Hydrogen Energy Systems as a Grid Management Tool

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Electric power grids operate at a frequency of 60 Hz;
Deviation from 60 Hz is a measure of the load balance of the grid – load matched to generation;
With increased penetration of intermittent renewables on the grid the supply and grid frequency may be subject to fluctuations;
Grid operators can stabilize the frequency by ramping power generation up/down or controlling variable loads or storage;
Project Thesis: An electrolyzer can be used as a variable controllable load that can be reduced/increased in order to maintain the total load balance and frequency stability.
Project Objectives

✓ Validate the performance, durability & cost benefits of grid integrated hydrogen systems;
  ➢ Demonstrate dynamic operation of electrolyzers to mitigate impacts of intermittent renewable energy;
  ➢ Demonstrate potential of multiple revenue streams from monetization of ancillary services and producing hydrogen;
  ➢ Supply hydrogen to shuttle buses operated by County of Hawaii Mass Transit Agency (MTA), and Hawaii Volcanoes National Park (HAVO);
✓ Support development of regulatory structure for permitting and installation of hydrogen systems in Hawaii.
HNEI’s concept to use an electrolyzer to provide grid ancillary services such as up-regulation, down-regulation, and off-peak load.
Economically viable electrolytic hydrogen will require low cost electricity + high capital utilization.

- Central site production for highest capital utilization;
- Distributed dispensing sites with minimum complexity to reduce fuel distribution costs;
- Optimize additional revenue streams from:
  - Quantify and monetize ancillary services;
  - Sale of hydrogen for transportation.
Use of Electrolyzer for Grid Ancillary Services

- HNEI demonstrated ability to regulate grid frequency on 150MW grid with a fast-acting 1MW battery;
- Cycling tests suggest electrolyzer more appropriate for slower-acting changes;
- Battery/electrolyzer hybrid may provide grid services across broad range of operating conditions;
- Using electrolyzer as a variable load as opposed to battery allows effective use of CAPEX plus other value added services.

Grid Frequency (Hz): Measured with battery off (black) and on (red) at twenty (20) minute intervals
Central Site Production Located at NELHA

- State of Hawaii facility:
  - Strong political & financial support;
  - Significant cost share provider;
  - Leverages available technical staff.

- Ease of permitting;

- Existing infrastructure reduces site costs;

- Kona Airport offers opportunity to leverage project:
  - Airport ground handling equipment;
  - Airport shuttle buses;
  - Rental cars.

- Supports NELHA Vision of a “Hydrogen Hub”;
  - Provides “enabling” infrastructure to attract new projects.
Site Preparation

Excavation

Concrete Pad
Equipment Installation

Setting Equipment
20-ton Lift
Site Work Completed
Site Work Completed
Tube Trailer Filling Bays
Dispenser
Converted 3 Fuel Cell Electric Hybrid Buses

- Hawaii MTA Fuel Cell Electric Hybrid Shuttle Buses demonstrate to the general public the advantages of fuel cell buses and electric drive.
  - Quiet ride;
  - No diesel fumes;
  - Potential for lower O&M costs (need low cost hydrogen).
- HAVO Buses will demonstrate HNEI’s “Smart” air filtration sensor systems in a high air contaminant environment.*
  *(Funded by ONR).*
Recertified 3 Hydrogen Transport Trailers

➢ Hydrogen Transport Trailer carries 105 kg @ 450 bar;
➢ Demonstrate distributed dispensing using cascade fill to 350 bar using a “Smart” dispenser;
➢ Trailer O&M costs will be evaluated including US DOT hydrostatic testing requirement every 5 years;
   ➢ Currently no facility in Hawaii can hydro test cylinders of this size:
   ➢ Must be shipped to mainland (very costly and time consuming);
   ➢ Recertified Trailers before shipping to Hawaii to give us a full 5-year window.
Collaborations

✓ US Department of Energy: Project Sponsor & Funding;
✓ Naval Research Laboratory: Federal Technical Program Manager;
✓ Hawaii Natural Energy Institute: Implementing Partner, Technical Lead;
✓ Office of Naval Research: Supplemental Funding;
✓ State of Hawaii - HSDC: Public Outreach, Significant Cost Share;
✓ Natural Energy Laboratory Hawaii Authority: Host Site; Site Work, Cost Share
✓ County of Hawaii MTA: Host Site, Bus Operator (Cost Share);
✓ Hawaii Volcanoes National Park: Host Site, Bus Operator;
✓ HCATT: Conversion of Shuttle Bus, Cost share;
✓ US Hybrid: Conversion of Shuttle Bus, Cost share;
✓ HELCO: Interested Observer, Potential Partner for Grid Analysis;
✓ Hydrogen Safety Panel: Design Hydrogen Safety Review;
✓ PNNL: First Responder Training (Cost Share);
✓ Proton Onsite: Electrolyzer Control System
✓ Aloha Petroleum: Hydrogen Delivery