VIII.E.2 Hydrogen Fuel Project - H_2Fuel*

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Contract Number: DE-FC36-04GO14247

Start Date: October 1, 2004
Projected End Date: September 30, 2006

** Congressionally directed project*

Objectives

H_2Fuel is an integrated, geothermal powered, hydrogen-fuel production and use cycle with robust characteristics suited to real world mass transit conditions. It is literally a "well to wheels" research project that includes:

- geothermal electrical energy production,
- hydrogen fuel production via electrolysis,
- storage, transmission, distribution, and dispensing of hydrogen fuel, and
- operation and maintenance of hydrogen powered transit vehicles in a real world fleet.

The major objectives of H_2Fuel are to:

- create a "green" fuel production and use cycle that utilizes renewable resources and results in low emissions of both criteria pollutants and greenhouse gases,
- develop an integrated hydrogen fuel production and use process that is scalable and has reliability comparable to today's mature fossil fuel technologies, and
- foster public and regulatory agency acceptance of hydrogen fuel technology as a safe, effective, and desirable path through extensive collaboration, education, and outreach.

Technical Barriers

This project will directly address or will provide valuable data for other researchers to address technical barriers from the following sections of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

Hydrogen Generation by Water Electrolysis Barriers (3.1.4.2.2)

Geothermal electricity is the most cost effective renewable resource presently available for operating an electrolysis plant. The H_2Fuel hydrogen production facility will provide realistic research data that will guide

R&D efforts to reduce hydrogen production costs, integration of electrolyzer and renewable energy resource, utility grid connected options, and general integration issues. H_2Fuel provides a research platform to study the long term effects of the feedstock water quality for producing hydrogen via electrolysis.

- G. Capital Cost
- H. System Efficiency
- I. Grid Electricity Emissions
- J. Renewable Integration
- K. Electricity Costs
- L. Durability
- M. Impurities
- P. Operating Temperature

Hydrogen Delivery (3.2.4.2)

H_2Fuel provides a research platform for evaluating a number of fuel preparation and delivery issues that will lead to an optimum system design for production/storage/transport of hydrogen fuel.

- A. Lack of Hydrogen/Carrier and Infrastructure Operations Analysis
- B. Reliability and Costs of Hydrogen Compression
- F. Hydrogen Delivery Infrastructure Storage Costs
- H. Storage Tank Materials and Costs
- I. Hydrogen Leakage
- J. Safety, Codes and Standards, Permitting and Sensors

On-Board Hydrogen Storage Barriers (3.3.4.2)

H_2Fuel provides a research platform for obtaining real world operations data that can be used to guide research programs that lead to reliability and cost targets and safety standards for on-board and off-board fuel storage subsystems. It will provide valuable data for validating life cycle cost and efficiency models.

- A. Cost
- B. Weight and Volume
- C. Efficiency
- D. Durability
- E. Refueling Time
- F. Codes and Standards
- G. Systems Life-Cycle Assessments
- H. Sufficient Fuel Storage for Acceptable Vehicle Range
- K. Balance of Plant (BOP) Components

Fuel Cell Power Systems (3.4.4.2)

H_2Fuel provides a real world test track for evaluating virtually every aspect from a user perspective of a hydrogen-fueled bus including on-board instrumentation and controls.

- A. Durability
- D. Thermal, Air, and Water Management
- H. Sensors

Technology Validation (3.5.4.2)

H_2Fuel provides a research platform for obtaining real world operations data that can be used to guide research programs that lead to reliability and cost targets and safety standards

- A. Vehicles
- B. Storage
- C. Hydrogen Refueling Infrastructure
- D. Maintenance and Training Facilities
- E. Codes and Standards
- H. Hydrogen from Renewable Resources

Hydrogen Codes & Standards (3.6.4.2)

The experiences gained by H_2Fuel engineers, mechanics, technicians and management personnel will enable them to make significant contributions in the codes & standards development processes.

- C. Limited State Funds for New Codes
- E. Lack of Consistency in Training of Officials
- I. Conflicts between Domestic and International Standards
- J. Lack of National Consensus on Codes and Standards
- M. Jurisdictional Legacy Issues
- N. Insufficient Technical Data to Revise Standards
- P. Large Footprint Requirements for Hydrogen Fueling Stations
- Q. Parking and Other Access Restrictions

Safety (3.7.4.2)

H_2Fuel will establish and maintain a comprehensive data base that can be used by others to develop model codes. H_2Fuel facilities will provide an excellent training venue for other DOE projects.

- A. Limited Historical Database
- C. Validation of Historical Data
- D. Liability Issues
- F. Safety is Not Always Treated as a Continuing Process
- G. Expense of Data Collection and Maintenance
- H. Lack of Hydrogen Knowledge by Authorities Having Jurisdiction
- I. Lack of Hydrogen Training Facilities for Emergency Responders

Education (3.8.4.1)

H_2Fuel is sufficiently large and broad in scope such that educational and public awareness programs can be maintained that keep the public's interest focused on successful outcomes.

- A. Lack of Awareness
- B. Lack of Demonstrations or Examples of Real World Use
- C. Institutional Barriers and Access to Audiences

Contribution to Achievement of DOE Technology Validation Milestones

H_2Fuel will contribute to achievement of the following DOE technology validation milestones from the Technology Validation section of the Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan:

- *Milestone 3. Demonstrate (on a vehicle) compressed and cryogenic storage tanks achieving the 2005 energy and mass density targets*. H_2Fuel will begin with 10 vehicles that require 13 kg hydrogen per day with annual increases until there are 50 vehicles that require 524 kg hydrogen per day. Thus a variety of storage tanks can be evaluated and compared under actual operating conditions.
- *Milestone 6. Validate vehicle refueling time of 5 minutes or less.* RTC's current paratransit fleet includes 40 CNG vehicles. The hydrogen powered vehicles will be integrated in to this fleet. This will provide critical side by side refueling experiences that will help guide the development of advanced hydrogen refueling technologies and procedures.
- *Milestone 11. Validate cost of producing hydrogen in quantity of $3.00/gge untaxed*. Since all costs will be run through RTC's controller, it will be relatively easy to track all costs associated with the hydrogen production and to identify areas where cost reductions can be effected.
- *Milestone 12. Five stations and two maintenance facilities constructed with advanced sensor systems and operating procedures.* H_2Fuel provides a research platform of sufficient size to determine and resolve integration issues related to handling the hydrogen fuel from both equipment and personnel perspectives.
- *Milestone 17. Validate prototype energy station for 12 months; projected durability >40,000 hours; electrical energy efficiency >40%; availability >0.85.* An essential aspect for H_2Fuel is the fact that it will be integrated into RTC's daily operations. Thus a total system reliability (equipment and human factors) database will be developed and carefully documented.

Approach

H_2Fuel is based upon a technical and economic feasibility study previously funded by the Regional Transportation Commission. This project will construct, integrate, and operate a geothermal electrical generation facility to power a hydrogen fuel production facility utilizing electrolysis technology. The project will also construct, integrate, and operate facilities for gas storage, transmission, distribution, dispensing fuel, and maintaining hydrogen powered vehicles. A number of transit vehicles using various types of hydrogen powered propulsion systems will be operated and maintained under real world conditions.

Figure 1 summarizes the nine-year, multi-step transition from diesel or compressed natural gas (CNG) fuel to hydrogen fuel for a portion of RTC's fixed-route and paratransit fleets. Each step represents a major transition milestone. A blended-fuel mixture of hydrogen and compressed natural gas (HCNG) is well established and will be used in the first phase. Hybrid-electric vehicles powered by hydrogen-fueled internal combustion engines will be the second phase. The final phase will involve the introduction of fuel cell powered buses.

This multi-step transition allows RTC personnel to be trained in gradual steps in dealing with fuel tanks and fueling systems consisting of compressed hydrogen gas, as well as becoming comfortable with hydrogen as a safe alternative fuel.

Until the primary geothermal powered fuel production facility is on-stream, hydrogen will be generated from electrolysis units operating on grid power. Over the life of H_2Fuel, new hydrogen

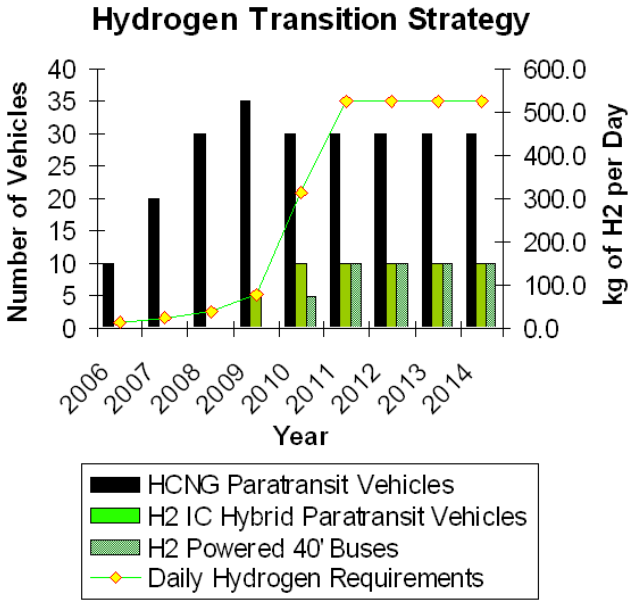

Figure 1. H_2Fuel Vehicle Acquisition and Hydrogen Production Schedules

generation, storage, and propulsion technologies will be introduced into the project to maximize the breadth and value of the generated data.

H_2Fuel affords unprecedented opportunities for working with regulatory agencies on the development and integration of codes and standards across multiple technologies and areas of operation. Finally, the project will provide an experiment in public outreach and education on the use of hydrogen fuel on a community-wide scale. H_2Fuel provides the nation a large scale, real-world facility for research and development of not only individual technologies and policies, but also the integration and interaction of these technologies and policies. Experience and data generated by this research and development effort will be reported to the scientific and industrial communities on an on-going basis over the projected nine-year life of the project providing much needed data for addressing a number of the barriers identified in the "Hydrogen, Fuel Cells and Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan."