

2010 DOE Hydrogen Program Hawaii Hydrogen Power Park

Richard Rocheleau, Principal Investigator
Mitch Ewan – Program Manager, Presenter
Hawaii Natural Energy Institute
June 10, 2010

Project TV009

Overview

Timeline

- ✓ Start - April 2009
- ✓ Finish - Jan 2013
- ✓ 25% Complete

Budget

- \$2.4 million
 - \$1.2 million - DOE
 - \$1.2 million – State of Hawaii
- Funding Received in FY09
 - \$2.4 million

* Additional \$1.6 million for vehicles to National Park Service under separate agreements

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)
- Office of Naval Research (DoD)
- Sandia National Lab
- *NREL*
- *Puna Geothermal Ventures*

DOE Technical Barriers/Targets

- ✓ **Lack of hydrogen refueling infrastructure performance and availability data**
 - The high cost of hydrogen production, low availability of hydrogen production systems, and challenge of providing safe systems are early market penetration barriers.
- ✓ **Hydrogen from renewables**
 - There is little operational, cost, durability, and efficiency information for large renewable electrolyzer systems that produce hydrogen
- ✓ **Lack of hybrid fuel cell vehicle performance and durability data**
 - Statistical data for vehicles that are operated under both controlled and real-world conditions is very limited.

Objectives - Relevance

- ✓ **Install hydrogen fueling station infrastructure at Hawaii Volcanoes National Park (HAVO) by August 2010.**
- ✓ **Support the operations of the National Park Service (NPS) hydrogen PHEV shuttle buses for 24 months through to Jan 2013.**
- ✓ **Conduct engineering and economic analysis of the HAVO fueling station and bus operations on different routes, grades, elevations & climatic conditions.**
- ✓ **Validate fuel cell system performance in harsh environment including high SO₂ levels in atmosphere.**
- ✓ **Position HAVO as an alternative fueled vehicle test bed for NPS.**
- ✓ **Provide a high level of public outreach with hydrogen technologies.**
- ✓ **Attract new partners & applications for Big Island to support the development of hydrogen transportation infrastructure.**

Approach

- ✓ **Procure turn-key H₂ fueling station for ease in installation**
- ✓ **Use fuel cell PHEVs to maximize the electrical efficiency of a new park hydrogen shuttle bus service at Hawaii Volcanoes National Park.**
- ✓ **Collaborate with national labs (Sandia & NREL) for data analysis.**
- ✓ **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**

Approach

Power Park Hydrogen Fueling Station

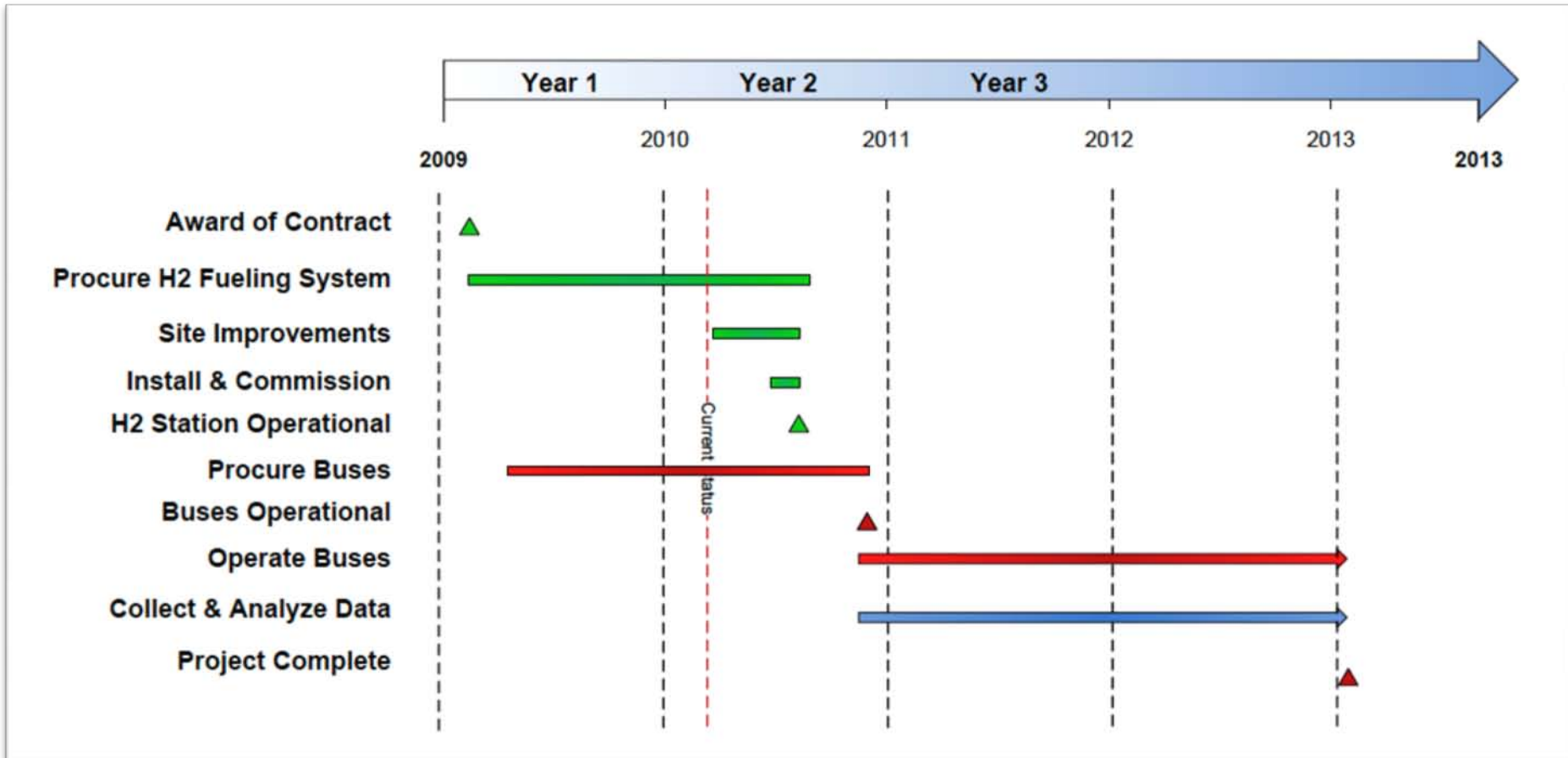
- ✓ **Produce hydrogen using an electrolyzer powered by renewable electricity from HELCO at special research rate.**
- ✓ **Design initial installation to produce 10-20 kg of hydrogen per day @ 350 Bar with flexibility to expand output**
- ✓ **Site fueling station at Kilauea Military Camp**
 - **DOD recreational facility located within HAVO**
 - **KMC to provide shuttle bus operators**



Approach System Installation

- ✓ Modular design & installation plan to greatly reduce installation timeline & cost & risk
 - Factory acceptance trial - modules integrated as a complete complete system prior to shipping.
 - Supplier to provide detailed infrastructure template with precisely located module connection points. These are precisely replicated on the site prior to shipping.
 - Systems modules craned into place and connected to utilities. Estimate ~4 days installation effort.

Approach – Task Timeline/Milestones



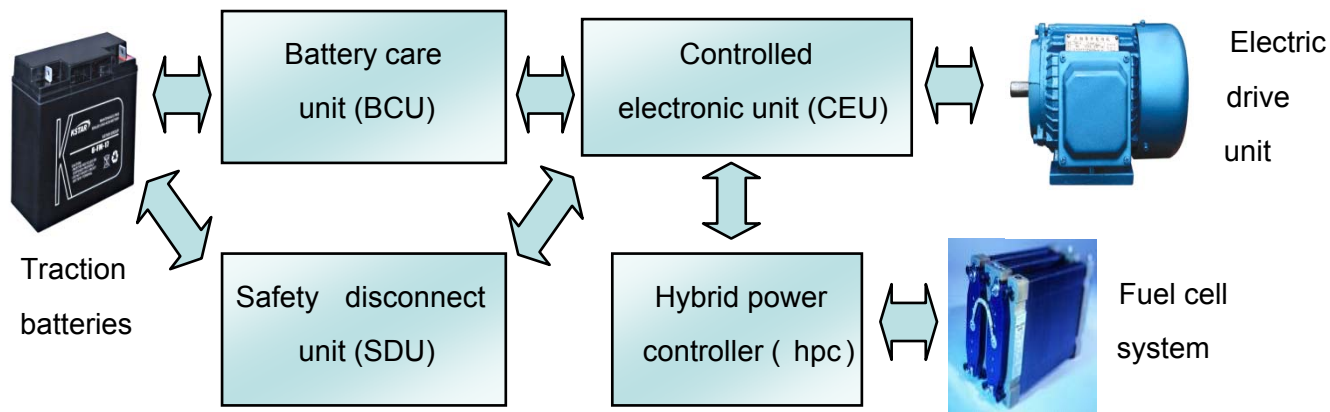
Approach - Vehicle Data Analysis



Hickam AFB Bus – Fuel Cell 1

- ✓ **Use HNEI computer modeling framework and GUI for data analysis and driving cycle simulation**
- ✓ **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**

Approach - Planned 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),
- Fuel cell stack voltage (V)
- Coolant temperature (°C)
- Requested power (kW)

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.

Results

Fueling Station RFP

- ✓ **Purchase order for station released April 2010**
- ✓ **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 Aug 2010**
- ✓ **Station to be co-located with EV recharging station**

Results

Aggressive Noise Specification

- ✓ **Hydrogen station acoustic level specification not to exceed 35 dba at 75 meters (based on closest sleeping quarters).**
- ✓ **Equipment manufacturers could/would NOT provide acoustic performance data. This was disappointing & caused delays. Required six months to complete.**
- ✓ **Extensive acoustic data analysis by NPS Natural Sounds Program department.**
- ✓ **Required delay in RFP process to ensure specification addressed by suppliers**

Results

Fueling Station Specifications

- ✓ For reviewer:
 - Final Purchase Order in Process. Station specifications to be presented on poster

Results

Major H2 Station Components

✓ For reviewer:

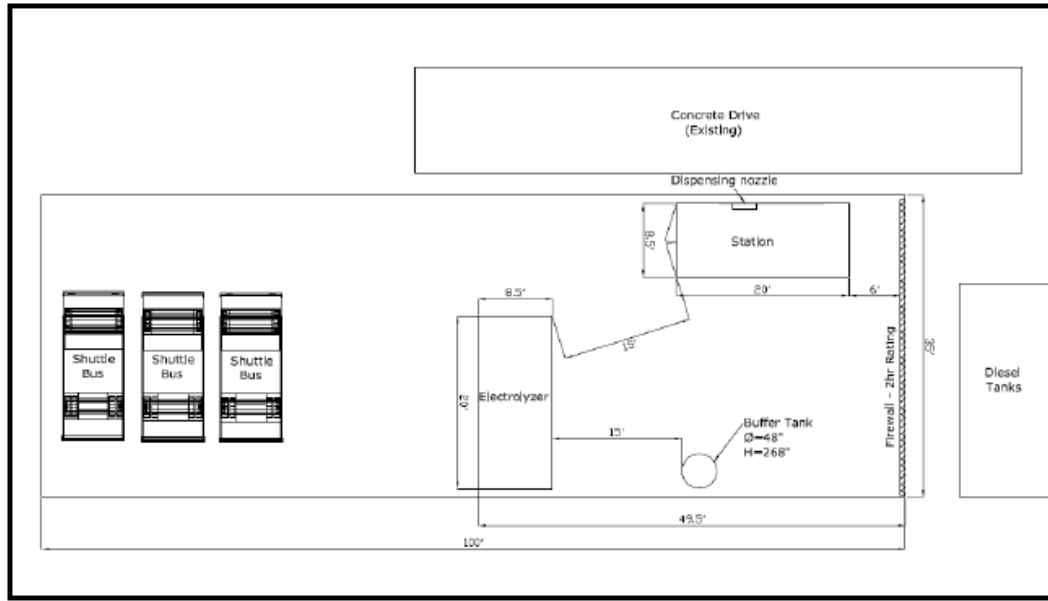
- Final Purchase Order in Process. Supplier and components to be presented on poster

Fueling Module

Dispenser

Compressor

Results - Station Layout



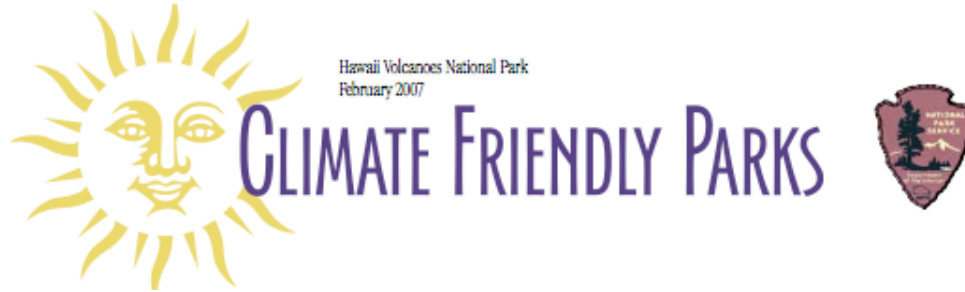
Location of station showing acoustic specification distance from nearest habitation

Collaborations

- ✓ **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**
- ✓ **ONR – supplemental funding for additional hydrogen capacity**
- ✓ **Puna Geothermal Venture – geothermal power (pending)**

Collaboration

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**

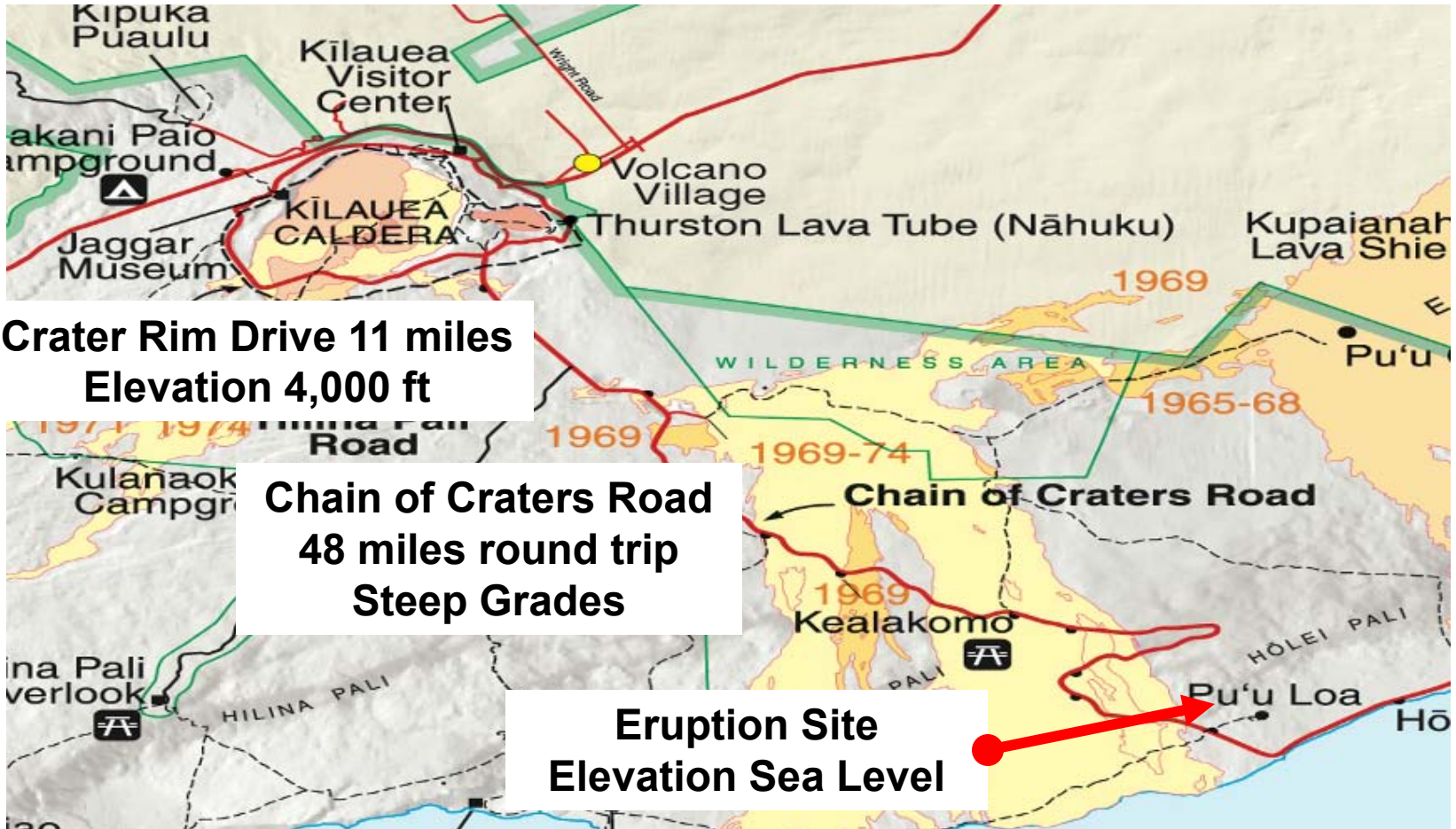
- ✓ **Test bed for range of NPS transportation solutions**

Collaboration

Vehicle Supply – HAVO & HCATT

- ✓ **Vehicle funding (\$1 million) obtained by NPS from Advanced Transportation for Parks and Public Lands program (ATPPL).**
- ✓ **Market Gap - no 20-25 passenger off-the-shelf hydrogen shuttle buses available.**
- ✓ **HAVO has prepared specification for supply of 2 conventional shuttle buses**
- ✓ **Hawaii Center for Advanced Transportation Technology (HCATT) supporting conversion of shuttle buses**
- ✓ **Leverages Hickam Air Force Base hydrogen vehicle programs**
- ✓ **Non-recurring engineering a major investment ~\$750k**
- ✓ **State of Hawaii supporting with additional \$600k from Hydrogen Fund**

Collaboration - Bus Routes HAVO & KMC



Education & Outreach - HAVO

- ✓ Over 2 million park visitors annually. Hawaii's biggest tourist attraction.
- ✓ HAVO has facilities & team of interpretive Rangers 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.



Accomplishments/Progress/Results

- ✓ **Developed acoustic specification for fueling station in National Park**
 - **Potential value for urban installations**
- ✓ **Developed specification, selected supplier & issued PO for supply of “turn-key” fueling station**
- ✓ **Initiated 4-way MOU among agencies**
- ✓ **Progressed permitting and NEPA documentation (awaiting final NEPA determination)**
- ✓ **Assisted HAVO to develop bus specification & secure additional funding (\$600k) from state of Hawaii H2 Fund**
- ✓ **Continued to work with HAVO, HCATT & KMC on project development**

Schedule Challenges

- ✓ **Multi-agency approvals**
 - Multi-agency participation generally a positive
 - BUT negotiations take considerable time & effort
- ✓ **No existing NPS acoustic specifications**
 - 6 months to develop with NPS
 - Delayed RFP process by like amount
- ✓ **Shuttle bus specification**
 - Many considerations to be addressed
 - No off-the-shelf solutions that meet NPS requirements
- ✓ **NEPA process slow – 5 months & waiting**

Future Work

- ✓ **Complete site prep for station – waiting to finalize MOU**
- ✓ **Install fueling station – waiting to finalize MOU**
- ✓ **Complete vehicle conversions – target Dec 2010**
- ✓ **Operate buses – through Jan 2013**
- ✓ **Collect and analyze fueling station & vehicle data**
- ✓ **Seeking opportunities for expansion of fleet and/or additional hydrogen infrastructure including grid support, transportation, and application to high-value products**

Summary

- ✓ **Hawaii Hydrogen Power Park expected to be fully operational by Jan 2011.**
- ✓ **Developed aggressive acoustic specification for fueling station in National Park**
- ✓ **Power Park being supported by several agencies including DOE, DOD (Army and ONR), DOI, NPS, State of Hawaii.**
- ✓ **High visitor count at HAVO offers opportunity for high visibility & extensive outreach**
- ✓ **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**