V.A Power Parks Analysis

V.A.1 Hawaii Hydrogen Power Park

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Implementing Partner:
Hawaii Natural Energy Institute, Honolulu, HI
Principal Investigator: Richard E. Rocheleau
Project Manager: Mitch Ewan

Objectives

- Demonstrate an integrated Hydrogen Power Park comprised of the following:
  - Electrolyzer powered by a renewable energy source,
  - Hydrogen storage and distribution system, and
  - Proton exchange membrane (PEM) fuel cell
- Demonstrate hydrogen as an energy carrier
- Investigate fuel cell interface issues
- Identify codes & standards required to site a Power Park
- Identify barriers to a hydrogen infrastructure
- Educate local authorities on hydrogen technologies
- Prepare an economic analysis of hydrogen infrastructure development
- Generate public interest and support

Technical Barriers

This project addresses the following technical barriers from the DOE Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Hydrogen Production

- T. Renewable Integration

Hydrogen Storage

- U. Codes and Standards
- V. Life Cycle and Efficiency Analysis

Technology Validation

- B. Hydrogen Storage

- E. Codes and Standards
- H. Hydrogen from Renewable Resources

Education

- A. Lack of Awareness
- B. Lack of Demonstrations or Examples of Real World Use
- C. Institutional Barriers and Access to Audiences

Approach

- Build a strong team of public and industrial partners
- Develop a flexible test site that allows new technologies and partners to join the project as opportunities arise
- Leverage existing hydrogen infrastructure from the Department of Defense (DOD)-funded Hawaii Fuel Cell Test Facility (HFCTF)
- Develop strategic partnerships with industry technology leaders to transfer technology and "Lessons Learned"
- Work with Hawaii electric and gas utility companies to leverage their expertise and gain their support for the hydrogen program in Hawaii
- Leverage Bishop Museum science education programs
- Work with City & County of Honolulu to educate public officials & overcome regulatory barriers

Accomplishments

- Installed and operated hydrogen infrastructure:
  - Obtained city permits
  - Installed and operated Stuart electrolyzer for 11 months
  - Interfaced electrolyzer to high-pressure storage systems
  - Demonstrated filling of high-pressure storage system
- Developed system model
- Completed education & outreach plan
- Briefed senior city officials, including Mayor and cabinet
- Identified site for Phase 2 activities
- Ordered first 5-kW PEM fuel cell module

Future Directions

- Complete testing of integrated 5-kW fuel cell system
- Design and install infrastructure to allow for delivery of up to 10 kg/hr hydrogen for Phase 2 Power Park site
- Deliver hydrogen from refinery for use in hydrogen-fueled 150-kW internal combustion engine (ICE) combined heat & power (CHP) system
- Characterize the effect of hydrogen on ICE CHP performance
- Continue outreach activities
- Identify other partners/technologies for incorporation into Power Park facility

Introduction

The "Hydrogen Power Park" concept is considered by DOE to be an important step towards developing the viability of using hydrogen as an "energy carrier" in distributed power generation applications. A "Hydrogen Power Park" is a distributed power system in which locally available energy sources such as propane or renewable electricity generated by wind, geothermal or solar are used to produce hydrogen. The hydrogen is stored and then used in a fuel cell or ICE to generate electricity to power a building complex.

In addition to the technical barriers being addressed through research, development, and demonstration (RD&D) in laboratories for specific components of a hydrogen system, there are obstacles to successful implementation that can only be addressed by integrating the components into complete systems. To have confidence in these technologies, they must work as designed in "real world" systems. The Hawaii Power Park project is part of the validation process.

Approach

Our approach was to assemble a strong public/private team whose members support the Power Park's objectives. Our project partners (Figure 1) include those companies that are responsible for supporting infrastructure for conventional fuels, electricity, and utility gas in Hawaii. The roles and interests of the team members are as follows:

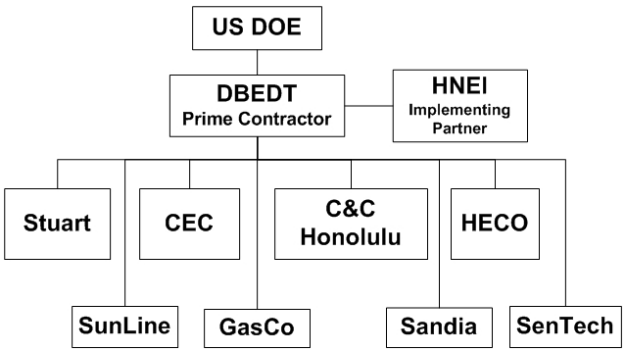

Figure 1. Project Team & Organization

- State of Hawaii - Hawaii Department of Business, Economic Development and Tourism (DBEDT):
  - Providing state leadership for the introduction of a hydrogen infrastructure in the State of Hawaii
  - Phase 1 Prime Contractor
- Hawaii Natural Energy Institute, University of Hawaii (HNEI):
  - Phase 1 Implementing Partner to execute the project on behalf of DBEDT
  - Phase 2 Prime Contractor
- The City and County of Honolulu (C&C):
  - Providing a site and supporting infrastructure in Phase 2
  - Providing access to photovoltaic (PV) array and 150-kW CHP system in Phase 2
- Sentech:
  - Engineering analysis & business case development
  - Public outreach program support
- Stuart Energy Systems
  - Providing electrolyzer and technology transfer
- Hawaiian Electric Company:
  - In-kind engineering support for grid interconnection
  - Support for CHP system during Phase 2
- The Gas Company:
  - In-kind engineering support for low-pressure hydrogen storage
  - Supplying tank for low-pressure hydrogen storage in Phase 2
- SunLine Services:
  - Technology transfer of "Lessons Learned"
- California Energy Commission:
  - Cost share partner supporting SunLine technology and "Lessons Learned" transfer
- Sandia National Laboratory Livermore:
  - Engineering and economic models & analysis

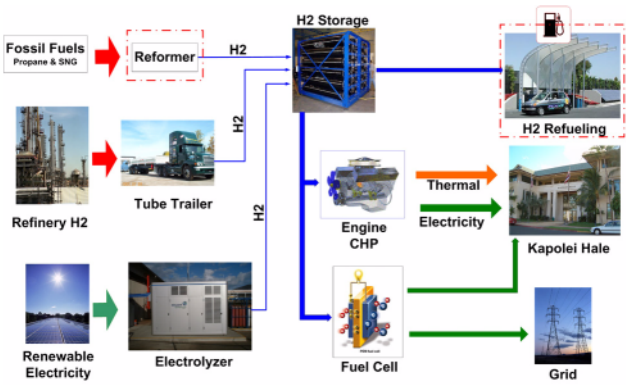

Figure 2. Hawaii Power Park Design

- The Bishop Museum (proposed):
  - Collaborative educational science program support

The second major component of our approach was to develop a Power Park infrastructure which has the flexibility to allow incorporation of new technologies and new partners as opportunities arise. Potential technologies are shown in Figure 2.

Results

Phase 1 of this Power Park project has focused on the design and installation of hydrogen infrastructure to fuel a 5-kW PEM fuel cell. During 2003, the hydrogen infrastructure was developed and incorporated into the HFCTF, a state-of-the art facility funded by the Office of Naval Research for the testing of full-size single cells and fuel cell stacks. A Stuart electrolyzer was acquired and commissioned in May 2003 (Figure 3). The electrolyzer was integrated with the HFCTF hydrogen storage system, allowing transport of the hydrogen into fuel cell test stands or on-site storage cylinders. System controls, safety systems, and data acquisition were implemented into this fully permitted facility. The permitting process provided valuable experience in working with city officials and educating them on hydrogen technologies. This will facilitate permitting for future phases of the project. Considerable operational experience and valuable insight has been gained from operating the unit. Operation of an electrolyzer has not been straightforward, requiring substantially more research effort than anticipated.

Figure 3. Stuart Power Park Electrolyzer at the HFCTF

Future phases of Power Park development are proposed to include integration of hydrogen into a 150-kW ICE CHP system proposed by the C&C. The site could also host installation of commercial-scale grid-connected fuel cells and future vehicle demonstration projects.

Conclusions

The Hawaii Hydrogen Power Park has been successfully launched and is already addressing several DOE Multi-Year Research, Development and Demonstration Plan objectives. In addressing the DOE objective of educating public officials, not only have we worked successfully on permitting issues, but the City & County of Honolulu has joined the project as a team member, has offered a site, has provided infrastructure design using city design staff, and is offering the opportunity of using Power Park-supplied hydrogen to fuel a city-supplied 150-kW CHP system. The major Hawaii utility companies have been actively involved in supporting the design of the Power Park and addressing operational issues involving the interface of hydrogen with the CHP system. Real-world operation of significant power systems has highlighted the need for a reliable supply of clean hydrogen. This is a challenge that we will be addressing in Phase 2.

Subsystem equipment such as the electrolyzer has undergone initial testing at the HFCTF, providing for considerable technology transfer to Hawaii. Testing has allowed the project team to become familiar with the equipment before it is installed at

the final site. Subsystem equipment has leveraged the investment of DOE and DOD in the HNEI hydrogen program.

A design has been developed and is awaiting Phase 2 implementation. The design demonstrates the significant footprint and related costs involved in meeting existing hydrogen storage code requirements. It also provides the flexibility to demonstrate new technologies as they become available.

FY 2004 Publications/Presentations

1. 2004 Hydrogen Program Review Meeting – 24-27 May 2004.

2. 2004 NHA Conference – 26-30 April 2004.

Special Recognitions & Awards/Patents issued

1. The Hawaii Fuel Cell Test Facility and Hydrogen Infrastructure received the 2004 "Meritorious Award" from ASME-Hawaii for excellence in mechanical engineering design.