Hydrogen Grid Management Project

Hawai'i Natural Energy Institute

The Hawai'i Natural Energy Institute (HNEI) is conducting research to assess the technical potential and economic value of using an electrolyzer-based hydrogen production and storage system as a demand response tool for grid management. The primary objective is to demonstrate long-term durability of the electrolyzer under cyclic operation required for frequency regulation on an island grid system. A secondary objective is to supply hydrogen for fuel-cell battery buses to be operated at Hawai'i Volcano National Park and by the County of Hawai'i Mass Transit Authority.

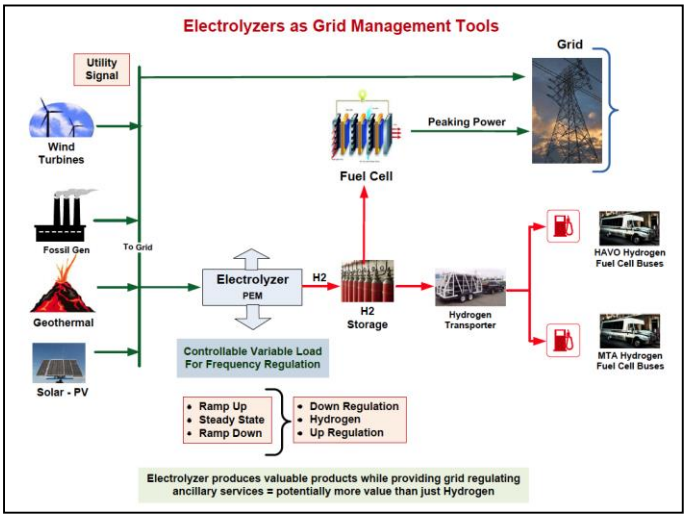

Figure 1: Batteries & Electrolyzers as Grid Management Tools

Challenges & Significance

While solar and wind resources offer a major opportunity for supplying energy, their variability and intermittency can raise challenges for the cost-effective and high-reliability integration of these renewable sources into grid electricity production and delivery systems. In Hawai'i, the curtailment and grid management-related challenges experienced by these renewable sources are a challenge at today's level of generation capacity, and will hinder the substantive additional penetration of electricity generation supplied by these renewable resources. Hydrogen production through electrolysis may provide an opportunity to mitigate curtailment and grid management costs by allowing real-time load control in response to changes in electricity production. The renewable hydrogen product can also create new and incremental revenue streams to the power producers through the sale of hydrogen to customers outside of the electricity delivery system. This monetary value can be used to offset the cost of hydrogen production and the hydrogen can be used in high value applications such as a transportation fuel.

Status & Accomplishments

- A 65 kg per day hydrogen production system consisting of an electrolyzer, compressor, hydrogen storage, and dispenser was completed in December 2012.
- Test protocols have been developed to evaluate the dynamic performance of the electrolyzer and system components under cyclical loads.
- A data acquisition system has been designed, fabricated, and installed on the hydrogen production system as of January 2015.

Contact(s):
Mitch Ewan
808-956-2337
ewan@hawaii.edu

Richard Rocheleau
808-956-8346
rochelea@hawaii.edu

Period of Performance:
2010-2015

Partner(s):
- Powertech Labs, Inc
- Hawai'i Center for Advanced Transportation Technology (HCATT)
- County of Hawai'i MTA

Funding:
- US Department of Energy
- Office of Naval Research
- State of Hawai'i
- US Hybrid

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- The system is being operated for experiments utilizing test protocols at Powertech Labs to be completed in June 2015.
- The system will be deployed at the Natural Energy Laboratory Hawai'i Authority (NELHA), with appropriate site improvements completed, in July 2015.

Project Detail

This project evaluates the value proposition of using electrolyzers to both regulate the grid and use excess electricity from renewables to make hydrogen for transportation. Hydrogen energy production at a utility scale offers the potential for increasing the levels of variable renewable energy that can be harnessed by the power producers or systems operators. HNEI has been operating a 1 MW battery on the HELCO grid and has demonstrated the ability to control grid frequency. Models comparing different sizes of electrolyzers to obtain the same results as a 1 MW battery demonstrated that electrolyzer power consumption variability is modest (Figure 2).

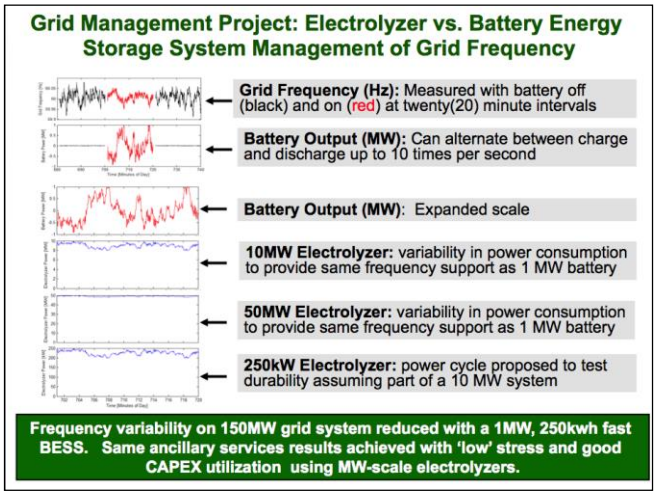

Figure 2: Comparison of a Battery Energy Storage System with a Dynamically Operated Electrolyzer Managing Grid Frequency

An electrolyzer system will be installed in July 2015 at the NELHA on the Big Island of Hawai'i. The electrolyzer will be operated in a dynamic mode designed to simulate future operation as a grid-connected variable load that can be quickly ramped up and down to provide frequency regulation. Data will be collected to analyze the ability of the electrolyzer system including the compressor, buffer tank, and storage system elements to ramp up and down, and to determine its durability and performance under dynamic operating conditions (Figure 2). The hydrogen produced by the system will be used to fuel hydrogen-fueled buses operated by the County of Hawai'i MTA and Hawai'i Volcanoes National Park (HAVO). The hydrogen is delivered in "drag & drop" 450 bar hydrogen transport trailers that have the ability to cascade fill vehicles without the requirement for an on-site compressor. The system is automated and remotely monitored to reduce the requirements for labor except for connecting the trailers to the hydrogen filling and the dispensing systems. A schematic of the project concept is shown in Figure 3.

Figure 3: Hydrogen Production and Delivery System.

Hawai'i Natural Energy Institute | School of Ocean & Earth Science & Technology
University of Hawai'i, 1680 East West Road, POST 109 • Honolulu, HI 96822
www.hnei.hawaii.edu • Ph: (808) 956-8890 • Fax: (808) 956-2336
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