Hawai'i National Marine Renewable Energy Center (HINMREC)
Quarterly Progress Report
For the period October 1 to December 31, 2011

DOE Golden Field Office

Recipient: University of Hawai'i Systems, 965088057
Award Number: DE-FG36-08GO18180
Project Title: National Marine Renewable Energy Center in Hawai'i
Project Period: 9/15/2008 – 9/14/2012

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Date of Report: February 1, 2012
Covering Period: October 1 to December 31, 2011
Report Frequency: quarterly

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Cost-Sharing Partners: University of Hawai'i (State Funds); Hawaiian Electric Company; Maui Electric Company; Department of Business Economic Development & Tourism (State of Hawaii); Ocean Power Technologies; OCEANLINX (Australia); Lockheed Martin; Energy Island Ltd. (UK)

DOE Project Team: DOE HQ Program Manager – Jose Zayas
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ACCOMPLISHMENTS

Project Objective

HINMREC was established to facilitate commercialization of Wave Energy Conversion (WEC) devices and to accelerate development and testing of Ocean Thermal Energy Conversion (OTEC) technologies. HINMREC is structured to provide engineering, science and policy support to developers by making available: resource assessments; baseline and post-test environmental studies; numerical models for analysis of device performance; and, support of permitting efforts.

Project Goals

HINMREC is collaborating with the US Navy to implement a wave-energy-test-site (WETS) in Kaneohe Marine Corps Base Hawaii (MCBH). The concept is to expand existing facilities to provide multiple-berthing for devices in the 100 to 500 kW range. WETS will allow for testing in water depths ranging from 30 m to 70 m. The vision for HINMREC consists of a fully operational WETS and continuing providing services required to evaluate WEC and OTEC designs. Major goals can be summarized as follows:

- Managing a fully operational multiple-berth WETS at the Kaneohe Marine Corps Base Hawaii by 2014 [contingent upon expanded funding from US Navy and USDOE];
- Ongoing support of the OTEC Heat Exchangers (HXs) Test Facility at the Natural Energy Laboratory of Hawaii Authority (NELHA);
- Ongoing advisory and facilitator services to developers using the UH environmental and engineering databases; numerical models; and, know-how required to evaluate OTEC and WEC concept and designs.

Goal Status

Task 1 - Project Management

HINMREC continues to nurture relationships and exchanging information with WEC and OTEC developers, the local electric utilities (Hawaiian Electric Company and Maui Electric Company) and the regulatory agencies as well as guiding UH research to address the needs of developers and designers. HINMREC has implemented MOUs and IP agreements with industrial partners (e.g., LM, OPT, OCEANLINX, OTEC International, Natural Powers) and established working relationship with federal (NOAA, FERC, BOEMRE) and state permitting and licensing agencies. All information obtained and developed is documented through the internet (http://hinmrec.hnei.hawaii.edu/).

HINMREC continues to work with NAVFAC in trying to leverage DOD and DOE funding for WETS while completing task already underway (Task 2.2).

Task 2.1 - Install a Utility Intertie WEC Device in Maui

OCEANLINX working with Maui Electric Company (MECO) and HINMREC completed the design and cost estimate of a 500 kW bottom mounted oscillating water column (OWC) system located in 10 m water depth off Pauwela, Maui.

Negotiations for the power purchase agreement and the HINMREC oceanographic work were postponed pending OCEANLINX's reevaluation of the project. The capital cost estimate including the EIS was $9M and OCEANLINX had secured their portion (> 60%) from private equity with MECO planning to provide the balance by supplying the infrastructure.

Task 2.2 - Wave Energy Test Site (WETS) at Marine Corps Base Hawaii (MCBH)

HINMREC continued working with NAVFAC-ESC to develop WETS in Kaneohe Bay MCBH. HINMREC characterized the wave energy resource at 30 and 50 m depths in the format required by WEC device designers. These include survival wave conditions. NAVFAC has funded the new EA process (Helbert Haster & Fee) that is expected to result in a FONSI in view of the environmental assessment surveys conducted in the original site since 2003. In parallel, HINMREC has used funding already available from DOE to obtain the bathymetry and ocean bottom data required to proceed beyond concept definition (Sea Engineering).

The most important challenge facing HINMREC relates to securing about $11M of funding required to implement WETS. HINMREC, working in coordination with NAVFAC, has been unable to secure funding for the final design and implementation. This situation might impact having WETS operational by 2014.

Task 2.3 - Makai Pier Site

Under the revised DOE SOPO, HINMREC was asked to concentrate on Tasks 2.1 and 2.2 and consider the Makai Pier site as an alternate. No DOE funding provided for activities at this site after September 14, 2011.

AS previously reported, HINMREC plans to provide the site for testing of emerging small scale (<10kW) WEC devices (TRL 7) using ONR funding as well as participating in the Task Force established by BOEMRE (DOI) to consider a research lease for marine renewable energy projects in the Outer Continental Shelf (3 nm to 200 nm offshore) off Makai Pier.

Task 2.4 – OTEC Heat Exchangers Test Facility at NELHA (Big Island)

HINMREC with NEPA compliance was able to issue a subcontract to Makai Ocean Engineering to incorporate aluminum corrosion testing into the HXs Test Facility.

Task 3.1 – Wave Forecasting: Hawai'i Wave Resource Assessment and Characterization

A high resolution wave prediction model has been made available. Improved accuracy of the wave forecast using high-resolution wind data is underway. The improved wave forecasting accuracy will aid deployment and operations planning. The wave energy resource has been characterized for five sites throughout the state of Hawaii in the format required by developers

to estimate electricity generation and the wave loading that devices must survive during their life cycle. The report, including 1D and 2D wave spectra, has been made available to several developers. The following developers requested wave spectra data: Carnegie Wave Energy Ltd. (Australia); Hann-Ocean Technologies (Singapore); Columbia Powers (USA); Bio Farms Hawaii (USA).

Task 3.2 Numerical Modeling

Ocean Thermal Resource Assessment and Characterization

Algorithms were implemented to extract and display field data available from assimilation models. Temperature differences ΔT between standard water depths (20 m and 1000 m) were estimated for Hawaii and worldwide.

Extractable Ocean Thermal Resource

To estimate the OTEC resource that can be extracted without affecting thermohaline circulation (the cold water source) the MIT ocean-general-circulation-model (OGCM) was modified to include sources and sinks to simulate the large-scale deployment of OTEC plants across tropical oceans. An ongoing task consists of implementing a web-based interactive atlas with thermal resource data and a thermodynamic model to provide nominal net-power output for OTEC systems deployed at a given site (longitude and latitude provided by user) for nominal parameters or user inputted parameters.

WEC Array

The modeling of an OWC Array is underway. Preliminary information of work conducted in Europe indicates that between 2.5 and 7 km^2 would be required for a 100 MW Array. To refine this model a generic array was conceived to determine spacing between devices and, therefore, ocean area requirements. The numerical model may be accessible through the Center's web-page and published as appropriate.

Coupled OTEC Plantship-Cold Water Pipe

An OTEC Plantship model is also under development. Computer models developed in the 80's under DOE/NOAA funding were identified and evaluated. Current programs are not capable of conducting hydroelasticity analysis of the vessel-platform combination for large cold-water-pipes (CWPs). The aim is to implement a PC-based computer program to determine the wave-induced hydroelastic response of moored and freely-floating OTEC platforms supporting a long large-diameter, cold-water pipe. Data available from the DOE at-sea test of a 2.4m diameter CWP will be used to calibrate the model. Executable version will be available through the web-page.

Task 3.3 - Environmental Impact Studies

The OTEC environmental baseline database, for the primary NAVFAC pilot plant site, has been documented and made available. HINMREC has been working in coordination with federal regulatory agencies (FERC, BOEMRE, and NOAA) to define differences between ocean energy systems and already established regulated industrial activities in support of the permitting process. Discharge of deep seawater below the photic zone is the OTEC differentiator; and, the effect of arrays/farms over large coastal regions (spacing and quantity) the WEC differentiator. Key oceanographic parameters to monitor during OTEC operations have been identified.

Task 3.4 - Corrosion and Biocorrosion Studies

As previously reported, work at HCL was not funded beyond September 2011. Tests underway will be completed with UH funding. Data obtained to date was incorporated into testing at the DOD sponsored OTEC Heat Exchangers Test facility at NELHA.

Plans for Next Quarter

Task 2 – Test Site Development

Pauwela, Maui: work on hold until OCEANLINX identifies additional funding to cover portion of costs that were supposed to be covered by MECO.

Kaneohe Bay: continue to support the EA process led by NAVFAC and complete bathymetric surveys while seeking funding for infrastructure acquisition and deployment in coordination with NAVFAC. The plan is to leverage DOD & DOE funding to achieve fully operational multiple-berth WETS facility in Kaneohe Bay *(TRLs 8-9)* with the following roles:

- Navy/MCBH – Provide/host test site, use/purchase power
- HINMREC – Operate & manage
- Developers – Responsible for: device, mooring, connection to socket, user fee *(plug & test)*

OTEC: Continue testing phase at OTEC HXs Facility *(TRL 5)* and continue supporting developers in design and permits phase.

Task 3 – Supporting Engineering and Research

The following work is underway and scheduled for completion by September 14, 2012:

- Implementation of web-based interactive atlas to determine OTEC plant power output for user inputted location (Long/Lat)
- Upgraded model of worldwide extractable thermal resource
- WEC array numerical modeling to estimate ocean area requirements
- PC based seakeeping and structural model of OTEC plantship with cold-water-pipe
- Conceive and document protocol for monitoring environmental impact of OTEC operations using parameters already identified
- Upgrade wave hindcast model to examine inter-annual cycles and extreme events
- Continue work with federal agencies and state energy office to streamline permitting process for ocean energy projects
- Continue providing developers with engineering and environmental tools & services required to evaluate WEC and OTEC designs

Project Schedule & Milestones Table

See page 16.

PRODUCTS / DELIVERABLES

To disseminate findings, HINMREC uses the Internet (http://hinmrec.hnei.hawaii.edu/), publishes reports and participates in appropriate conferences. The web page serves as information repository and has led to substantive working relationships with developers, NOAA, NREL, BOEM, NAVFAC, Mexico, Spain, UK, Norway, American Samoa as well as sister Centers.

The HINMREC web page was updated with information obtained under the tasks described above.

UNIVERSITY of HAWAII PARTICIPANTS

Name	Project Role	Person Month Worked	Contribution	Non-DOE Funding	Foreign Collaborators	Foreign Trips
R. Rocheleau	Principal Investigator	10% FTE	Overall guidance	100% State of Hawaii		
L. Vega	HINMREC Manager	3-months	Managed all tasks by UH and Subcontractors			
G. Nihous	Professor: Ocean Resources & Numerical Modeling	1-month	- Extractable ocean thermal resource; - WEC Array modeling	100% State of Hawaii		
K. Rajagopalan	Post-Doc under Nihous	3-months	"			
Y. Chen	Professor: Wind modeling input into wave forecasting and hindcasting model	1-month	- Generating hindcast of ocean surface winds over Hawaii; - Real-time high-resolution modeling and forecast of ocean surface winds over Hawaii in comparison with observations	100% State of Hawaii		
T. Le	GRA under Chen	1.5 months	"			

Name	Project Role	Person Month Worked	Contribution	Non-DOE Funding	Foreign Collaborators	Foreign Trips
C. Tu	GRA under Chen	2-months	"			
K. Cheung	Professor: Offshore and nearshore wave modeling	1-month	Wave hindcast modeling and statistical analysis.	100% State of Hawaii		
R. Ertekin	Professor: Hydrodynamics	1-months	Developing hydrodynamic component for model of OTEC Plantship coupled to Cold Water Pipe	100% State of Hawaii		
H. Riggs	Professor: Structural Mechanics	1-months	Structural aspects of Ertekin model	100% State of Hawaii		
A. Schwartz	GRA under Ertekin	3-months	"			
C. Comfort	GRA under Vega	3-months	Develop OTEC environmental monitoring plan			

FTE: Full Time Equivalent
GRA: Graduate Research Assistant

HINMREC Partner Organizations

(I) Lockheed Martin, Manassas, VA

OTEC Pilot Plant Design

Develop, install, and conduct a 2-year demonstration of a megawatt scale pilot OTEC plant in the state of Hawaii. The ability to seek financing for utility scale OTEC plants addressing both aggressive military renewable energy goals and commercial utility applications requires the demonstration of a significant scale pilot plant. This project brings together stakeholders and OTEC team members to address technology development & validation, environmental measurements & permitting, pilot plant fabrication & installation, and operation & maintenance for the 2-year test period. Successful test conduct leads directly to development and production of utility scale OTEC plants for military and commercial applications.

Many to-be-determines (TBDs) exist with this project. Funding availability will determine the specific configuration to be tested and the resultant test site. The baseline project is to test a 5 MW floating pilot plant offshore from Pearl Harbor. The ideal pilot plant would be similar to initial commercial configurations to reduce scale-up risks. However, the large cost of a small scale commercial configuration may result in either a smaller capacity plant or in parsing out critical demonstrations as individual projects.

Funding: $12.5 M from Department of Defense from August 2009 through December 2011.

Comments: The Lead Organization may be the US Naval Facilities Command depending upon approval of the 2012 President's Budget. Lockheed Martin will continue to seek funding to support pilot plant requirements.

(II) Makai Ocean Engineering, HI

(i) Physical and Biochemical Numerical Modeling of OTEC Plumes

Previously, Makai Ocean Engineering developed a numerical model to simulate the dynamic near and far field properties of OTEC plant discharge plumes under realistic ocean conditions. The model consists of an EPA-approved EFDC numerical domain off SW Oahu, with outer boundary conditions supplied by the NOAA-funded Hawaii Regional Ocean Model (HIROM). The combination of these models gives the ability to simulate the large OTEC intake flows, and simulate the discharge flows and plumes in a realistic oceanographic context. The model was used to investigate the sustainable operation of single and clustered OTEC plants and to quantify the resulting nitrate and nitrite nutrient distribution as a function of varying discharge configurations and representative time-varying ocean conditions. This work was completed in September 2010 and showed that that the nutrient levels are elevated but within natural variability within 880 meters downstream of a 100 MW OTEC plant. The elevated concentrations are below the photic zone. Nutrient impacts are reduced further if up-current or abeam of the plant. Temperature and oxygen variations are affected significantly less than nutrient levels.

Under current DOE funding the project adds biochemical modeling to the model described above. It will allow for quantitative analysis of how OTEC pipe discharge depths and flow rates

impact algal conditions (e.g., algal blooms) downstream of the plant. The effort also included deployment of a NavFac and Makai-funded-oceanographic sensor array off SW Oahu during May-Dec 2010 to validate the HIROM predictions at that location.

Funding: DARPA ($485 K); Lockheed Martin ($21 K); DOE ($240 K); and Makai Ocean Eng. ($140 K) from 9/09 through 2/12.

(ii) OTEC Heat Exchangers Test Facility
Makai Ocean Engineering, Inc. has designed and constructed a 40'-tall OTEC facility at the Natural Energy Laboratory of Hawaii Authority (NELHA) near Kona, Hawaii. The facility can operate with warm (26°C) and cold (6°C) seawater flows of up to 6000 gpm each, in order to test candidate closed cycle OTEC heat exchangers using ammonia. The system is large enough and flexible enough to test up to three condensers and three evaporators. Construction of the facility is complete. Essentially, the facility is a complete 100 kW OTEC plant, except that it lacks a turbine-generator.

Currently a HXs designed by Lockheed Martin and CHART are under testing. In addition to testing the performance of heat exchangers, corrosion samples of various alloys and fabrications are being tested in coordination with HINMREC using NELHA seawater from 914 m deep, 620 m deep, and 20 m deep.

Funding: ONR/HNEI ($4 M); and, NAVFAC ($1.7 M) from 9/08 through 12/11.

(III) OCEANLINX, Sydney, Australia
Wave Energy Project in Pauwela Maui
Oceanlinx, an Australian company developing a technology to convert the energy in ocean waves into electricity, is in the process of developing an installing a project off the north coast of Maui. The project is planned to have a peak installed capacity of 500 kW. It will be situated approximately 200 meters north of Pauwela Point, which itself is several miles east of the main Maui airport at Kahului. The project is being developed in collaboration with Maui Electric Company (MECO) and HINMREC. Electricity from the project will be fed directly in to the MECO grid.

The project's completion date is heavily dependent on permitting activities and the approval of expenditures by MECO by the Public Utilities Commission (PUC). Once permits and approvals are granted, it is expected the project construction and commissioning timeframe will be about one year. Initial activities include bathymetric and geotechnical studies by HINMREC, along with environmental and permitting tasks.

Funding: Private Equity (Proprietary) and MECO (TBD) with bathymetric surveys by HINMREC through DOE funding.

(IV) Ocean Power Technologies, NJ

40 kW PowerBuoy at Marine Corps Base Hawaii (MCBH), Kaneohe Bay, Oahu

Three OPT PowerBuoys have been ocean tested since 2002 as part of this ongoing program with the US Navy to develop and test the OPT's PowerBuoy wave energy technology. The current PowerBuoy was deployed on December 14, 2009 approximately three-quarters of a mile off the coast of MCBH in water depth of 100 feet.

The project began as a Small Business Innovation Research (SBIR) program at the Office of Naval Research (ONR). Key program goals include demonstrating system reliability and survivability, and the successful interconnection with the grid serving MCBH. In September 2010 Ocean Power Technologies, Inc. announced that it completed the first-ever grid connection of a wave energy device in the United States at the MCBH in conjunction with the US Navy. This connection demonstrates the ability of OPT's PowerBuoy systems to produce utility-grade, renewable energy that can be transmitted to the grid in a manner fully compliant with national and international standards.

The PowerBuoy grid interface was certified in 2007 by an independent laboratory, Intertek Testing Services, as compliant with national and international standards, including the safety standards UL1741 and IEEE1547, and also bears the ETL Listed mark. The wave power project at MCBH underwent an extensive environmental assessment by an independent environmental firm in accordance with the National Environment Policy Act (NEPA) that resulted in a Finding of No Significant Impact (FONSI). The FONSI is the highest rating assigned. The project has utilized local Hawaiian subcontractors, including Sea Engineering Inc. for the installation, test and servicing of the systems.

Funding: Funded by the US Navy from September 2001 through December 2011.

Comments: The system has numerous on-board sensors that monitor a wide variety of system performance variables, external conditions and lifecycle parameters. Data collected by on-board computers is transmitted to a shore-based facility via a fiber optic cable embedded in the submarine power transmission cable and then transmitted via the Internet to OPT's facility in Pennington, New Jersey. The Company's engineers have collated much of this data and compared it to OPT's proprietary models which analyze the performance given actual in-coming wave conditions. This information has provided a strong correlation between the 'actual' and 'expected' system performance, which serves to confirm OPT's models for its higher output PowerBuoys, including the PB150, 150 kW units to be deployed in Reedsport, OR.

(V) Natural Power Concepts, HI

Articulated Wave Energy Conversion Buoy Array

Natural Powers Concepts' (NPC) "Buoy Grid" is an articulating hydrokinetic ocean buoy array featuring a simple, mechanical power take-off approach and a unique array management structure. NPC has developed initial proof-of-concept prototypes and is engaged in planning, development, and component testing efforts. NPC intends to work with the Hawaii Natural Energy Institute (HNEI) and the Hawaii National Marine Renewable Energy Center (HINMREC) to advance the design and optimization of primary Buoy Grid components as far as possible, paving the way for further sub-scale prototype development and testing. Pending successful completion of these objectives, NPC plans to continue construction of a fully functional ¼ scale prototype, and utilize HINMREC sites for wet-testing the system in the future.

Funding: Proprietary

Comments: NPC and its teaming partners will utilize rapid-prototyping methods to develop the ¼ scale physical model of the primary component of the proposed Articulating Buoy Array; a point-absorbing buoy system that employs an externally mounted, above-water generator that is turned by rotational torque developed through a mechanical system capturing surface wave activity. NPC will also engage in additional R&D to explore other buoy designs and power take-off approaches.

CHANGES / PROBLEMS

The most important challenge facing HINMREC continues to be securing about $11M of funding required to implement WETS in Kaneohe Bay. NAVFAC has funded the new EA process that is expected to result in a FONSI in view of the environmental assessment surveys conducted in the original site since 2003. In parallel, HINMREC has used funding already available from DOE to obtain the bathymetry and ocean bottom data required to proceed beyond concept definition. HINMREC, working in coordination with NAVFAC, has been unable to secure funding for the final design and implementation. This situation might impact having WETS operational by 2014.

Interactions with developers indicate that they tend to be extremely enthusiastic but often inexperienced and undercapitalized. They perceive their major challenges as follows: Federal funding available is not sufficient to support pre-commercial in-water testing and advance beyond TRL 6; and, the permitting and licensing process is cumbersome and time consuming due to the absence of a coordinated-all-inclusive-one-stop shop. WEC developers have indicated that to achieve TRLs 8 and 9 they need a location to perform in-water prototype testing with units reasonably sized at no more than about 500 kW. This is one of the major barriers they face in their path to commercialization.

As previously reported work beyond September 2011 in the area of small scale tests of prototype devices in the UH Wave-Tanks was discontinued because it was determined that our sister organization at OSU as well as the US Naval Academy have superior and larger facilities. This action will not impact progress. Experiments were already conducted at UH under different wave conditions to examine single devices and series of devices arranged in different patterns. The information will be made available to developers and in a report posted in the HINMREC web page.

In addition, work underway at the UH Hawaii Corrosion Laboratory (HCL) was not funded beyond September 2011. Instead, data obtained to date will be incorporated into testing underway at the DOD sponsored OTEC Heat Exchangers Test facility at NELHA. This action will not impact progress.

IMPACT

HINMREC facilitates communicating between developers and academia to ensure the usefulness of the research as well as with utilities to ensure compatibility of purpose. The approach followed encompasses developing a concept to implement a wave-energy-test-site (WETS) at Kaneohe Bay that would be available for developers to "plug & play" and supporting tests at the OTEC HXs facility. What is unique about this approach is that expanding or maintaining existing facilities is expedient and cost effective compared to developing new sites. The eventual implementation of WETS will provide the facility required in the USA for developers to reach TRLs 8 and 9 leading to the commercialization of WEC systems. The availability of the OTEC HXs Facility allows for the testing of innovative designs as well as the characterization of compact aluminum HX modules.

HINMREC also provides tools consisting of numerical models and databases as well as design advice and inputs to environmental impact studies that will be required to obtain licenses and permits. HINMREC is developing an improved Hawaii wave forecast model as input to deployment planning and operations of WEC devices.

BUDGETARY INFORMATION

Spending Summary Table: see page 17

Cost Share Contributions Table: see page 18

Spend Plan Data Table: see page 19

Project Schedule & Milestones						DE-FG36-08GO18180
SOPO Task Number	Title / Task Description	Task Completion Date				Progress Notes
		Original Planned	Revised Planned	Actual	Percent Complete	
1.0	Project Management	NA	NA	NA	NA	Ongoing work
2.1	Maui Site: OCEANLINX WEC device operational	12/2012	12/2013	TBD	20%	Design available but non-DOE funding questionable due to PUC ruling
2.2	MCBH (Kaneohe Bay) Wave -Hub	09/2014	09/2014		25%	Concept available, bathymetry work 100% completed and EA underway. Funding for final design, infrastructure , acquisition and installation currently not available
2.3	Makai Pier protected water WEC testing	NA	NA	NA	NA	Per SOPO modification site held as alternate with no further DOE funding
2.4	OTEC Facility (Big Island)	09/2014	09/2014		5%	Ongoing testing with non –DOE funds. With NEPA compliance obtained 3/11 DOE work planned to begin next quarter
3.1	Advanced Wave Forecasting	09/2012	09/2012		80%	Work on schedule to be completed as planned
3.2 a	Numerical Modeling	09/2012	09/2012		60%	Encompasses several models
3.2 b	Wave Tank Tests	09/2012	09/2011	09/2011	NA	Work discontinued after 09/2011
3.3	Environmental Studies	09/2012	09/2012		50%	Work on schedule to be completed as planned
3.4	Corrosion and Biocorrosion	09/2012	09/2011	09/2011	NA	DOE sponsored work t UH discontinued after 09/2011

Spending Summary DE-FG36-08GO18180			FROM	TO
		Project Period	10/01/2011	12/31/2011
		Current Quarter		
Object Class Categories (SF424a)	Approved Budget	Project Expenditures		
		This Quarter	Cumulative to Date	Est. Costs Next Quarter
a. Personnel	**$1,806,200**	$114,007	$831,545	$120,000
b. Fringe	**$427,907**	$15,691	$116,444	$16,000
c. Travel	**$45,750**	$5,225	$47,584	$6,000
d. Equipment	**$650,000**	$5,490	$46,930	$5,000
e. Supplies	**$115,000**	$3,241	$23,740	$3,500
f. Contractual	**$790,000**	$112,853	$144,723	$150,000
g. Construction	**$0**	$0	$0	$0
h. Other (Cost Share)	**$2,095,000**	$156,591	$1,679,202	$1,019,000
i. Total Direct Charges	**$5,929,857**	$423,098	$2,890,168	$1,319,500
j. Indirect Charges	**$706,078**	$37,842	$330,112	$37,000
k. Totals (i+j)	**$6,635,935**	$460,940	$3,220,280	$1,356,500
DOE Share	**$3,311,414**	$305,527	$1,561,707	$365,500
Recipient Cost Share	**$3,324,521**	$155,413	$1,658,573	$1,000,000
Cost Share Percentage	**50.10**	33.7	51.5	73.7

Cost Share Contributions					**DE-FG36-08GO18180**	
Funding Source	**Approved Cost Share**		**This Quarter**		**Cumulative to Date**	
	Cash	**In-Kind**	**Cash**	**In-Kind**	**Cash**	**In-Kind**
University of Hawai'i		$3,324,521		$155,413		$1, 658,573
TOTAL	$0	$3,324,521	$0	$155,413	$0	$1, 658,573
Total Cumulative Cost Share Contributions					$1, 658,573	

Spend Plan Data						DE-FG-08GO18180	
Column A	*Column B*	*Column C*	*Column D*	*Column E*	*Column F*	*Column G*	*Column H*
Quarter	**From (mm/dd/yy)**	**To (mm/dd/yy)**	**Est. Federal Share**	**Actual Federal Share**	**Est. Recipient Share**	**Actual Recipient Share**	**Actual Total (E+G)**
Q1	10/01/08	12/31/08		$0		$0	$0
Q2	01/01/09	3/31/09		$0		$0	$0
Q3	04/01/09	6/30/09		$10,657		$97,995	$108,652
Q4	07/01/09	9/30/09		$124,216		$75,846	$200,062
Q5	10/01/09	12/31/09		$145,406		($855)	$144,551
Q6	01/01/10	3/31/10		$65,195		$982,283	$1,047,478
Q7	04/01/10	6/30/10		$95,032		$32,697	$127,729
Q8	07/01/10	9/30/10		$129,791		$0	$129,791
Q9	10/01/10	12/31/10		75,795		$0	$75,795
Q10	01/01/11	3/31/11		$169,365		$19,346	$188,711
Q11	04/01/11	6/30/11		$240,265		$41161	$281,426
Q12	07/01/11	9/30/11		$202,458		$254,687	$457,145
Q13	10/01/11	12/31/11		$303,527		$155,413	$458,940
Q14	01/01/12	3/31/12	$600,000		$555,316		
Q15	04/01/12	6/30/12	$620,000		$555,316		
Q16	07/01/12	9/30/12	$529,707		$555,316		
Totals			$3,311,414	$1,561,707	$3,324,521	$1,658,573	$3,220,280