawaii access to this capability, thus offering the potential to reduce the overall cost to the Government for designing and constructing future facilities for the Center or elsewhere in the U.S.

2.2.1 Strategy

The proposed Center will serve as a hub, linking technology developers, support organizations, utility companies, government agencies, and academia. One of its primary functions will be promoting and implementing partnerships between participants that will facilitate demonstration and commercialization of marine renewable energy technologies. As noted previously, a primary task during the first year of operation of the Center will be to execute cooperative research and IP agreements between itself and industry partners. The Center will also serve as a clearinghouse that provides stakeholders with easy access to non-proprietary data and know-how.

The Hawaii field test facilities planned by the Center will offer technology developers unique opportunities to obtain standardized operational data that can be compared to a common benchmark, explore refinements to enhance performance and reliability, and demonstrate their products to potential clients. From the opposite perspective, utilities, regulatory agencies, and the public will be able to critically evaluate these technologies. The test facilities will offer access to power and instrumentation hook-ups that will provide cost benefits to users. More importantly, we will be seeking permits for facilities that will cover a wide range of possible test scenarios. In general, users may still need to undertake a certain level of permitting, but it is anticipated that this burden will be significantly reduced. A similar permitted ocean research corridor exists at NELHA on the west coast of the island of Hawaii. In order to encourage oceanographic research and the development of deep ocean water and marine resources, the state of Hawaii established an offshore research corridor that extends 10,000 ft. from the shoreline. Since the Center partnership includes substantial expertise in permitting marine facilities in Hawaii (e.g., see letter from PSI), that expertise will be fully leveraged during the permitting process.

In their letters of support, our international partners have indicated a strong interest to conduct parallel testing of devices at both the Center's facilities in Hawaii and at sites in Europe, such as Runde Island in the Norwegian Sea. This may provide opportunities to developers to secure operational and environmental data for their products under significantly different conditions. This type of information will benefit the marketing and export of technologies to a wide range of markets.

Finally, the Center will also coordinate and support a portfolio of scientific and engineering research projects that will address engineering and environmental issues of importance to commercialization. These projects have been described previously.

HNEI has past experience in managing complex private-public partnerships with challenging IP issues. For example, HNEI operates the multi-million dollar Hawaii Fuel Cell Test Facility (HFCTF) under the sponsorship of the Office of Naval Research. HFCTF was initiated as a collaboration between HNEI, UTC Fuel Cells, Inc., and the Hawaiian Electric Company. It currently has 8 state-of-the-art test stands and provides a range of fuel cell testing services to private sector clients.

HNEI has been successful in developing IP and data management plans that protect the proprietary information of our partners while maximizing public access to this information. Although not a plan element *per se*, much of our success in this area is a direct result of the trust we have been able to establish between HNEI and our industry partners. Having gained the trust of these partners, opportunities generally emerge for the dissemination of publicly funded information. Dissemination occurs at several levels with fullest disclosure between HNEI and its industrial partners, followed closely by disclosure to DOE, and finally release of non-proprietary or reformatted data to the public.

The first step of our IP management plan will be to negotiate and execute non-disclosure agreements (NDAs) between HNEI and industry partners. These NDAs will protect both sensitive corporate data and internally-developed intellectual property. This allows industry partners to be forthcoming and share information beyond that which was developed using public funds--which, in turn, will provide HNEI with a more complete understanding of the value of the publicly funded development or testing. HNEI will then help these partners prepare information for release to DOE and eventually to the public.

It is our intent, subject to any Federal restrictions, that IP developed by Center partners be retained by that partner, whether the IP comprises technical developments or data obtained from the testing of the partner's technology at the Center. Should Center personnel contribute substantially to the intellectual property, then we would expect that such IP will be shared jointly between its inventors.

We will ensure that sub-award agreements contain mutually-acceptable language governing future licensing of any jointly-developed IP. This may take the form of non-exclusive or exclusive licensing.

During the Center start-up phase, HNEI will work closely with both DOE and key private sector partners to develop a detailed plan and procedures that will protect sensitive IP while keeping as much information as possible in the public domain. Our approach will be to model this plan after those employed by other HNEI programs and facilities such as the HFCTF. Intellectual property management plans employed by other universities with similar centers will also be reviewed and, where appropriate, integrated with ours. The key private sector partners will then be consulted and the plan revised accordingly. Once consensus is reached with these partners, the plan will be submitted to DOE for review, revisions, and ratification.

2.2.2 Scale-up

As stated, the primary objective of the proposed National Marine Renewable Energy Center in Hawaii will be to facilitate the development and implementation of commercial wave energy systems that can supplement the current fossil fuel electricity base on different islands in the state of Hawaii. This is to be accomplished by emphasizing commercial-scale, at-sea testing and validation. The Oceanlinx facility in Maui will comprise several full-scale platforms and the OPT device planned for Kaneohe will also be near full size; scale up of the OPT concept requires deployment of arrays of buoys. At least two, and possibly all, of the three planned offshore wave power test facilities will be permitted to accommodate both single units and arrays. Undersea transmission cables and grid interconnects at the Maui site will be sized to handle MW levels of power.

Scale-up of prototypes may be pursued by future Center participants. In those cases, we will encourage developers to take advantage of the expertise of the participating faculty who can assist them with computer modeling and scale testing of their devices at-sea or in the available wave tanks at UH. The Makai Research Pier facility may be particularly well-suited for at-sea testing of small prototypes.

2.2.3 Dissemination of Results

Another important objective of the Center will be to serve as a clearinghouse that provides stakeholders with easy access to non-proprietary data and know-how.

Results and data will be disseminated via conventional means including reports and journal publications, as well as through a secure web-based virtual Center. The virtual Center will be operated by

HNEI and hosted on its server. Besides providing information about the Center's facilities, projects, and participants and links to related webpages, it will also maintain open and restricted forums where participants can interact with the public (open) or with other participants (restricted). Data, other results, reports, and publications will be catalogued and archived and available from a fast FTP server. We will also explore the possibility of making available feeds from video cameras deployed offshore at test facilities and real-time test data. Obviously access to this type of information may be restricted and will depend on conditions imposed by specific projects and investigators.

The Center will also assemble a database of information provided (and cleared for distribution) by Center participants in the U.S. and abroad. To the extent possible and given available resources, these data will be reviewed and, if necessary, converted to an accessible format.

Finally, the Center will host annual stakeholders meetings where participants will be encouraged to present results and participate in breakout sessions. The meetings will provide an opportunity to review progress and update the Center's agenda and strategic plans. The stakeholders meeting will not be open to the general public. Additional technical meetings and public forums may be organized depending on the availability of support and interest by the Center participants.

2.3 Criterion 3: Qualifications and Resources

This section discusses the technical and administrative qualifications of the proposers and the adequacy of available resources to operate a successful marine renewable energy research program.

2.3.1 Previous Experience

The lead organization of the National Marine Renewable Energy center in Hawaii will be the Hawaii Natural Energy Institute of UH. HNEI is a research unit and is part of the School of Ocean and Earth Science and Technology which also includes the Departments of Oceanography, Ocean and Resources Engineering, Meteorology, and Geology and Geophysics, as well as the Hawaii Institute of Geophysics and Planetology and the Hawaii Institute of Marine Biology. HNEI was established in 1974 by an Act of the Hawaii State Legislature in response to the oils shocks of the 1970's with a mandate to help reduce the state's dependency on imported oil. For over 30 years, HNEI has pursued research and promoted commercialization of renewable energy including solar, biomass, geothermal, ocean, and wind.

Since 2002, HNEI has actively engaged in the development of public-private partnerships focused on the validation of emerging technologies and/or programs directed toward facilitating greater penetration of available renewable energy technologies into the grid. These include the Hawaii Hydrogen Power Park, a partnership which includes 3 federal agencies and more than 6 companies to demonstrate clean hydrogen-fueled vehicles to support Advanced Clean Transportation for the National Park Service. HNEI also manages the Hawaii Distributed Technologies for Energy Security program, a partnership involving DOE, the State of Hawaii, GE Global Research Center, and the local utility which is funding the grid modeling efforts relevant to section 2.1.2 of this work. Future phases of this program will focus on the development of partnerships to facilitate increased penetration of renewable energy technologies into the power grid. Most recently, HNEI was the recipient of a $15 million award ($8 million in cost share from industry) to reduce peak congestion in the MECO grid system. Similar to the effort proposed here, this project includes energy technology companies (UPC Wind and a yet unnamed energy storage company) and the local utility.

In 2006, the Hawaii State Legislature established HNEI in statute and expanded its mission to include efforts to facilitate the deployment and validation of near-term pre-commercial technologies to help accelerate commercialization. HNEI is currently completing negotiations with the State to manage efforts within the State to develop a comprehensive biofuels master plan. Although not ocean-energy related, the management team and processes put in place for these public-private partnerships will enable HNEI to

effectively and efficiently work with our industry partners to accelerate the deployment of ocean energy technologies. HNEI also has in-house expertise in this area. Richard Rocheleau, the PI, while not practicing, has an M.S. degree in Ocean Engineering. The other key members of the HNEI management team, Stephen Masutani, and Gérard Nihous, have extensive experience in marine renewable energy systems. Although housed in SOEST, HNEI works closely with the UH College of Engineering. Drs. Rocheleau and Masutani hold graduate faculty appointments in the College of Engineering, providing another avenue for coordination with engineering programs at UH.

2.3.2 Team Capabilities

We have assembled a critical mass of participants from the private sector, academia, government, and NGOs to advance new technologies to commercialization. The participants provide a broad range of expertise in areas including engineering, environmental sciences, public policy, and business. Our partners from industry have an established record of technical success and innovation with power generation systems and renewable energy. Letters of commitment or support have been received from the Maui Electric Company, Hawaiian Electric Company, Ocean Power Technologies, Lockheed-Martin, AECOM, CIIIS, LLC, SwellGen, Sea Engineering, Inc., Planning Solutions, Inc., and the State of Hawaii Department of Business, Economic Development and Tourism. International participants will include the Norwegian Institute for Water Research and the Runde Environmental Centre from Norway, the Club des Argonautes from France, and the UK SuperGen Marine Energy Research Centre from the United Kingdom. The attached letters provide background on the companies and organizations that will be part of the Hawaii Center. In addition, letters of endorsement from the Office of Naval Research, Kaneohe Marine Corps Base Hawaii, and the Governor of the State of Hawaii have been included to offer additional evidence of the credibility of the proposers.

Curricula vitae of the participating UH faculty and key members of the other partner organizations are appended. These résumés provide the requested information on the credentials, qualifications, and experience of these personnel in areas of importance to the Center. Many of the team members have worked successfully with each other on past and ongoing projects. These established relationships will be of benefit to the Center.

2.3.3 Facilities

We will leverage existing and planned infrastructure for the Maui Oceanlinx project and the OPT demonstration tests offshore of KMCBH. The attached letters of support from MECO, OPT, and KMCBH are offered as evidence that the Center will have access to these sites. The Makai Research Pier is owned and operated by the State of Hawaii. Tenants of the Makai Pier are Center partners and one of them, the Hawaii Undersea Research Laboratory of UH, has offered the use of its facilities for Center activities. Rent paid (non-federal funds) by HURL for space at the pier is part of the cost share commitment. As indicated in the submitted project budget, a portion of the funding awarded to the Center will be applied to install power and instrumentation hook-ups at the Makai Pier for offshore testing.

Laboratory facilities at UH that will be available to conduct the supporting science and engineering studies have been described in Section 2.1.1. These facilities include two water tunnels and wave generators and a 3-D LDV and 3-D PIV at the Hydraulics Laboratory of the Department of Civil and Environmental Engineering, as well as the state-of-the-art Hawaii Corrosion Laboratory and equipment to synthesize protective ceramer coatings, at the Department of Mechanical Engineering. Computer facilities and codes to analyze wave-structure interactions, wave prediction models, GCMs, and ROMS which are available at SOEST will be used in the numerical studies. UH also can provide a host of oceanographic test equipment, analytical services, and information resources.

2.3.4 Partnership Commitments

Approximately $1,000,000/year of cost share has been committed and more is anticipated from industry once the Center is established. As evidence of the level of industry involvement, MECO is providing $1.7 million over 5 years in the form of infrastructure and technical support for the Maui test facility and HECO and AECOM are providing $250,000 and $500,000, respectively, in support services. As indicated in their letter, Lockheed-Martin was unable to secure internal approvals for cost share before the proposal deadline, but expects to be able to do so. OPT also is expected to provide funding support to the Center for future testing at KMCBH.

UH is offering $2 million over 5 years as cost share. This amount includes faculty salaries, rent for space at the HURL facility on the Makai Research Pier, and State of Hawaii-funding for upgrades and operation of Hydraulics Laboratory equipment that will be used in this project. The Department of Business, Economic Development and Tourism of the State of Hawaii has committed funds for a position to assist with permitting and other regulatory issues.

Letters of commitment for cost-sharing from the non-UH partners are attached to this proposal. Letters of support from industry partners who are not offering a cost share at this time are provided as well. Letter of support from international organizations indicating an intent to test devices at the Center also are attached, along with letters of endorsement from the Office of Naval Research, the Governor of the State of Hawaii, and KMCBH.

3 PROJECT TIMETABLE

Figure 2, attached at the end of this narrative, presents the project timetable and indicates the duration of major tasks and project milestones (shown as diamonds). The tasks have been discussed previously in the Project Description and Implementation Plan sections. During the first year, effort and resources will focus on executing cooperative research agreements with industry partners and IP agreements with all parties; bringing the virtual Center online, initiating the permitting process for the field test sites, and selecting and preparing a site for OTEC component tests. The supporting science and engineering projects conducted by UH faculty, which, due to the limited space available in the figure are lumped under one Task (No. 31) will be initiated immediately upon receiving the award and will continue throughout the 5 year period of performance. We anticipate completing the permitting for the field test sites during Year 2 and to commence all field tests projects by the summer or fall of 2010. The schedule for offshore installation of devices must be coordinated with the developers and will depend on sea and weather conditions. On the northern coasts of the Hawaiian Islands, good sea conditions (for towing and deployment) generally prevail during the period between late spring and early fall.

Figure 2 does not show the regular stakeholders meetings which we plan to hold on an annual basis, probably just before the end of the federal fiscal year. The figure also does not include the Center reviews and decision points by DOE after the end of Years 1 and 3.

4 REFERENCES

Acuna, N., B. O. Ortega-Morales and A. Valadez-Gonzalez. 2006. Biofilm colonization dynamics and its influence on the corrosion resistance of austenitic UNSS31603 stainless steel exposed to Gulf of Mexico seawater. *Marine Biotechnology* **8**, 62-70.

Al-Darbi, M. M., Z. M. Muntasser, M. Tango and M. R. Islam. 2002. Control of microbial corrosion using coatings and natural additives. *Energy Sources* **24**, 1009-1018.

Aleman, C., C. Ocampo, E. Armelin, D. Curco, J. Casanovas and F. Liesa. 2006. Conducting polymers: Influence on the anticorrosive properties of marine paints. *Ciencias Marinas* **32**, 361-368.

Bermont-Bouis, D., M. Janvier, P. A. D. Grimont, I. Dupont and T. Vallaeys. 2007. Both sulfate-reducing bacteria and Enterobacteriaceae take part in marine biocorrosion of carbon steel. *Journal of Applied Microbiology* **102**, 161-168.

DBEDT, State of Hawaii. 2006. Summary of permits which may apply to wave power projects in the state of Hawaii, draft report available online at http://hawaii.gov/dbedt/info/energy/publications/oceanpermitsummwithmapsOct2006.pdf

de Figueiredo, 2003. The Hawaii carbon dioxide ocean sequestration field experiment: a case study in public perceptions and institutional effectiveness. M.S. Thesis. Massachusetts Institute of Technology, 232 pp.

EPRI. 2004. E21 EPRI survey and characterization of potential offshore wave energy sites in Hawaii. 87 pp. (http://oceanenergy.epri.com/attachments/wave/reports/003_Hawaii_Site_Report_Rev_1.pdf).

Fenchel, T. 2002. Microbial behavior in a heterogeneous world. *Science* **296**, 1068-1071.

Hawaii Energy Policy Forum. 2007. Ocean energy development guidelines. Meeting report available online at http://hawaiienergypolicy.hawaii.edu/PDF/Reports/OEG1.pdf

Hihara, L. H., R. T. Zanowicz, et al. 2008. The Army's Pacific Rim Environmental Degradation of Materials Research Program. AMMTIAC Quarterly **2,** 3-7.

Kaya, M.H., M. Anderson and A.T. Gill. 2008. The Hawaii wave energy opportunity. In *Proc. 7th European Wave and Tidal Energy Conference*, in press.

Lechevallier, M. W., C. D. Cawthon and R. G. Lee. 1988. Inactivation of biofilm bacteria. *Applied and Environmental Microbiology* **54**, 2492-2499.

Nihous, G.C. 2005. An order-of-magnitude estimate of ocean thermal energy conversion resources. *Journal of Energy Resources Technology*, **127**(4), 328-333.

Nihous, G.C. 2006. Near-field evaluation of artificial upwelling concepts for open-ocean oligotrophic conditions. *Journal of Marine Environmental Engineering* **8**(3), 225-246.

Nihous, G.C. 2007a. Far-field evaluation of a Lagrangian artificial upwelling concept," *Journal of Marine Environmental Engineering* **9**, 17-35.

Nihous, G.C. 2007b. A preliminary assessment of ocean thermal energy conversion (OTEC) resources. *Journal of Energy Resources Technology* **129**(1), 10-17.

Nihous, G.C. 2007c. An estimate of Atlantic ocean thermal energy conversion (OTEC) resources. *Journal of Ocean Engineering* **34**, 2210-2221.

Quinby-Hunt, M.S., D. Sloan and P. Wild. 1987. Potential environmental impacts of closed-cycle ocean thermal energy conversion. *Environ. Impact Assess. Rev.* **7**, 169-198.

SEASUN Power Systems. 1992. Wave energy resource and economic assessment for the State of Hawaii. Report prepared for State of Hawaii Dept. of Business, Economic Development and Tourism (report available online at http://hawaii.gov/dbedt/info/energy/publications/wave92.pdf).

Sansone, F.J. and T.J. Kearney. 1984. Unusual chlorine kinetics of tropical seawater, and the potential environmental effects. In: *Proc. of the Pacific Congress on Marine Technology*, Marine Technology Society, Honolulu, HI. pp. MRM2/35-39.

Sansone, F.J. and T.J. Kearney. 1985. Chlorination kinetics of surface and deep tropical seawater. In: Water Chlorination: Environmental Impact and Health Effects, Vol. 5, Chap. 60; R.L. Jolley *et al*., Eds. 755-762.

Sansone, F.J. and S.V. Smith. 1986. Environmental effects of open-cycle OTEC. In: *Proc. of the Advanced OTEC Project Workshop*, Pacific Center for High Technology Research, Honolulu, HI. pp. 57-69.

Scotto, V., G. Alabiso and G. Marcenaro. 1986. An Example of microbiologically influenced corrosion - the behavior of stainless steels in natural seawater. *Bioelectroch Bioener* **16,** 347-355.

Tsai, Y. P., T. Y. Pai, J. Y. Hsin and T. J. Wan**.** 2003. Biofilm bacteria inactivation by citric acid and resuspension evaluations for drinking water production systems. *Water Science and Technology* **48,** 463-472.

Videla, H. A. and L. K. Herrera. 2005. Microbiologically influenced corrosion: looking to the future. *International Microbiology* **8,** 169-180.

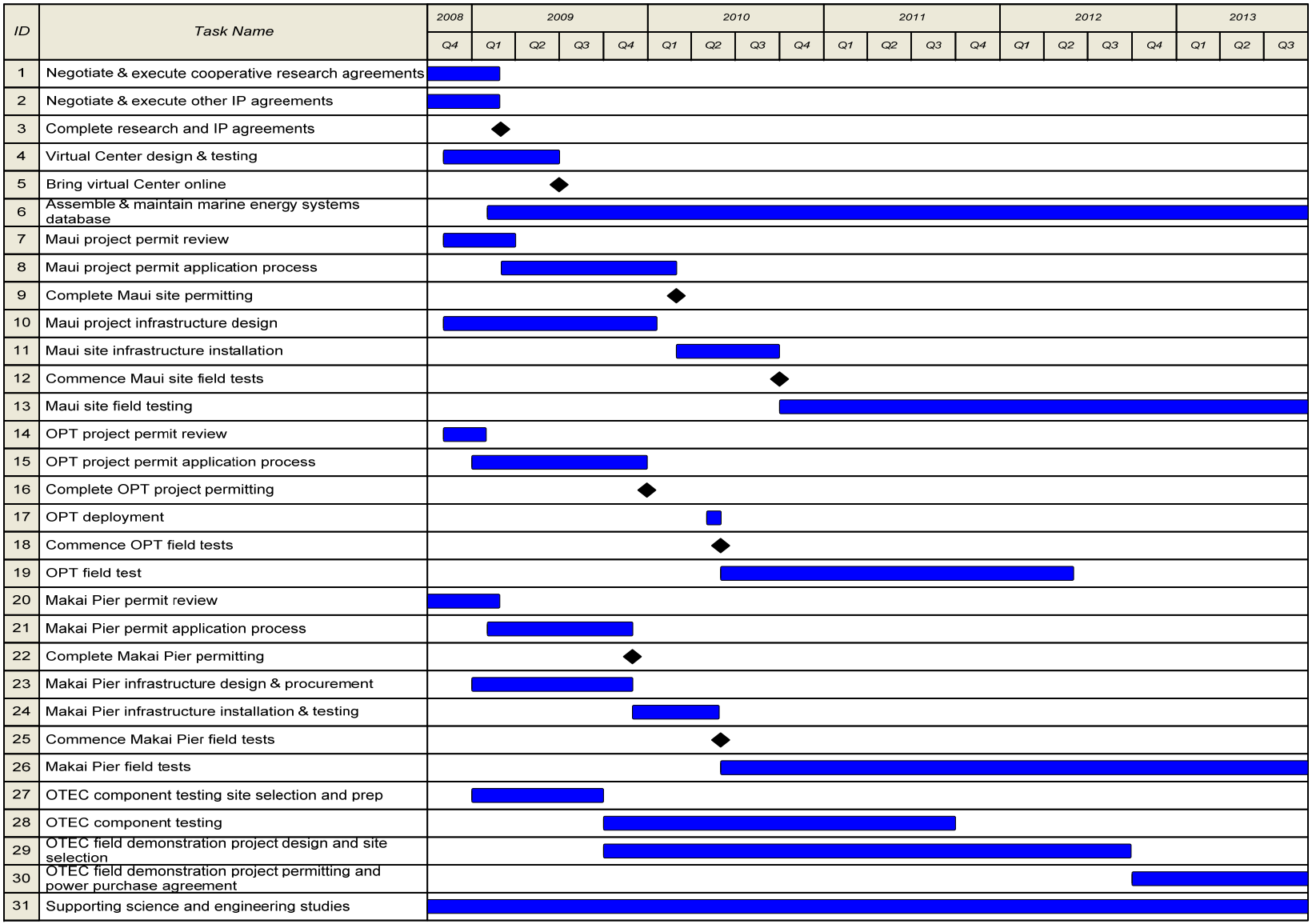


Figure 2. Project timetable.

5 APPENDIX A, LETTERS

EXECUTIVE CHAMBERS

HONOLULU

LINDA LINGLE
GOVERNOR

June 13, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, Hawaii 96822

Dear Dr. Rocheleau:

I am extremely pleased to support the University of Hawaii's efforts to establish a National Marine Renewable Energy Center in Hawaii. In its request for proposals to establish this center, the U.S. Department of Energy noted that the facility will serve as an integrated test center to advance research, development, demonstration and commercial application of marine renewable energy.

Creating a sustainable energy future, which will rely on significantly increasing our renewable energy generation while implementing energy efficiency measures, is a major goal of my Administration. With Hawaii's superior wave energy, ocean thermal and other renewable resources, we are confident that we can create a secure and sustainable energy system to benefit our people and to serve as a model for other communities.

A few months ago, my Administration entered into a cooperative agreement, the Hawaii Clean Energy Initiative (HCEI), with the U.S. Department of Energy. HCEI's goal is to achieve 70% clean energy in Hawaii by the year 2030. The proposed U.H. National Marine Renewable Energy Center could play an instrumental role in achieving that goal.

Sincerely,

S/

LINDA LINGLE

Maui Electric Company, Ltd. • 210 West Kamehameha Avenue • PO Box 398 • Kahului, Maui, HI 96733-6898 • (808) 871-8461

Edward L. Reinhardt
President

June 4, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

Dear Dr. Rocheleau,

SUBJECT: Supporting Letter for National Marine Renewable Energy Center

Maui Electric Company, Ltd. (MECO) is pleased to become a partner with the Hawaii Natural Energy Institute (HNEI) in the University of Hawaii's (UH) National Marine Renewable Energy Center (NMREC) that UH is proposing in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary focal points of this center is to serve as an integrated, standardized test center for developers of advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy.

MECO fully supports this objective and believes that our participation can make a significant contribution toward your goals. As you know, Maui, like the rest of the Hawaiian Islands, is blessed with an excellent wave energy resource. MECO has publicly stated its intent to work with developers of advanced wave energy technology to accelerate the commercial viability of this important resource.

We welcome the opportunity to collaborate with HNEI to develop a commercial scale wave energy test bed in Maui County. Working together, I believe we can develop the infrastructure and grid interconnects that will help attract the most advanced and promising wave energy technologies such as that provided by Oceanlinx Ltd. (OLX) with whom we are already having discussions.

In addition to providing a test site for potential wave energy systems, MECO is a relatively small grid system which already incorporates substantial amounts of wind, with more proposed. This project will allow MECO, under our existing partnership with HNEI and GE Global Research Center (GE) to address the cross-fertilization and economies of scale among hydrokinetic and other renewable resources. Under this latter program, MECO, HNEI, and

GE are developing high fidelity models to characterize the economic dispatch and dynamics of the grid system with significant penetration of renewables. The addition of wave energy to this mix is an opportunity, I believe, unique to the Hawaiian Islands.

MECO's contribution to this effort will include assistance in the design, development, and deployment of cabling and grid interconnects, sharing of information on utility interconnect issues, and interaction of wave energy systems with other grid connected renewable technologies. We estimate that MECO's in-kind participation will be valued at **$ 1,700,000** over the proposed five-year lifetime of the NMREC, pursuant to a mutually acceptable binding agreement to be negotiated between MECO and UH.

Thank you for the opportunity to work with you on this exciting project.

Sincerely,

Edward L. Reinhardt

Hawaiian Electric Company, Inc. • PO Box 2750 • Honolulu, HI 96840

RECEIVED

'08 JUN 10 P3 :02

HAWAII
NATURAL ENERGY INSTITUTE
UNIVERSITY OF HAWAII

Karl Stahlkopf, PhD
Senior Vice President
Energy Solutions and
Chief Technology Officer

June 5, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

SUBJECT: Supporting Letter for National Marine Renewable Energy Center

Dear Dr. Rocheleau:

Hawaiian Electric Company (HECO) is pleased to support the Hawaii Natural Energy Institute's efforts to secure one of the National Marine Renewable Energy Center awards under the U.S. Department of Energy solicitation DE-PS36-08GO98030. HECO, through its subsidiary, Maui Electric Company, Limited (MECO), is supporting the testing of advanced wave energy technology developed by Oceanlinx. In this capacity, HECO will have rights to performance data characterizing the operation of the Oceanlinx Energy Systems. When analyzed in conjunction with real-time wave-spectra data and UH led advanced wave forecasting, these data will provide an unequaled opportunity for understanding the performance of this promising commercial scale wave energy technology.

While our subsidiary company, MECO, proposes to participate through the design, development and deployment of hardware to support testing of wave energy technologies, HECO proposes to participate through sharing of non-proprietary data and through technical assistance in analysis of promising commercial scale wave energy systems. We estimate that HECO's in-kind participation will be valued at as much as $50,000 per year.

We look forward to working with you on this exciting project.

Sincerely,

LINDA LINGLE
GOVERNOR
THEODORE E. LIU
DIRECTOR
MARK K. ANDERSON
DEPUTY DIRECTOR

DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM

No. 1 Capitol District Building, 250 South Hotel Street, 5th Floor, Honolulu, Hawaii 96813
Mailing Address: P.O. Box 2359, Honolulu, Hawaii 96804
Web site: www.hawaii.gov/dbedt

Telephone: (808) 586-2355
Fax: (808) 586-2377

June 9, 2008

Dr. Richard Rocheleau
Director
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, Hawaii 96822

SUBJECT: Supporting Letter for National Marine Renewable Energy Center Proposal

Dear Dr. Rocheleau:

DBEDT is pleased to support the Hawaii Natural Energy Institute in its efforts to develop a National Marine Renewable Energy Center as proposed by the University of Hawaii in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary purposes of this center will be to serve as an integrated, standardized test center for developers of advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy.

As you certainly know already, Hawaii currently has some of the highest energy costs in the nation and is uniquely dependent on oil for the generation of electrical power. Identifying and commercializing alternative energy technologies is absolutely critical to the future well-being of our State. This Center will be a critical infrastructure component for utilizing our State's rich natural resources of ocean energy for power research and generation.

Hawaii has been at the international forefront of ocean energy, being the premier location for ocean thermal energy conversion research and demonstration. More recently, our wave energy resources have been assessed and several companies are pursuing demonstration and commercial projects in our waters.

DBEDT intends to provide the following in support of this very important project:

- Assistance with project permitting to minimize time required from project conception to approval.
- Assistance in identifying ocean energy technology providers and attracting them to Hawaii.
- Participation/support of workshops and information exchanges.

DBEDT currently participates as a sponsor to various meetings and symposia in this field, such as the upcoming Energy Ocean 2008, that will be used not only to attract new participants but also to share lessons learned from this project. We estimate the value of the in-kind contributions associated with these activities to be between $10,000 and $30,000 per year.

As you know, energy independence for our state has been a top priority for Governor Lingle throughout her Administration, and much progress is being made. On January 28, 2008, the State of Hawaii and the U.S. Department of Energy signed a Memorandum of Understanding to establish the Hawaii Clean Energy Initiative, a long-term partnership designed to accelerate the transformation of Hawaii into one of the world's first economies based primarily on clean energy resources.

The goal of the Hawaii Clean Energy Initiative is to use energy efficiency and renewable resources – such as wind, sun, ocean, geothermal and bioenergy – to supply 70 percent or more of Hawaii's energy needs by 2030. This will reduce the State's dependence on imported oil and help bring energy price stability to Hawaii consumers. The research conducted through the proposed Center will be a key contributor to this Initiative.

This innovative, unprecedented partnership builds on the progress the State has already made to increase energy independence by decreasing Hawaii's reliance on imported oil.

We look forward to participating in and supporting this project throughout its term and working with you to ensure its success. Thank you for including us as a partner in your efforts. We look forward to working with you to make this project a success.

Sincerely,

Theodore E. Liu

AGS
1200 Summit Avenue, Suite 320, Fort Worth, Texas 76102
T 817.698.6755 F 817.698.6801 www.ags.aecom.com

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

May 30, 2008

Subject: Supporting Letter for National Marine Renewable Energy Center

Dear Dr. Rocheleau,

AECOM is pleased to have been invited to support the Hawaii Natural Energy Institute on its efforts to develop a National Marine Renewable Energy Center in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary purposes of this center is to serve as an integrated, standardized test center for developers of advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy. In addition to research and testing - the solicitation indicates DOE's special interest in collaboration with international organizations and wishes for the center to be an information clearinghouse for the marine renewable energy industry.

AECOM and the Hawaii National Energy Institute have a collaborative history of supporting one another in renewable energy efforts. Whether the issue is "global" warming, imposing caps on greenhouse gas emissions to promote conservation or the switch to nonpolluting technologies through spinning-up advances in renewable energy technologies – the breakthroughs' come from intellectual and economic investment. The differentiator of success comes from the wise integration of policy, research, investment, manufacturing and deployment of technologies that meet the need while using locally available resources. Ultimately the energy solution will come in the form of applied renewable energy technologies – derived from basic science, based on sound scientific and public policy, commercialized by industry, academia, finance and government. Such a leadership strategy for global renewable energy technologies and innovative approaches for deployment of those technologies is both a responsibility and a worthy effort for any company that leads globally in renewable energy technology deployment.

AECOM is an acknowledged global leader in infrastructure and sustainable design with projected 2008 revenues of $5.6 billion and 42,000 employees. In the most recent Engineering-News Record (2008) AECOM ranked number one in the TOP "Pure" Designers; number one among the top 20 design and engineering firms, and number three among the top 500 Design Firms in the world.

AECOM services range from infrastructure and deployment of renewable technologies; study and analysis, design, and project and program management in hydropower, wind energy, thermo acoustics, geothermal, waste-to-energy, solar power, and energy efficient "green buildings." AECOM understands the challenges, both policy and technical, in such endeavors and the value of renewable energy systems to the communities and nations that deploy them.

AECOM, brings best-in-class expertise in applying renewable energy technologies in a wide-ranging spectrum of contracts. AECOM also provides a full suite of management tools relevant to client mission, including quality, safety, and risk mitigation.

AECOM is uniquely qualified to assist you in your efforts. AECOM has offices in 600 cities and all seven continents. We believe that the proposed center in Hawaii would provide an excellent vehicle for validation of promising wave technologies. Given our Pacific Rim, Antarctic, North Sea and other extreme environment technology applications, AECOM looks forward to participating in your center through the exchange of information, assistance to identify appropriate technology and companies for future collaboration and hopefully, should the situation allow, through the joint testing of ocean energy systems.

While there may be additional investment in the future, AECOM's commitment at this time, as indicated, is through the exchange of information and technical assistance. We estimate the value of our participation would be as much as $ 100,000.00 per year.

AECOM has established an entity specifically to develop third-party financing for its customers. AECOM will give the National Marine Renewable Energy Center (NMREC) access to this capability, thus offering the potential to reduce the overall cost to the Government for designing and constructing future facilities for NMREC in Hawaii or elsewhere in the U.S. This capability, AECOM Enterprises, Inc., delivers expertise in Public Private Partnerships (PPP). Their mission is to provide primary strategic and professional services to developers, financiers, owners, and other key players in the PPP market. The unit works with developers early in the process to improve their competitiveness on projects. It also works with its strategic partner, the Meridiam Infrastructure Fund, to identify and support PPP investment opportunities. The fund is a 25-year-old private equity investment fund designed for investment purely with PPP clients.

We look forward to participating in and supporting this project throughout its term. Thank you for including us in your efforts. We look forward to working with you to make this project a success.

Sincerely

Harry Steinke
Vice President
Strategic Programs

Lockheed Martin Maritime Systems and Sensors
9500 Godwin Drive Manassas, VA 20110-4157
Telephone 703·367·2121

LOCKHEED MARTIN

June 11, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

Subject: Supporting Letter for National Marine Renewable Energy Center in Hawaii

Dear Dr. Rocheleau

Lockheed-Martin Corporation (LM) is pleased to support the Hawaii Natural Energy Institute in the University of Hawaii's (UH) proposed National Marine Renewable Energy Center in response to the U.S. Department of Energy (DoE) solicitation DE-PS36-08GO98030. We especially support one of the primary focal points of this Center to advance ocean thermal energy conversion (OTEC) systems toward commercialization.

LM currently is pursuing a program to commercialize OTEC and we believe that our participation can make a significant contribution toward your goals. We have already engaged a number of firms in Hawaii to conduct OTEC component testing and to begin preparing an EIS for deployment of a megawatt scale pilot plant OTEC facility there.

We believe a partnership between LM and your proposed Center will provide significant benefits to our program and to the OTEC community as a whole. Though our internal approval processes preclude our being able to commit to specific dollar amounts in time to meet proposal deadlines, we are planning to fund HNEI to (1) extend recent HNEI studies of global ocean thermal resource assessments, (2) support pilot plant EIS development, (3) conduct extended heat exchanger testing at NELHA beyond that being proposed in our own submittal to the DoE solicitation, and (4) support development of our pilot plant and follow on commercial plants. We will be willing to contribute to the Center's proposed OTEC development effort through technical assistance provided by our employees, capital investments for component testing, and direct funding for services provided to LM by the Center and its partners.

Thank you for the opportunity to work with you on this exciting project.

Sincerely,

Dr. Ted G. Johnson
Director of Alternative Energy

Oceanlinx Limited
ABN 85 077 104 404

The Lakes Business Park
Level 2, 2A Lord Street
Botany NSW 2019

PO Box 116
Botany NSW 1455
Australia

Telephone: +61 2 9549 6300
Facsimile: +61 2 9549 6399

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

12 June 2008

SUBJECT: Supporting Letter for National Marine Renewable Energy Center

Dear Dr. Rocheleau,

Oceanlinx Ltd. is an Australian wave energy company which develops, deploys and operates Wave Energy Converter Systems. We are pleased to be invited to participate with the Hawaii Natural Energy Institute in its efforts to develop a National Marine Renewable Energy Center in Hawaii in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary objectives of this center is to serve as an integrated, standardized test center for advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy.

As you are aware, Oceanlinx, together with Maui Electric Company, have announced plans for development of a multi-megawatt grid connected wave energy demonstration program on Maui, Hawaii. As your proposed program has been described to us, we believe that there are mutual benefits to our participation in you center. In particular, early investment by the Center to assist in environmental and permitting processes can help facilitate the project. The scientific activities associated with the center, particularly activities dealing with advanced wave forecasting and grid interconnection will be of long term value to the wave energy industry.

For our part, we are confident that Oceanlinx is the leader in commercialization of wave energy technologies. By working with the center to establish protocols and through sharing of non-proprietary performance data we believe we can help advance the center goals. Our commitment will be subject to formal agreement to be negotiated with HNEI and is initially anticipated to include participation in your workshops and the exchange of information. We are hopeful that Oceanlinx will be involved in more specific technical activities as the project evolves.

Good luck with your proposal and we look forward to the opportunity to work with you on this exciting project.

Sincerely

Stuart Bensley
CEO - Oceanlinx Ltd.

Email: info@oceanlinx.com
Web: www.oceanlinx.com

OPT
OCEAN POWER TECHNOLOGIES

Ocean Power Technologies, Inc. · 1590 Reed Road · Pennington, New Jersey 08534 USA
Phone: 609-730-0400 · Fax: 609-730-0404

June 10, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

SUBJECT: Supporting Letter for National Marine Renewable Energy Center

Dear Dr. Rocheleau:

Ocean Power Technologies (OPT), a US wave energy company incorporated in the state of Delaware, is pleased to be invited to participate with the Hawaii Natural Energy Institute in its efforts to develop a National Marine Renewable Energy Center in Hawaii in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary objectives of this center is to serve as an integrated, standardized test center for advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy.

As you aware, OPT, has completed several rounds of testing of smaller (ca. 20 kW) PowerBuoy® systems in waters directly off the Kaneohe Marine Corps Base Hawaii (KMCBH), is currently engaged in deployment of a 40 kW system and is, in fact, the only company to have deployed and tested wave energy systems of this size in Hawaii. Testing to date represents a significant investment in funding from private and Department of Defense sources. With testing of these smaller scale systems nearing completion, OPT and DOD are engaged in discussions for deployment and testing of larger energy buoys, in the 100+ kW range.

We believe that testing of these early systems in Hawaii and sharing of non-proprietary data with the Center will greatly assist UH and DOE in understanding the potential of and the remaining development needs of this technology. In addition, support to OPT from the Center will help OPT to move forward in a timely and effective manner, consistent with the Center's objective to advance research, development and demonstration to accelerate commercialization of this promising technology. In particular, assistance from the Center to accelerate OPT's permitting for deep water access at the KMCBH site and possible assistance in development of cable and interconnects will leverage expected private and DOD funding allowing deployment of these larger systems in a time-frame consistent with Center objectives.

In addition to sharing data (with appropriate protection of proprietary data and IP), OPT also looks forward to working closely with Center partners and with UH faculty to assist

in the validation of important supporting technology developments such as advanced wave forecasting, modeling, and environmental issues associated with deployment of commercial wave energy systems. We believe that OPT participation can help make a significant contribution toward your goals.

Good luck with your proposal, and we look forward to the opportunity to work with you on this exciting project.

Sincerely,

Herbert T. Nock
Vice President
Business Development and Marketing

UNITED STATES MARINE CORPS
MARINE CORPS BASE HAWAII
BOX 63002 KANEOHE BAY, HAWAII 96863-3002

IN REPLY REFER TO:
11000
LFPU/086-08ha
June 9, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

Dear Dr. Rocheleau:

SUBJECT: SUPPORTING LETTER FOR NATIONAL MARINE RENEWABLE ENERGY CENTER

Marine Corps Base (MCB) Hawaii, Kaneohe Bay, has hosted the testing of the Ocean Power Technologies (OPT) wave buoy since May 2002. We understand, that as part of the Hawaii Natural Energy Institute's proposed National Marine Renewable Energy Center in Hawaii to advance marine and hydrokinetic technologies, there is interest in further development of this site for testing of future OPT systems and other ocean power technologies that may be of interest to the Department of Defense (DOD) and which meet the objectives of (MCB) Hawaii.

(MCB) Hawaii is excited about the potential of ocean energy to help meet our nation's and DOD energy needs. Leveraging possible DOD investment with the activities of the Center to accelerate testing of larger OPT wave energy buoys and other ocean power technologies will help validate this promising source of renewable energy, and help industry to move forward more rapidly to commercialization, one of the key objectives of the Center as we understand it. (MCB) Hawaii also welcomes the opportunity to participate in the team meetings, sharing our experiences and learning about other promising technologies.

Good luck with your proposal. We look forward to the opportunity to work with you on this exciting project.

Sincerely,

G. P. SANDLIN
Lieutenant Colonel, U. S. Marine Corps
Director, Facilities Department
By direction of the Commanding Officer

Copy to: NAVFAC Pacific (PW6 - Kendall Kam)
MARFORPAC G-4

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
875 NORTH RANDOLPH STREET
SUITE 1425
ARLINGTON VA 22203-1995

IN REPLY REFER TO

9220
Ser 33/052
13 JUN 08

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

Dear Dr. Rocheleau:

The Office of Naval Research (ONR) has substantial interest in the development of ocean energy technologies and supports research and development in this area, including an on-going wave energy project by Ocean Power Technology in Hawaii. Hawaii is an optimal environment for the development, validation, and implementation of ocean energy technologies due to several factors, including excellent wave climate, resident supporting companies and infrastructure, dependence on costly imported fuel, and high concentration of DoD facilities. Furthermore, with its high electricity rates, Hawaii holds great promise in being a leader for the early commercialization of these technologies.

As defense energy security demands and conventional fuel costs continue to increase, we are seeing growing interest within ONR and across DoD in the development of alternative energy sources, and in particular in ocean energy technologies for shore-based installations. The potential to leverage our current and potential future investments with that of the Department of Energy and your private partners through the University of Hawaii's proposed National Marine Renewable Energy Center can help to accelerate progress in meeting DoD's future energy needs.

Good luck with your proposal, and I look forward to discussing topics of mutual interest in this critical area.

Sincerely,

Dr. Richard Carlin, PhD
Department Head
Sea Warfare and Weapons Department
Office of Naval Research

Sea Engineering, Inc.

Makai Research Pier • 41-305 Kalanianaole Hwy • Waimanalo, Hawaii 96795-1820
Phone: (808) 259-7966 • FAX (808) 259-8143 • E-mail: sei@seaengineering.com • Website: www.seaengineering.com

June 10, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

SUBJECT: Supporting Letter for National Marine Renewable Energy Center

Dear Dr. Rocheleau:

I am writing to confirm that Sea Engineering, a Hawaii based ocean engineering company, intends to collaborate with the University of Hawaii (UH) on the National Marine Renewable Energy Center that UH is proposing in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030.

Sea Engineering was founded in Hawaii in 1973, and specializes in ocean and coastal engineering, marine geophysical surveys, marine construction and commercial diving. Sea Engineering has played a major role in the testing of the Ocean Power Technologies wave energy conversion buoy at Kaneohe Marine Corps Base, Oahu. Our work has included site assessment, cable route surveys, installation and maintenance. We are also working with Oceanlinx, the other wave energy firm active in Hawaii. We have deployed a wave gauge at the proposed buoy site, and are completing a wave hindcast analysis to determine wave climate at the site. Recently, we completed for HECO an assessment of the potential for inflow tidal current energy in Hawaii.

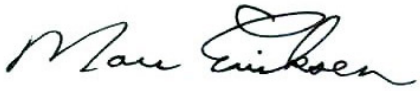
Thus, Sea Engineering is thoroughly familiar with the requirements for developing and installing ocean energy systems around the islands. For the proposed National Marine Renewable Energy Center, we would provide local expertise in site surveys, data collection to assist the permitting process, deployment, on-site maintenance, and collection of operational performance data.

Sea Engineering has a long history of working closely with the University of Hawaii, including working with faculty to address engineering and oceanographic issues, and providing vessel and diving support to various research groups. Sea Engineering is ideally located at Makai Pier in Waimanalo, on the windward side of Oahu, close to the proposed Oahu test sites allowing cost effective support for deployment and maintenance of systems.

As you are aware, Hawaii has an excellent resource for wave energy and is attracting the attention of a number of technology providers. We believe that the proposed Center will be an excellent vehicle to attract additional ocean energy companies and will help to accelerate the safe, cost effective demonstration of emerging technologies.

We look forward to actively participating in your Center by providing ocean engineering services for permitting, for the safe and timely deployment of wave energy technologies, and through the sharing of our experience in the deployment, maintenance, and operations of these systems.

Sincerely,



Marc Ericksen
Vice President, Sea Engineering, Inc.

P L A N N I N G
S O L U T I O N S

June 5, 2008

Dr. Richard Rocheleau, Director
Hawaii Natural Energy Institute
University of Hawai'i
1680 East West Road, POST 109
Honolulu, HI 96822

Dear Dr. Rocheleau:

I am writing to confirm that Planning Solutions, Inc. intends to collaborate with the University of Hawai'i (UH) on the National Marine Renewable Energy Center that UH is proposing in response to U.S. Department of Energy solicitation DE-PS36-08GO98030. A key aspect of the UH proposed project is the identification of government permitting constraints and the completion of permitting and environmental assessment plans that will be required for the commercial development of renewable energy systems in Hawai'i. As discussed below, Planning Solutions, Inc. (PSI) has extensive experience in this area.

PSI is a small business incorporated in the State of Hawai'i. Founded in 1996, its mission is to provide affordable, high-quality environmental and land use planning services. Its emphasis is on providing sound regulatory and environmental solutions for technically complex and projects in Hawai'i. PSI relies on its principals' extensive local experience and their proven ability to work with government agencies at all levels for the acquisition of discretionary permits and the resolution of potential regulatory and environmental impediments to moving projects forward.

PSI provides the most appropriate team for each project by assembling local and mainland experts to work under its direction in response to specific project requirements. By keeping our company small, we retain the flexibility to team with the best talent for particular tasks without the need to support a large, in-house staff. PSI is committed to the use of technology when it can increase efficiency and decrease costs. We keep current and proficient with GIS mapping and spatial analysis, CAD, computer graphics, and standard business office systems. We are well versed in using field techniques based on GPS, photographic, and chemical sensors. In this way, we can work efficiently and effectively with technical experts in many fields to fulfill clients' needs.

The firm's capabilities and previous projects that are most relevant to the National Marine Renewable Energy Center include are summarized below.

- *Preparing Environmental Assessments and Environmental Impact Statements*: Our staff has prepared Federal (National Environmental Policy Act) and State (Chapter 343, Hawaii Revised Statutes) environmental documentation for a wide variety of projects. These projects range from small structures occupying less than an acre to large, multi-faceted resort, residential, research, utility, and industrial facilities occupying hundreds or thousands of acres. At present we are assisting with the permitting and environmental impact assessment process for the Oceanlinx kinetic wave energy project on Maui. Other recent ocean-related projects include: (i) permitting and environmental monitoring for the Hoakalei Marina (formerly 'Ewa Marina) project on O'ahu, (ii) planning and permitting for the restoration of the Duke Kahanamoku Lagoon fronting the Hilton Hawaiian Village Hotel in Waikīkī; (iii) preparing an EIS and permit applications for the State of Hawai'i's Kalaeloa Artificial Reef project; and (iv) assisting with preliminary planning for an ocean thermal energy conversion project. We are also directing an international team that is working on behalf of the United Nations International Seabed Authority to assemble geological, biological, and oceanographic information and us it to test various hypotheses of deposit formation; the work is part of a

Ward Plaza, Suite 330 • 210 Ward Avenue • Honolulu, Hawaii 96814-4012
Phone: 808 550-4483 • Fax: 808 550-4549 • www.psi-hi.com

quantitative resource assessment of the deep seabed mineral deposits within the Clarion-Clipperton region of the Northeastern Tropical Pacific Ocean.

Preparing Land Use and Environmental Permitting Strategies: Large and technologically sophisticated or socially sensitive projects often require an array of Federal, State, and county land use approvals and environmental permits. The PSI staff is experienced at identifying these requirements, evaluating alternative strategies for obtaining needed approvals, and preparing permit acquisition plans. Directly relevant to this program, we have completed such tasks for all of the electrical utilities in the State of Hawai'i, including preliminary planning for generating system siting and assistance in obtaining approval for the projects from the Public Utilities Commission. Current and recent projects in this category include those for wind, wave, and fossil electrical energy generating facilities, and biodiesel manufacturing facilities.

- *Conducting Site Selection Studies*: PSI helps landowners, developers, utilities, and government agencies identify appropriate locations and configurations for their projects. The skills that we have developed in working on past projects ranging from energy facilities (generating stations, transmission lines, and substations) to locations for large-scale scientific experiments are applicable to the kind of effort that will be needed for the National Marine Renewable Energy Center.
- *Preparing Land Use Permit Applications*: PSI staff is conversant with State and County land use laws and regulations. It has the technical qualifications and experience to prepare successful applications.
- *Preparing Water Quality Evaluations and Discharge Permit Applications*: Staff members have evaluated existing water quality, prepared comprehensive applications for discharges of wastewater, stormwater, and fill, and coordinated the preparation and processing of applicable permits at the Federal, State, and County level.
- *Preparing Habitat Conservation Plans*: PSI has prepared Habitat Conservation Plans for species protected under the federal Endangered Species Act. While preparing these plans, it has worked in concert with Federal and State agencies to identify and develop measures that minimize and mitigate take of endangered species.
- *Developing and Applying Geographic Information Systems (GIS) & Computer-Aided Design (CAD) Technology*: PSI routinely uses GIS & CAD software for a wide variety of spatial analysis & mapping tasks.

Planning Solutions, Inc. has worked successfully in the past with faculty from UH on marine-related projects. We believe that the proposed Center will be an excellent vehicle to continue our collaborations and to promote commercialization of a host of renewable marine energy technologies that will play vital roles in providing clean energy to the residents of Hawaii and the U.S. and in future global energy scenarios. We anticipate actively participating in the critical permitting and environmental activities the Center will be pursuing.

Sincerely,

Perry J. White
President

29 Av. de la Republique
92140 Clamart France

Le 27 mai 2008

Dr. Richard Rocheleau
Director
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822
USA

Dear Dr. Rocheleau:

I am writing to confirm that the Club des Argonautes intends to facilitate the collaboration of French academic, governmental and private organizations with the University of Hawaii (UH) on the National Marine Renewable Energy Center that UH is proposing in response to U.S. Department of Energy solicitation DE-PS36-08GO98030.

The Club des Argonautes is a think tank of retired officials dedicated to the promotion of policies and technologies aimed at improving our understanding of oceanic processes, of the role of the ocean in the global climate and of the potential contributions of marine-based renewable technologies to sustainable development. The main thrust of our activities consists of public outreach and education, lobbying, and the cross-fertilization of different but synergetic fields in the marine and earth sciences.

We believe that the proposed Center will be an excellent vehicle to foster technical collaborations and to pursue international efforts to implement, safely and effectively, a host of renewable marine energy technologies that will play vital roles in future global energy scenarios. We anticipate that a number of French organizations will be interested in actively participating in your Center through the exchange of data and personnel and, hopefully, the joint testing of equipment and systems in Hawaii or France and its Territories.

With Best Regards,

Bruno Voituriez
Président du Club des Argonautes

The Blue Sky Technology Company

1960 E. Grand Avenue, Suite 1150
El Segundo, CA 90245
Tel: (310) 607-0053
Fax: (310) 607-9738

June 6, 2008

Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

SUBJECT: Supporting Letter for National Marine Renewable Energy Center

Dear Dr. Rocheleau:

CIIIS LLC would be pleased to collaborate with the Hawaii Energy Institute in the University of Hawaii's (UH) National Marine Renewable Energy Center that UH is proposing in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary focal points of this center is to serve as an integrated, standardized test center for developers of advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy. CIIIS LLC fully supports this objective and believes that our participation can make a significant contribution toward your goals.

CIIIS LLC is developing wave energy technology and is seeking sites for potential deployment and testing. If UH is successful in winning one of the DOE Marine Renewable Energy Center awards, we would welcome the opportunity to participate in the center by joint testing of equipment and systems in Hawaii and through the exchange of data with, of course, the appropriate protections for IP.

Good luck with your proposal and we look forward to the opportunity to work with you on this exciting project.

Sincerely,

Sidney C. Chao, Ph.D.
Chief Executive Officer
CIIIS LLC
Email: scchao@ciiis.com

NIVA
Norsk institutt for vannforskning

- an institute in the Environmental Research Alliance of Norway

Norwegian Institute for Water Research

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Dr. Richard Rocheleau, Director
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822, USA.

Your reference	*Your letter*	*Our reference*	*Date*
		J.No. V-064/08 *S.No. 404*	*27 May, 2008*

Supporting letter for renewable energy research

Dear Dr. Rocheleau:

I am writing to confirm that NIVA, the Norwegian Institute for Water Research, intends to collaborate with the University of Hawaii (UH) on the National Marine Renewable Energy Center that UH is proposing in response to U.S. Department of Energy solicitation DE-PS36-08GO98030.

NIVA celebrates this year it's 50ieth anniversary, still expanding on new research fields related to the use and mananagement of water sesources, fresh as well as marine. The staff now counts more than 200, of which most have an academic degree. Research into renewable energy has a long record at NIVA with hydrogen production from algae, water-based heat pump applications and ocean thermal energy (OTEC) studies, besides significant activities on hydro and now also on wave energy and osmotic power. We also put increasing focus on energy saving, both within our own premises, and also as consulting projects for customers.

Personnel at NIVA have worked successfully in the past with faculty from UH on marine-related projects. We believe that the proposed Center in Hawaii will be an excellent vehicle to continue our technical collaborations and to pursue international efforts to implement, safely and effectively, a host of renewable marine energy technologies that will play vital roles in future global energy scenarios. We anticipate actively participating in your Center through the exchange of data and personnel and, hopefully, the joint testing of equipment and systems in Hawaii or Norway.

Yours sincerely
NORWEGIAN INSTITUTE FOR WATER RESEARCH

Odd Skogheim

Odd Skogheim

e-mail: odd.skogheim@niva.no

Dr. Richard Rocheleau, Director
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822, USA

Runde Miljøsenter AS

Your reference	*Your letter/email*	*Our reference*	*Date*
	May, 2008	*J.nr. 114/08*	
Dr. Stephen Masutani		*S.nr. 27331*	*27.05.2008*

Support letter for the establishment of an Ocean Energy centre at UH

Dear Dr. Rocheleau:

I am writing to confirm that the Runde Environmental Centre (REC; Runde miljøsenter) in Norway (http://www.rundecentre.no) intends to collaborate with the University of Hawaii (UH) on the National Marine Renewable Energy Center that UH is proposing in response to U.S. Department of Energy solicitation DE-PS36-08GO98030.

REC was formally established in 2004, following 10 years of planning and preprations by the founders.The centre will be formally openned in early 2009, following completion of the the 2,200 m2/10 Mill USD new building now under construction at Runde island on the west coast of Norway.

REC has been appointed by the County to become a regional competence centre for ocean energies. In this context, international cooperation will be essential. REC welcomes the initiative to establish the new energy centre at UH, and is already preparing it's strategy with this centre in mind.

Personnel at Runde Environmental Centre have worked successfully in the past with faculty from UH on marine-related projects, including work on OTEC, Next Generation Fisheries and CO2 sequestration. We believe that the proposed Center will be an excellent vehicle to continue our technical collaborations and to pursue international efforts to implement, safely and effectively, a host of renewable marine energy technologies that will play vital roles in the future. We anticipate actively participating in your Center through the exchange of data and personnel and, also, the joint testing of energy equipment and systems in Hawaii or Norway.

Best regards
RUNDE MILJØSENTER AS

Lars G. Golmen, co-founder, chairman of the Board

lars@rundecentre.no, tel: +47 4789 0957

SwellGen
302 West Washington Avenue Suite G
Fairfield, Iowa 52556
641-209-9048

June 11, 2008

Dr. Richard Rocheleau
Director
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822
USA

Dear Dr. Rocheleau:

I am writing to confirm that SwellGen intends to collaborate with the University of Hawaii (UH) on the National Marine Renewable Energy Center that UH is proposing in response to U.S. Department of Energy solicitation DE-PS36-08GO98030.

SwellGen is a wave power company who is developing a new more efficient means of converting the energy density of waves to electricity. SwellGen is committed to using the University of Hawaii's Hawaii Natural Energy Institute to partner with us to provide wave power device testing, environmental studies, data analysis, marine engineering and more.

We believe that the proposed Center will be an excellent vehicle for collaboration with the other partners to promote commercialization of a host of renewable marine energy technologies that will play a vital role in future global energy scenarios. We anticipate actively supporting Hawaii Natural Energy Institute's role as a National Marine Renewable Energy Center and utilizing the rich resources and expertise being made available.

Sincerely,

Carl Wagener
President

9th June 2008

Institute for Energy Systems
SCHOOL *of* ENGINEERING *and* ELECTRONICS

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Dr. Richard Rocheleau
Hawaii Natural Energy Institute
University of Hawaii
1680 East West Road, POST 109
Honolulu, HI 96822

Dear Dr. Rocheleau,

Supporting Letter for National Marine Renewable Energy Center

I am Principal Investigator and Executive Director of the UK SuperGen Marine Energy Research Consortium and lead the research theme *Future Sources of Energy* within the UK Energy Research Centre. SuperGen is the flagship research initiative shaping the future of the United Kingdom's energy landscape through the development of new and improved devices for efficient and sustainable power generation and supply. The SuperGen Marine Consortium brings together staff from the Universities of Edinburgh, Queen's Belfast, Lancaster, Heriot-Watt and Strathclyde. The UK Energy Research Centre is the focal point for UK research on sustainable energy, taking an independent, whole-systems approach drawing on engineering, economics and the physical, environmental and social sciences. It has produced and maintains a Research Atlas describing UK R&D capacity, and is author of the UKERC Marine Energy Technology Roadmap that defines the necessary R&D to support the technology and sector along a deployment pathway from now to 2020. The Roadmap is being adopted by a number of UK government departments, the EU Ocean Energy Association, and in Canada. UKERC is also heavily involved in technology and policy research to accelerate development of the marine energy and other sectors.

I am writing to confirm that the SuperGen Marine Consortium and UKERC are pleased to be invited to participate with the Hawaii Natural Energy Institute in its efforts to develop a National Marine Renewable Energy Center in Hawaii in response to the U.S. Department of Energy solicitation DE-PS36-08GO98030. We understand that one of the primary objectives of the Center is to serve as an integrated, standardized test center for advanced marine and hydrokinetic technologies with the intent to advance research, development, demonstration and commercial application of marine renewable energy. In many respects these priorities align with ours and are very complementary. We believe that the proposed Center will be an excellent vehicle to foster technical collaborations and to pursue international efforts to implement, safely and effectively, a host of renewable marine energy technologies that will play vital roles in future global energy scenarios. We would expect SuperGen Marine partners and other UK organizations will be interested in working with you in the Center through the exchange of data and personnel and perhaps ultimately in the joint testing of equipment and systems in Hawaii or the UK.

Good luck with your proposal and we look forward to the opportunity to work with you on this exciting project.

Yours sincerely,

Professor A R Wallace
Head of Institute for Energy Systems

cc Prof Ian Bryden

HEAD OF SCHOOL Professor P M Grant FREng FRSE FIEE FIEEE
DIRECTOR OF RESEARCH Professor C Hall FRSC FIM
DIRECTOR OF TEACHING Dr T Bruce

CALVIN K.Y. SAY
SPEAKER

HOUSE OF REPRESENTATIVES
STATE OF HAWAII
STATE CAPITOL
HONOLULU, HAWAII 96813

June 13, 2008

Dr. Richard Rocheleau
Director, Hawaii Natural Energy Institute
1680 East West Road, POST 109
University of Hawaii at Manoa
Honolulu, Hawaii 96822

Dear Dr. Rocheleau:

In my capacity as Speaker of the House of Representatives of the State of Hawaii, I wish to express my strong support for the University of Hawaii's Hawaii Natural Energy Institute as it proposes to develop a National Marine Renewable Energy Center. Hawaii has an urgent need to attract technology industries which would create technical job opportunities and build a larger technical base for our State. The proposed Center would become a test center for various marine technologies and lead to the advancement of marine renewable energy through research, development, demonstration, and ultimate commercial applications. As such this Center would provide a hub for expansion of marine technology in Hawaii and associated economic benefits.

The National Marine Renewable Energy Center is a natural for the State of Hawaii, not only in terms of Hawaii's obvious location within the Pacific Ocean, but its ideal situation with regard to abundant renewable energy sources. Furthermore, Hawaii recently embarked on the Hawaii Clean Energy Initiative, a cooperative agreement with the U.S. Department of Energy. The proposed Center would be very useful in helping to achieve the goals of the Clean Energy Initiative.

If your efforts in establishing the proposed Center are successful, I am confident that the House of Representatives will support the project to the extent possible.

Sincerely,

Calvin K.Y. Say, Speaker
House of Representatives
State of Hawaii