

# **FINAL TECHNICAL REPORT**

## **Executive Summary**

### **Asia Pacific Research Initiative for Sustainable Energy Systems**

**Office of Naval Research**

**Grant Award Number N00014-12-1-0496**

**For the period May 1, 2012 to June 30, 2017**



**HNEI**

**Hawai'i Natural Energy Institute**

University of Hawai'i at Mānoa

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**Final Technical Report**  
**Asia Pacific Research Initiative for Sustainable Energy Systems**  
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## **EXECUTIVE SUMMARY**

This report summarizes work conducted under Grant Award Number N00014-12-1-0496, the Asia Pacific Research Initiative for Sustainable Energy Systems 2011 (APRISES11), , funded by the Office of Naval Research (ONR) to the Hawaii Natural Energy Institute (HNEI) of the University of Hawaii at Manoa (UH). The overall objective of the APRISES11 effort was to develop, test, and evaluate distributed energy systems using Hawaii as a model to address integration of emerging technologies in Hawaii and throughout the Pacific Region. APRISES11 encompassed fuel cell testing and evaluation including technologies developed at the Naval Research Laboratory (NRL); synthetic fuels processing and production to accelerate the use of liquid biofuels for Navy needs; the extraction and stability of seabed methane hydrates; and alternative energy systems for electric power generation, energy efficiency, and secure-smart microgrids. Testing and evaluation of alternative energy systems includes work on Ocean Thermal Energy Conversion (OTEC), grid-scale battery energy storage, support for hydrogen fuel operations at the Marine Corps Base Hawaii and on the Island of Hawaii, building energy efficiency test platforms, end-use high value energy efficiency technologies, and development of several microgrid test projects

Under Task 1, Program Management, HNEI managed the program, developed and monitored partner and subcontract agreements, and developed outreach materials for both technical and non-technical audiences. HNEI continued to collaborate closely with ONR and NRL to identify high-priority areas requiring further detailed evaluation and analysis.

Under Task 2, Fuel Cell Systems, , HNEI conducted testing and evaluation of single cells, stacks and balance of plant components to support NRL efforts to develop fuel cell powered UAVs; to improve understanding of contamination mechanisms, assess the tolerance of alternate catalysts to contaminants, and, development of contaminant mitigation techniques. Support to NRL including validation of the impedance-based NRL battery state of health diagnostic method with a battery pack. Under Task 2, HNEI also designed, built and commissioned an air filter test station that is being used to test and evaluate filtration materials and designs for fuel cell demonstration buses in the harsh atmosphere of Hawaii Volcanoes National Park.

Efforts under Task 3, Alternative Fuels, focused on the development, testing and evaluation of alternative fuels and technologies included activities in the areas of Methane Hydrates, Technology for Synthetic Fuels Production, Sustainable Biomass, Low-cost Material for Solar Fuels Production, and Hydrogen Fuel Production. Methane hydrates efforts focused on hydrate stability and related environmental issues; hydrogen fuel storage in binary hydrates; and promoting international research collaborations. Technology for Synthetic Fuels Production included efforts in Hydrogen Production for Fuel Cell Applications, Evaluation of Second Generation Biofuels, Novel Solvent Based Extraction of Bio-oils and Protein from Oil-Bearing Biomass, Biochemical Conversion of Synthesis Gas into Liquid Fuels, Bio-contamination of Fuels, Biofuel Corrosion Control, and Waste Management Using the Flash-Carbonization<sup>TM</sup> Process.

Task 4, Ocean Energy work included continued development and testing of cost effective heat exchangers for Ocean Thermal Energy Conversion (OTEC) under a subaward to Makai Ocean Engineering; and technology support of wave energy testing at the Navy's Wave Energy Test Site (WETS), off Marine Corps Base Hawaii (MCBH).

The objective of Task 5, Geothermal Resource Assessment, was to perform preliminary surveys on DOD lands in Hawaii to assess their potential for hosting a geothermal resource, using audio-magnetotelluric survey methods.

Task 6, Microgrids/Grid Integration included efforts on developing Solar Hydrogen at Marine Corps Base Hawaii, a range of projects to develop, test and evaluate cost effective Secure Microgrids along with the enabling technology, and Grid Integration at a Community College, focused on integration of renewable energy generation and related technologies.

Task 7 comprised three projects relating to Energy Efficiency in buildings. This instrumenting and monitoring zero energy research platforms and existing, conventional classrooms to determine comparative performance in energy, indoor environmental quality, and comfort. Desiccant dehumidification was examined as a means to improve comfort at lower energy expense, and the applicability of ceiling fans to low energy thermal comfort.

This report provides detail of the work that has been accomplished under each of these tasks, along with summaries of task efforts that are detailed in journal and other publications, including reports, conference proceedings and presentations. Publications produced through these efforts are listed and available on HNEI's website at <http://www.hnei.hawaii.edu/publications/project-reports#APRISES11>.