California Hydrogen Infrastructure Project

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10 June 2008

Project ID #TV7
Overview

Timeline
- Start – Aug. 2005
- End – Sept. 2008
- 85% Complete

Cost of delivered hydrogen

Budget
- Total project funding
  - DOE $5.5 million share
  - Contractor $5.4 million share
- Funding received through FY07
  - Total $4.4 million
- Funding for FY08
  - Total $0.7 million (2/29/08)

Partners
- Various collaborators and funding groups including:
  - SCAQMD
  - OEM’s
  - UC Irvine
  - Energy Companies
Objectives

● Demonstrate a cost effective infrastructure model in California for possible nationwide implementation
  – Design, construct and operate seven hydrogen fueling stations
  – Collect and Report Infrastructure Data
  – Document permitting requirements and experiences
  – Validate expected performance, cost, reliability, maintenance, and environmental impacts

● Implement a variety of new technologies with the objective of lowering costs of delivered hydrogen
  – New Delivery Concept (NDC)
  – Hydrogen Based Unit (HBU)
Approach

- Work with OEM’s to determine vehicle usage needs and general station equipment requirements
- Work with OEM’s and others to determine preferred locations/areas for fueling station deployment
- Select potential Station Operators and work to locate suitable sites
- Initiate and complete required agreements, determine and address specific site issues including liability, billing, etc.
- Complete detailed Station Design, permits, installation, operation, and maintenance of stations
- Collect and report Infrastructure Data to the DOE once stations put online
- Monitor and collect feedback which can be incorporated to improve station user’s fueling experience
Project Tasks

- Station Installation
  - UCI Fueling Station
  - Torrance Pipeline Fueling Station
  - Hydrogen Fuelers (HF-150)
  - New Delivery Concept (NDC)
  - Hydrogen Based Unit (HBU)

- Novel Compressor Development

- Hydrogen Infrastructure Study (UC Irvine)

- Infrastructure Data Acquisition, Analysis and Delivery (includes eRAM)
Operating Stations

UCI 350/700 Bar Station
- Excellent operating performance, increasing station utilization
- Liquid hydrogen station project cancelled

Long Beach Mobile Fueler
Station installed in June 2007
Continuing to negotiate vehicle access agreements
New Delivery Concept (NDC) Trailer

Liquid H₂ trailer modified to deliver both liquid and low/medium/high pressure gaseous products. Efficiency of liquid distribution for bulk H₂ stations.

Status:
NDC#1 fabricated and deployed to CA
HBU#1 built, station operator to be identified
Status of Other Station Development Activities

Torrance Pipeline Hydrogen Fueling Station

- Agreements could not be reached with landowners at original site for fueling station equipment
- Station Operator is negotiating lease for a new location along Air Products’ hydrogen pipeline
- Equipment lease and station funding agreements to be finalized

South Lake Tahoe Mobile Fueler

Conditional approval by City Council of agreement to site station
Negotiating vehicle access and station funding agreements
Novel Compressor System

New equipment design which can compress hydrogen from 100 psi to 14,000 psi in one stage.

- System leak-checked to 14,000 psi
- Function test performed at 4,000 psi
- Functional test completed on all major components
- System ready for next phase of operation
Assessing the Impacts of Hydrogen Infrastructure Deployment in Southern California

Advanced Power and Energy Program
University of California, Irvine

Shane D. Stephens-Romero, Graduate Researcher
Professor G. Scott Samuelsen
U.S. Department of Energy
6/10/08
Overview of H₂ Infrastructure Assessment

Goal -
Assess the impacts associated with the deployment of hydrogen infrastructure in Southern California by designing and modeling a variety of scenarios for deployment.

1. Develop a methodology to analyze the integration of technologies in a hydrogen infrastructure with respect to criteria pollutant emissions, GHG emissions, energy consumption, and water consumption.

2. Develop hydrogen infrastructure scenarios with a high level of geographic detail and utilize the capabilities of the Computational Environmental Sciences Laboratory at the University of California, Irvine to simulate the air quality impacts.
1. Analysis of Integrated H$_2$ Infrastructure

**Total Hydrogen**

**Input:**
- Natural Gas
- Electricity
- Renewable
- Water
- Coal/Pet. Coke

**Distributed:**
- SMR
- Electrolysis - Grid
- Coal/Pet. Coke Gasification
- Electrolysis - Renewable

**Centralized:**
- SMR
- Pipeline Distribution
- Compression
- Liquefaction
- Tube Trailer Distribution
- Compression
- Liquefaction

**Output:**
- Vehicle Dispensing

Criteria pollutant emissions
GHG emissions
Energy consumption
Water consumption
1. Analysis of Integrated H₂ Infrastructure

GHG emissions with the adoption of hydrogen infrastructure in Southern California

GHG emissions in CO₂ equivalents (metric tons per day)

- H₂ Scenario 1 (more fossil fuel)
- H₂ Scenario 2 (more renewable)
- Conventional

12.5% adoption of hydrogen vehicles
75% adoption of hydrogen vehicles

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2. Simulating Air Quality Impacts

Southern California
Year: 2060

- Interstates & Freeways
- H2 fueling stations
- Central SMR facilities
- Petroleum coke
- Coal
- Renewable (Solar, Wind, Geo)
- H2 Pipelines
2. Simulating Air Quality Impacts

Output:
- Criteria pollutant emissions
- GHG emissions
- Energy consumption
- Water consumption

Air Quality Simulation

- Ozone: peak
- Ozone: 8-hour average
- Particulate Matter
2. Simulating Air Quality Impacts

Ozone: 8-hour average
[Δ H2 vs. conventional]

Southern California
Year: 2060
Future Work

- UCI Fueling Station – Finalize LHys Dispensing System
- Torrance Pipeline Fueling Station – Complete Agreement with Station Operator; Install and Commission both 350 and 700 bar Systems
- Hydrogen Fuelers (HF-150) – Begin Operation at Long Beach; Identify Other Locations and Station Operators
- New Delivery Concept (NDC) – Complete Fabrication of NDC #1 and Deploy; Fabricate NDC #2 and Deploy
- Hydrogen Based Unit (HBU) – Fabricate HBU #2; Identify Locations and Station Operators
- Infrastructure Data Acquisition, Analysis and Delivery – Report Data to DOE
- Novel Compressor Development – Complete Operating Program
- Hydrogen Infrastructure Study by UCI – Perform Scope of Work
Summary

- Demonstrate a variety of options for delivery of low-cost hydrogen in the deployment of Hydrogen Infrastructure
  - First permanent CHIP station (350 and 700 bar gaseous hydrogen) opened at UCI
  - First mobile CHIP station (HF-150) opened in Long Beach
  - Commissioning of Novel Compression System
  - Infrastructure Data Data Reporting at each station

- Near Term Activities
  - First pipeline supplied hydrogen station in permit phase
  - Equipment fabrication nearly complete in most cases

- Continuing to develop site locations and Station Operators for other stations

- Initiating Hydrogen Infrastructure Study at UCI
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Additional Slides
Response to Previous Year Reviewers’ Comments

- Heavy reliance on mobile and temporary station design may prohibit learning transfer to future commercial situation and may limit near-term development of a true fuel cell vehicle fueling network including a “retail” feel for near/mid-term customers.
  - Mobile and temporary fueling stations provide a low-cost way to introduce hydrogen into communities that may have little or no experience with fuel cell vehicles. Long Beach and South Lake Tahoe are excellent examples where the demonstration of extensive experience with the same equipment was important to both landowners where the equipment was sited and to fire inspectors that reviewed and approved the installation. These mobile systems are also easy to remove and replace with permanent stations once vehicle demand increases.

- Limited to distribution of gaseous and liquid hydrogen; no on-site generation options.
  - As part of other DOE-sponsored programs not part of the Technical Validation efforts, Air Products has installed and operated on-site hydrogen generation systems for vehicle fueling stations. Given the low capacity factor of these systems, our analysis indicates that the utilization of the existing infrastructure of gaseous (via pipeline and bulk transport) and liquid hydrogen delivery provides the lowest-cost approach to supply hydrogen during the transition to the hydrogen economy.
Publications and Presentations


Critical Challenges and Issues

- Locating Optimal Sites for Fueling Stations
  - Available space, close to freeways with convenient access (24/7 access preferred), minimize overlap with existing or planned stations (~10 mile separation distance)
  - Completing contracts and legal agreements (primary issues around liability, indemnification, insurance, etc.)

- Challenges in Retail Settings
  - Station Constraints - Limited Space: Stations typically designed to accommodate existing fueling requirements (gasoline), limited parking, specific traffic flow, max. C-store presence, setback distances, etc.
  - Low Station Utilization in early years. Unclear on timing for increased expected usage.

- Codes and Standards
  - Close interaction with local authorities to educate and work through existing codes and standards, areas of conflict and differences.
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