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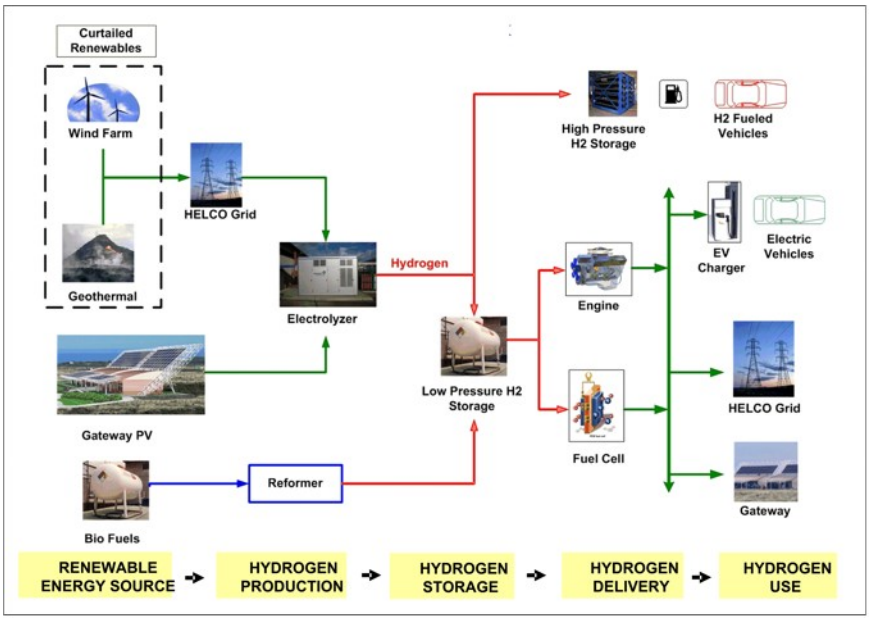
Hawaii Hydrogen Power Park

Background

The U.S. Department of Energy (U.S. DOE) has promoted the vision that the transition to a hydrogen economy will begin with small-scale Distributed Generation (DG) systems fueled by hydrogen. In addition to providing stationary power, these systems may also have the capability of dispensing hydrogen for hydrogen-fueled vehicles. The U.S.DOE has named these hydrogen DG and transportation fueling systems "Hydrogen Power Parks". The hydrogen supply for hydrogen power parks can be produced by a variety of locally available energy sources including electrolyzers powered by electricity generated from renewable energy sources such as hydro, wind, geothermal and solar, or various sources of biomass, or reformation of biofuels (Figure 1).



[1]

Figure 1: Hydrogen Power Park Generic Concept

In October 2002, Hawaii's Department of Business, Economic Development & Tourism (DBEDT) was awarded a U.S. DOE contract to develop a hydrogen power park project in Hawaii. DBEDT in turn contracted the University of Hawaii's Hawaii Natural Energy Institute (HNEI) to implement the project. Power Park provides the opportunity of operating an integrated hydrogen energy system, measuring operational results, and evaluating technical and economic performances in a real-world environment. The results of these evaluations are being used to identify areas that require further research, development and validation. Power Park also increases public awareness of the potential of hydrogen for the generation of electricity and for transportation applications. Initial testing of various full scale and subscale components has been completed and a ?Power Park? system was installed at Kahua Ranch.

Kahua Ranch Test Site

Kahua Ranch located on the Big Island has excellent wind and solar resources and was used by HNEI to test wind-to-hydrogen and solar-to-hydrogen Power Park hydrogen generation systems. This site is home to a small village renewable energy power system that was installed by the Pacific International Center for High Technology Research (PICHTR). The objective of the PICHTR project was developing and testing the use of wind and solar power to power small villages as found in many parts of the Pacific. In the original configuration, the energy from wind turbines and photovoltaic arrays was stored in a large industrial battery. The battery then supplied AC power via a converter to power lights and electrical appliances at the ranch.

In the Kahua Power Park demonstration program we used the electricity generated by the wind turbine and solar array to power an electrolyzer and make hydrogen. The hydrogen was stored without further compression at low pressure (approximately 175 psi) in a rack of compressed gas cylinders (?K? bottles). When electricity was needed the hydrogen was supplied to a fuel cell to produce electrical power. The hydrogen could also have been used to fuel an internal combustion engine which would power anelectric generator [2].

Layout

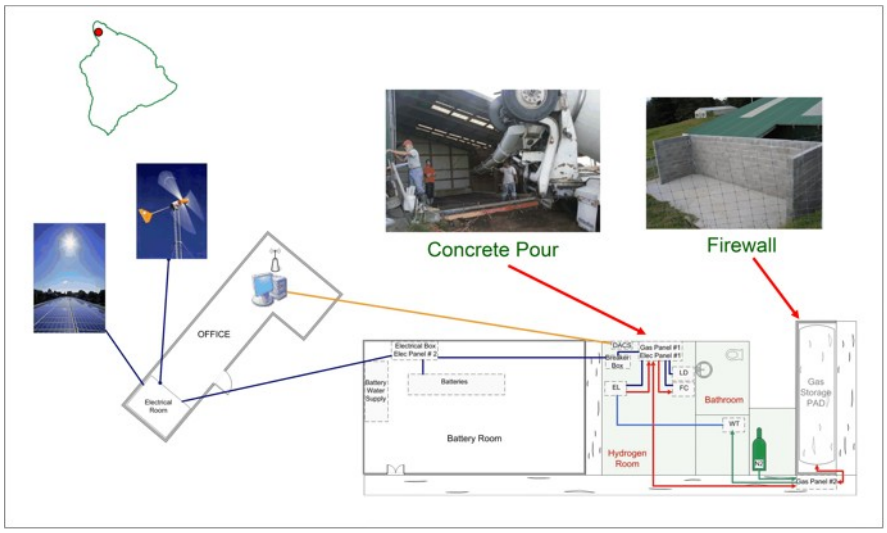


Figure 2: Kahua Ranch Layout

Figure 2 describes the different locations at Kahua Ranch showing a general diagram of the final installation. Concrete pads were poured in the hydrogen room and the gas tank location, and a fire wall surrounds the hydrogen storage tank which acts as a heat shield between the hydrogen storage tank and the facility. Fences also protect the area to keep out horses, sheep, and unauthorized humans.

System Description

As shown in Figure 3, all components are connected to a 48 VDC Bus Bar via DC/DC or AC/DC converters. The wind turbine initially designed for 240 VDC supply has been modified to produce 48 VDC. The PV field was rewired for 48 VDC supply. 24 battery cells have been connected to allow 48 VDC short term electricity storage. Built and tested at the FC test facility, the hydrogen storage system includes an Electric Hydrogen (EH!) electrolyzer (48 VDC unit producing 0.2 Nm3/h of hydrogen delivered at 12 Bar), a rack of hydrogen steel cylinders for hydrogen storage, 15 bar), and a Plug Power Gencore 48 VDC Fuel Cell system. Gas and electrical management panels have been built. Sensors, contactors and valves are connected to an autonomous Data Acquisition and Control System (DACS) that allows the system to be

monotored and controlled over the internet.

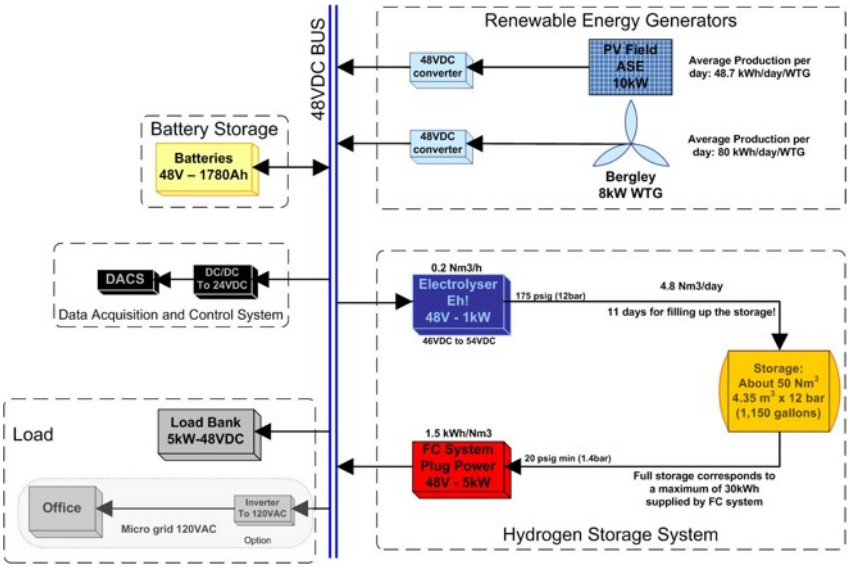


Figure 3: Kahua Ranch Power Park System Schematic

Hawaii Volcanoes National Park Hydrogen System

Under a continuation of the Power Park project, HNEI has received new funding of $2.4 million ($1.2 million from US DOE and $1.2 million from the State of Hawaii Hydrogen Investment Capital Special Fund) to build a hydrogen production and fueling station. The complete system was originally intended to be installed at Hawaii Volcanoes National Pary (HAVO) to support their Hydrogen Shuttle Bus project. However delays in the acquisition of the HAVO buses, the arrival of a fleet of GM Equinox FCEVs on Oahu, and the start of a new project on the Big Island to produce hydrogen at the Puna Geothermal Venture power plant resulted in a change of plan to reallocate the HAVO system to Marine Corps Base Hawaii. A hydrogen dispensing system supplied by hydrogen produced at the geothermal plant and delivered by road transport to HAVO will provide the hydrogen requirements for the HAVO Hydrogen Shuttle Bus project.

Marine Corps Base Hawaii Hydrogen Hydrogen System

The hydrogen production, storage, and dispensing system originally planned for HAVO is being installed at Marine Corps Base Hawaii Kaneohe on Oahu. Originally built as a 350 bar (5,000 psi) system, it is being upgraded to support 700 bar (10,000 psi) ?Fast Fill? (under 5 minutes) to support the GM Equinoc FCEVs currently deployed on Oahu.

Contacts

HNEI is actively seeking industrial and academic partners who would like to participate in future opportunities in Hawaii. Hawaii's constrained geography, diverse climate zones, generous investment tax credits, and Renewable Hydrogen Program funding may meet your program needs.

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Related Information

For other HNEI research and development activities related to the hydrogen power park, please refer to

the Fuel Cells [7], Grid Systems [8], Hydrogen [9], and Transportation [10] sections of our website.

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Links:
[1] http://www.hnei.hawaii.edu/sites/web41.its.hawaii.edu.www.hnei.hawaii.edu/files/page/2010/05/Figure%201.pdf
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