VIII.8 Hawaii Hydrogen Power Park

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Partners:

- State of Hawaii Department of Business, Economic Development & Tourism, Honolulu, HI
- Volcanoes National Park, Volcanoes, HI
- Kilauea Military Camp (KMC), Volcanoes, HI
- Hawaiian Electric Company, Honolulu, HI
- Hawaii Electric Light Company, Hilo, HI
- Sandia National Laboratories (SNL), Albuquerque, NM
- National Renewable Energy Laboratory (NREL), Golden, CO
- Puna Geothermal Ventures, Puna, HI
- Office of Naval Research, Washington, D.C.

Project Start Date: June 29, 2009
Project End Date: September 30, 2012

Objectives

- Install hydrogen fueling station infrastructure at Hawaii Volcanoes National Park (HAVO) on the Big Island of Hawaii.
- Support the operations of the National Park Service (NPS) hydrogen plug-in hybrid electric vehicle (PHEV) shuttle buses for 24 months through December 2013.
- Conduct engineering and economic analysis of HAVO bus operations on different routes, grades, elevations and climatic conditions.
- Validate fuel cell system performance in harsh environments including high SO_2 concentrations.
- Position HAVO as an alternative fuel vehicle test bed for the NPS.
- Attract new partners and applications for the Big Island hydrogen infrastructure.
- Conduct outreach to local authorities and the general public regarding hydrogen infrastructure.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) Lack of Fuel Cell Vehicle Performance and Durability Data

(C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

(H) Hydrogen from Renewable Resources

Contribution to Achievement of DOE Technology Validation Milestones

This project will contribute to the following Technology Validation milestones from the Multi-Year Research, Development and Demonstration Plan:

- **Milestone 34: Complete power park demonstrations and make recommendations for business case economics (2Q, 2008).** Our HAVO system will generate hydrogen utilizing an electrolyzer powered by renewable energy resources delivered over the grid. Data will be collected to evaluate cost and technical performance.

Accomplishments

- Signed an implementation agreement with the State of Hawaii (DOE funds via State Energy Office) contracting HNEI as the project "Implementing Partner" on behalf of the State of Hawaii.
- Secured State of Hawaii $1.2 million cost share funds via Kolohala Holdings LLP.
- Completed a hydrogen station specification. Compressor, storage and dispenser sized to support increased production capacity.
- Issued a request for proposal for the supply of "turn-key" fueling station.
- Applied for and received a special research and development energy supply agreement from the Hawaiian Electric Light Company through the State of Hawaii Public Utilities Commission.
- Obtained KMC approval and support as the site of the fueling station.

- Hawaii Volcanoes National Park superintendent approved Categorical Exclusion for siting and operation of the fueling station.
- Completed background sounds survey at the KMC site.
- Assisted HAVO to develop an aggressive acoustic specification for the fueling station. Extensive acoustic data analysis by NPS Natural Sounds Program department. Acoustic level specification not to exceed 35 dba at 75 meters based on proximity of closest sleeping quarters;
- Assisted HAVO to secure bus funding ($1 million) from the Federal Transit Administration via the Department of Interior. These buses to serve as the primary vehicles for the Power Park project.
- Assisted HAVO to secure $600,000 in cost share funding from the Hawaii Hydrogen Investment Capital Special Fund (Hydrogen Fund) to support the HAVO bus conversion funding.
- Issued a contract to Powertech for the supply of a "turn-key" fueling station due for completion by the end of July 2010 and delivery by the end of August 2010.
- Developed a fueling station site plan layout.

Introduction

The Hawaii Hydrogen Power Park (Power Park) was established to support the DOE Hydrogen Program Technology Validation sub-program. Funded by the DOE through the Department of Business, Economic Development and Tourism's Strategic Industries Division, in its role as the Hawaii State Energy Office, with the University of Hawaii's HNEI as the implementing partner, the Power Park conducts engineering and economic validation of pre-commercial hydrogen technologies. The Power Park is supporting the testing and validation of hydrogen fueling system technologies on the big island of Hawaii including production utilizing renewable energy, compression, storage, delivery, and dispensing to hydrogen vehicles. In parallel, HAVO is planning to acquire initially two battery-dominant fuel cell plug-in hybrid electric vehicle shuttle buses. The source of HAVO funds is from the Department of Transportation though the NPS Alternative Transportation in the Parks and Public Lands Program. It is intended to support HAVO's hydrogen fueling requirements with the infrastructure developed in the Power Park.

Approach

- Procure a turn-key H_2 fueling station designed for ease of installation:
  - Modular design and installation plan to greatly reduce installation timeline, cost, and risk.
  - Conduct a factory acceptance trial prior to shipping the system.
  - Supplier to provide detailed infrastructure template with precisely located module connection points. These are precisely replicated on the site prior to shipping.
  - System modules craned into place and connected to utilities. Estimate ~4 days installation effort.
- Use fuel cell PHEVs to maximize the electrical efficiency of a new park shuttle bus service at Hawaii Volcanoes National Park.
- Collaborate with existing data analysis groups at the national labs (SNL and NREL) to compare system data under different operating conditions (fueling station and vehicles).
- Evaluate the effect of different grades, climatic zones, and air quality conditions including SO_2 on vehicle performance.
- Identify areas that require further technical development such as air filtration systems.
- Transfer results to industry and government agencies.
- Produce hydrogen using an electrolyzer powered by renewable electricity from the Hawaii Electric Light Company at a special research rate.
- Design the initial installation to produce 10-20 kg of hydrogen per day @ 350 bar with the flexibility to expand production.
- Site the fueling station at KMC:
  - Department of Defense recreational facility located within HAVO.
  - KMC to provide shuttle bus operators.

Results

Contract Issued for the Supply of a "Turn-Key" Hydrogen Fueling Station

A major accomplishment this year was issuing a contract to Powertech for the supply of a "turn-key" hydrogen production and fueling station. The challenges involved included working closely with the Natural Sounds Program department of the NPS to develop an acoustic level specification for the system. The lack of industry data required a major effort by the project to conduct in-field acoustic measurements on existing equipment and extrapolate the results to develop a

specification for HAVO. This required almost six months of effort and delayed the request for proposal process by a like time frame. The benefit of the effort is that an aggressive acoustic specification of 35 dba at 75 meters (illustrated in Figure 1) was developed and our supplier can meet it. This will have application in the future to the overall hydrogen program as hydrogen production and fueling system will start moving from industrial to urban sites. In particular, cooling fans and compressors in particular will need to meet these reduced acoustic levels.

Identified Fuel Cell PHEV Shuttle Bus Market Gap

Working with HAVO, the Power Park team identified a market gap for shuttle bus-sized fuel cell PHEVs. The lack of a suitable off-the-shelf vehicle requires HAVO to convert an existing internal combustion engine shuttle bus and this is proving to be very costly and time-consuming. The project team assisted HAVO in obtaining addition funding ($600,000) from the State of Hawaii Hydrogen Investment Capital Special Fund (Hydrogen Fund) to help pay for non-recurring engineering for the bus conversions. This will result in a set of engineering designs that can be used to convert additional buses for other projects.

Progressed Multi-Party Legal Agreements

While the involvement of several agencies and organizations is highly desirable for outreach across many agencies, the requirement to negotiate suitable agreements among all the parties is time-consuming and has become a serious barrier to the timely implementation of the project. While considerable progress had been made in execution of a 4-way Memorandum of Understanding, and bilateral Memoranda of Agreement among the various federal and state agencies it, remains outstanding after almost a year of negotiations.

Utilize HAVO as Test Bed for Testing and Mitigating the Effects of SO_2 on Vehicle Performance

A significant advantage of the HAVO test site is the opportunity to test fuel cell vehicles in challenging environmental conditions and particularly in high SO_2 conditions. This is a challenge that must be addressed as fuel cell vehicles are introduced into general use. As illustrated in Figures 2 and 3, HAVO has extensive monitoring and data collection capabilities for SO_2. This

FIGURE 2. Halema'uma'u Emissions of 1,400 tonnes of SO_2 per Day

FIGURE 1. Acoustic Sound Level Specification

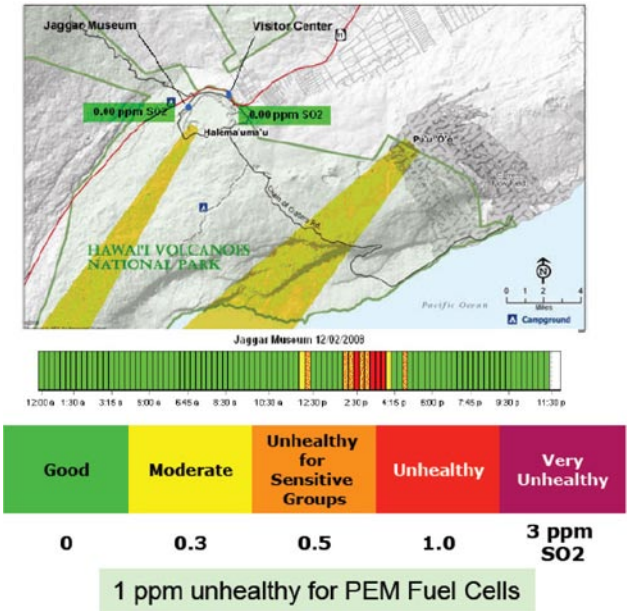

FIGURE 3. HAVO SO_2 Monitoring and Data Collection

provides the opportunity to develop and test fuel cell vehicle air filtration systems.

Conclusions and Future Directions

- Based on unanticipated delays by HAVO in acquiring its shuttle buses, the Power Park team is developing alternative plans to deploy the hydrogen fueling station to support the October 2010 deployment of GM Equinox vehicles at Marine Corps Base Hawaii on Oahu until HAVO shuttle buses are ready. Preliminary discussions with both DOE and the State have been positive. Efforts will commence once written approval is obtained from both funding agencies.
- Subject to a new timetable for HAVO vehicles including availability in January 2012, complete KMC site prep in November 2011.
- Install the Power Park fueling station at HAVO – target: December 2011.
- Conduct hydrogen fueling operations of HAVO buses – January 2012 to December 2014.
- Collect and analyze fueling station and vehicle data.
- Seek opportunities for expansion of fleet and/or additional hydrogen infrastructure.

FY 2010 Publications/Presentations

1. M. Ewan and R. Rocheleau, "Deploying a Hydrogen Transportation System at Volcanoes National Park – Challenges & Opportunities," *National Hydrogen Association Conference & Expo*, Long Beach, CA - May 3–6, 2010.

2. R. Rocheleau and M. Ewan, Poster "The Hawaii Hydrogen Power Park", *US DOE Annual Merit Review*, Washington, D.C. May 2010.