

Hawaii Hydrogen Power Park

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Project
tv_09_rocheleau

Overview

Timeline

- ✓ Start - April 2009*
- ✓ Finish - Jan 2012
- ✓ 5% Complete

Budget

- \$3.4 million
 - \$1.2 million - DOE
 - \$1.2 million – State of Hawaii
 - \$ 1.0 million – *NPS for vehicles*
- Funding Received in FY07
 - \$0
- Funding Received in FY08
 - \$2.4 million

* Final agreement with State of Hawaii

Barriers

- ✓ Validation
 - A. FCV Performance
 - C. H2 Refueling Infrastructure Data
 - H. Hydrogen from Renewables
- ✓ Safety
 - H. Hydrogen Knowledge by AHJ

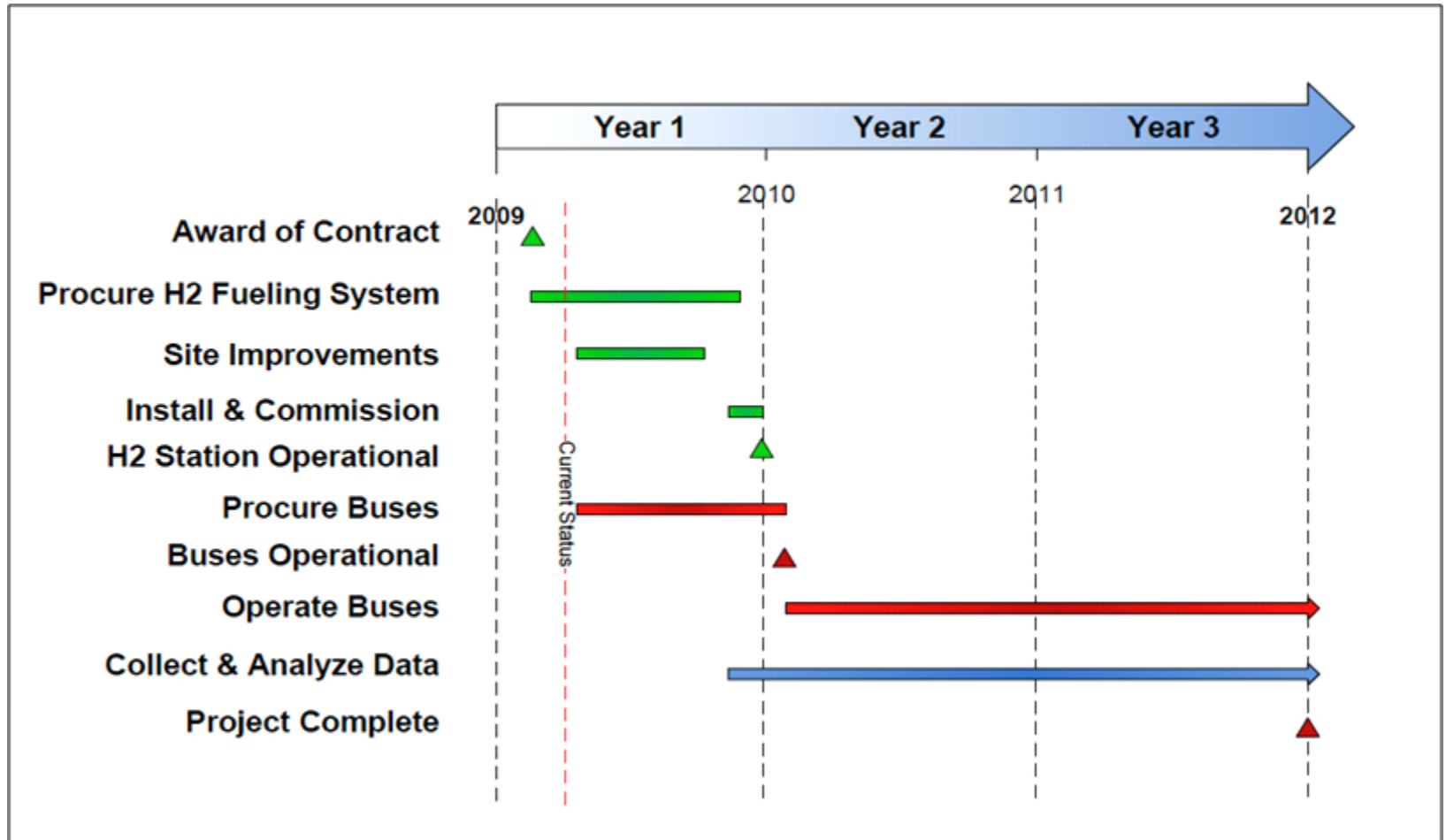
Partners

- State of Hawaii
- Hawaii Volcanoes National Park (NPS)
- Kilauea Military Camp (DoD)
- Hawaii Ctr for Adv. Transp. Technology
- Hawaiian Electric Light Co (HELCO)
- Sandia National Lab
- *Puna Geothermal Ventures*
- *Office of Naval Research (DoD)*
- *NREL*

Objectives

- ✓ **Install hydrogen fueling station infrastructure at Hawaii Volcanoes National Park (HAVO) by Dec 2009.**
- ✓ **Support the operations of NPS hydrogen PHEV shuttle buses for 24 months through to Jan 2012.**
- ✓ **Conduct engineering and economic analysis of HAVO bus operations on different routes, grades, elevations & climatic conditions**
- ✓ **Validate fuel cell system performance in harsh environment including high SO₂.**
- ✓ **Position HAVO as an alternative fueled vehicle test bed for NPS.**
- ✓ **Attract new partners & applications for Big Island hydrogen infrastructure.**

Milestones



Approach

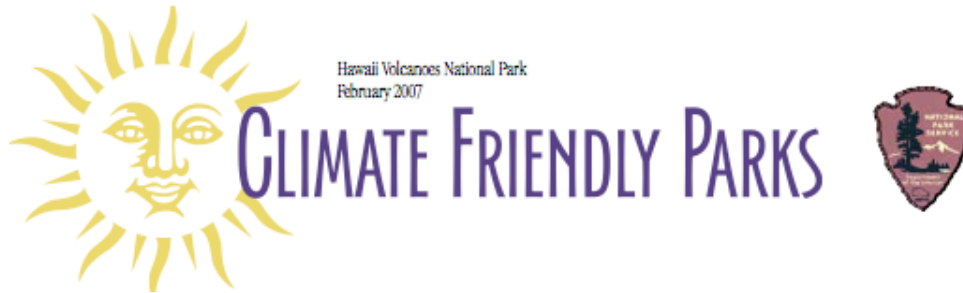
- ✓ Procure turn-key H₂ fueling station designed for easy expansion
- ✓ Use fuel cell PHEVs to maximize the efficiency of a new park shuttle bus service at Hawaii Volcanoes National Park.
- ✓ Collaborate with existing data analysis groups to compare system data under different operating conditions (fueling station & vehicles).
- ✓ Evaluate the effect of different grades, climatic zones, air quality conditions including SO₂ on vehicle performance.
- ✓ Identify areas that require further technical development such as air filtration systems.
- ✓ Transfer results to industry and government agencies

Hawaii Hydrogen Power Park



Power Park to provide hydrogen infrastructure to support hydrogen shuttle bus program at Hawaii Volcanoes National Park

Hawaii Volcanoes National Park



- ✓ **Power Park supports NPS “Climate Friendly Parks” program to reduce carbon footprint & improve visitor experience.**
 - **Reduce traffic congestion- cars and buses**
 - **Reduce size of buses in the park**
 - **Reduce emissions pollution**
 - **Reduce noise pollution**
- ✓ **Evaluate performance of plug-in hybrid electric vehicle (PHEV) shuttle buses using hydrogen**
- ✓ **Test bed for range of NPS transportation solutions**

Education & Outreach

- ✓ Over 2 million park visitors annually. Hawaii's biggest tourist attraction.
- ✓ HAVO has facilities & team of tour guides dedicated to public outreach.
- ✓ Visitor Center theater and interpretation center will host static displays & movie
- ✓ Theater to be powered by 5 kW stationary fuel cell
- ✓ Park interpreters on shuttle buses to incorporate hydrogen outreach into presentations.



Power Park Hydrogen Fueling Station

- ✓ **Hydrogen production using electrolysis**
- ✓ **Electrolyzer powered by renewable electricity from HELCO at special research rate.**
- ✓ **Fueling station sited at Kilauea Military Camp**
 - **DOD recreational facility located within HAVO**
 - **KMC to provide shuttle bus operators to support project**
- ✓ **Initial installation to produce 10-20 kg of hydrogen per day @ 350 Bar with flexibility to expand**



Fueling Station RFP

- ✓ **RFP for station released March 31, 2009**
- ✓ **Station to be supplied on a “turn-key” basis including production, compression, storage & dispenser**
- ✓ **Compressor, storage & dispenser sized to support increased production capacity.**
- ✓ **Station projected to be operational by Dec 09**
- ✓ **Station to be co-located with EV recharging station**

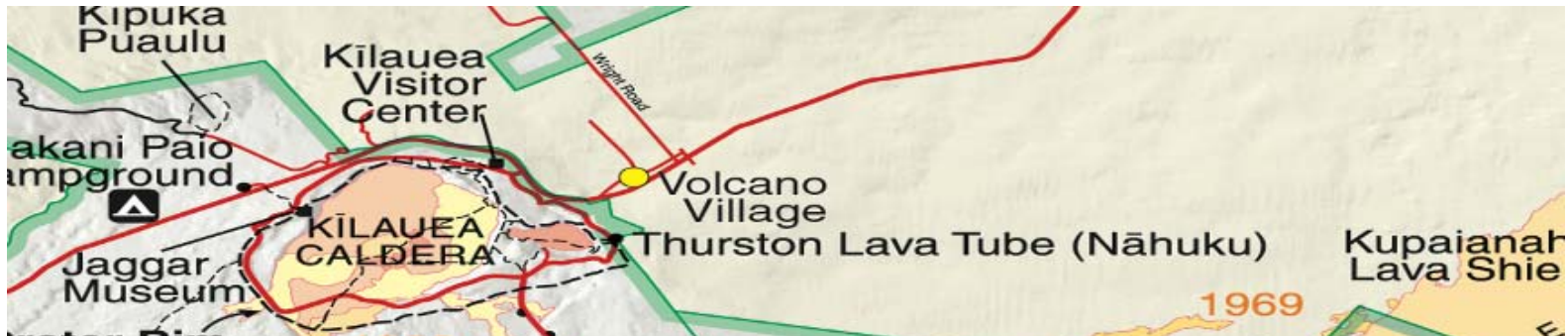


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Vehicle Supply

- ✓ **Vehicle funding obtained by NPS from Advanced Transportation for Parks and Public Lands program (ATPPL).**
- ✓ **Hawaii Center for Advanced Transportation Technology (HCATT) supporting conversion of shuttle buses**
- ✓ **Leverages Hickam Air Force Base hydrogen vehicle programs**
- ✓ **Options for purpose-built Proterra vehicle under consideration**

Bus Routes



**Crater Rim Drive 11 miles
Elevation 4,000 ft**



**Chain of Craters Road
48 miles round trip
Steep Grades**

**Eruption Site
Elevation Sea Level**

**FROG building at eruption site with PV
panels to charge bus (pending)**



FROG Unit

Partner Roles

- ✓ **US DOE – program leadership & funding**
- ✓ **HNEI – Program management & implementation**
- ✓ **State of Hawaii – cost share & policy support**
- ✓ **HAVO & National Park Service**
 - **Host site.**
 - **Vehicle funding**
 - **Education & public outreach.**
- ✓ **Hawaii Electric Light Company (HELCO) – supply of renewable electricity.**
- ✓ **Kilauea Military Camp (DOD)**
 - **Host fueling infrastructure & provide bus operators**
- ✓ **HCATT – vehicle conversion & technical support**
- ✓ **Puna Geothermal Venture – geothermal power (pending)**
- ✓ **ONR – FROG Buildings, supplemental funding (pending)**

Accomplishments/Progress/Results

- ✓ **Signed implementation agreement with State of Hawaii (DOE funds via State Energy Office).**
- ✓ **Secured State of Hawaii \$1.2 million cost share funds via Kolohala Holdings LLP**
- ✓ **Completed hydrogen station specification**
- ✓ **Issued RFP for supply of “turn-key” fueling station**
- ✓ **Developed energy supply agreements – HELCO, PGV, PUC**

- ✓ **Obtained KMC approval and support as site of fueling station**
- ✓ **Progressed permitting and NEPA documentation**
- ✓ **Completed noise survey at KMC site**

- ✓ **Assisted HAVO to secure bus funding (\$ 1 million)**
- ✓ **Continue to work with HAVO on project development**

Future Work

- ✓ **Select supplier for fueling station – May 2009**
- ✓ **Complete site prep for station – Fall 2009**
- ✓ **Install fueling station – target Dec 2009**
- ✓ **Complete vehicle conversions – target Jan 2010**

- ✓ **Operate buses – Feb 2010 to Jan 2012**
- ✓ **Collect and analyze fueling station & vehicle data**

- ✓ **Seek opportunities for expansion of fleet and/or additional hydrogen infrastructure**

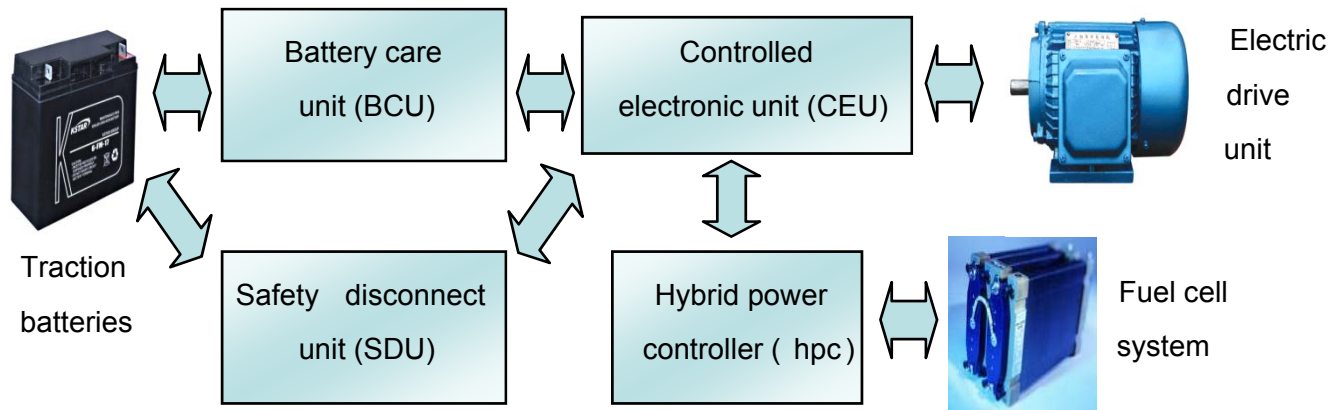
Hybrid Electric Vehicle Data Analysis



Hickam AFB Bus – Fuel Cell 1

- ✓ **HNEI has extensive experience in electric & hybrid vehicle data acquisition & analysis**
 - 2001 – 2003: Hyundai Santa Fe EV test program
 - 2004 – 2009: Data collection & driving cycle analysis of hybrid FC fleet operated at Hickam AFB
- ✓ **HNEI has ongoing battery evaluation, analysis & simulation projects**
 - 2007 – 2009: Lithium Ion battery cell testing for USAF
- ✓ **HNEI has developed a unique computer modeling framework and GUI for data analysis and driving cycle simulation**

Vehicle Data Collection



Motor Data

- Motor Voltage (V),
- Requested power (kW),
- Motor speed (RPM),
- Temperature of the motor (°C),
- Operating mode (warming up, motoring),
- Temperature within the CEU box (°C).

Battery Data

- Voltage (V),
- Current (A),
- Power (kW),
- State of charge (%),
- Individual voltage of the modules (V),
- Temperature of sensors within the battery pack (°C)
- Fault status

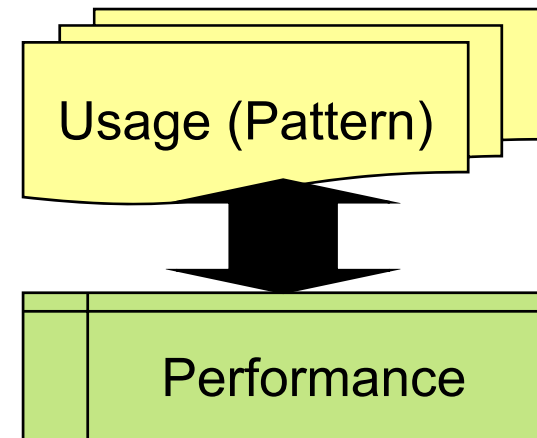
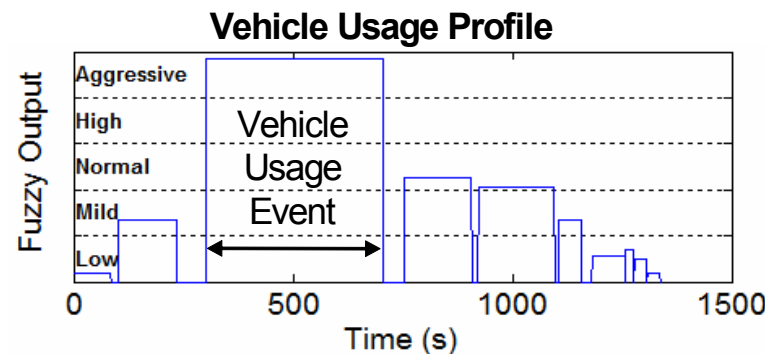
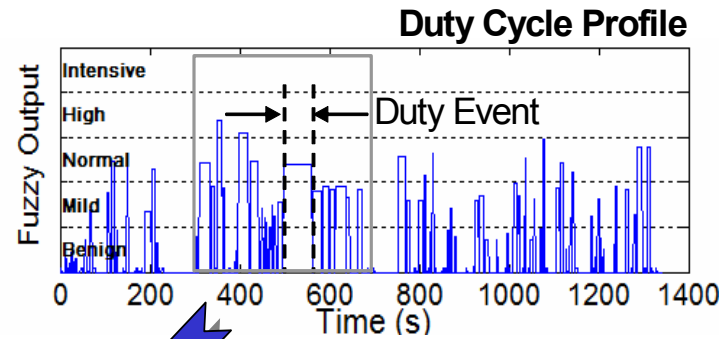
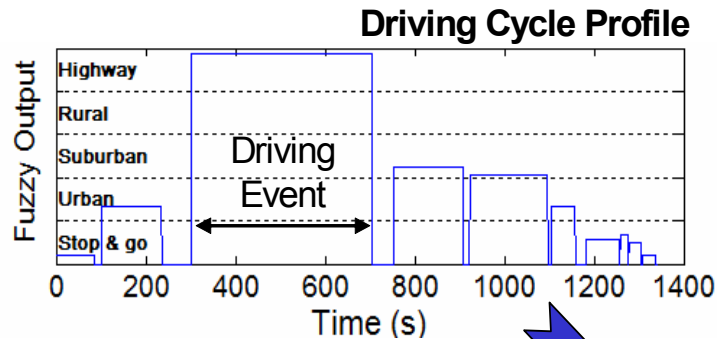
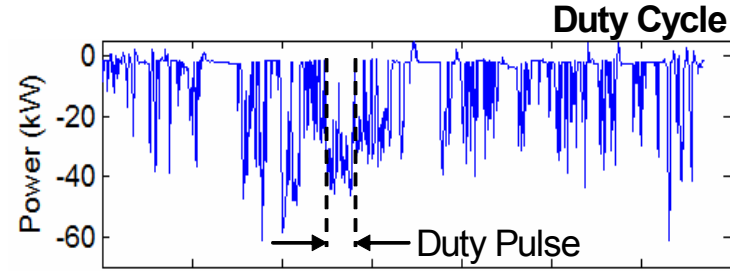
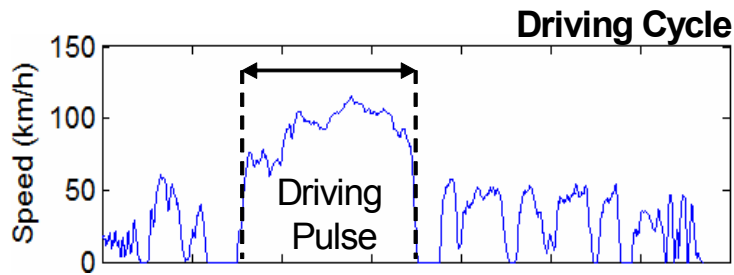
Fuel Cell Data

- Current density (A),
- Allowed drawn current (A),
- Requested drawn current (A),
- Fuel cell stack voltage (V),
- Coolant temperature (°C).

Hybrid Power Controller Data

- HPC is active – Y/N
- HPC operating mode,
- Voltage of the batteries (V),
- Current delivered to the batteries (A),
- Voltage of the associated fuel cell stack (V),
- HPC fault status.

HNEI has developed driving & duty cycle analysis capabilities



Summary

- ✓ **Hawaii Hydrogen Power Park expected to be fully operational by Jan 2010**
- ✓ **High visitor count at HAVO offers opportunity for high visibility & extensive outreach**
- ✓ **Power Park being supported by several agencies including DOE, DOD (Army and ONR), DOI, NPS, State of Hawaii.**
- ✓ **Power Park positions HAVO as NPS system-wide resource to demo zero emission transportation solutions**
- ✓ **Power Park will serve as the cornerstone for expansion of the Hawaii “Renewables to Hydrogen” program**