DOE Hydrogen Program

California Hydrogen Infrastructure Project

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Air Products and Chemicals, Inc.

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Project ID #TV7

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Overview

Timeline

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

Barriers

- 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

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New Delivery Concept (NDC) Trailer

Liquid H_2 trailer modified to deliver both liquid and low/medium/high pressure gaseous products. Efficiency of liquid distribution for bulk H_2 stations.

LH_2 Tank

Bulk H_2

HF-150

Hydrogen Based Unit (HBU)

Status:

- **NDC#1 fabricated and deployed to CA**
- **HBU#1 built, station operator to be identified**

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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**

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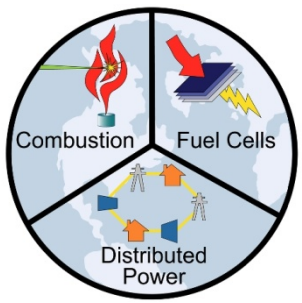
Assessing the Impacts of Hydrogen Infrastructure Deployment in Southern California



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

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Overview of H2 Infrastructure Assessment

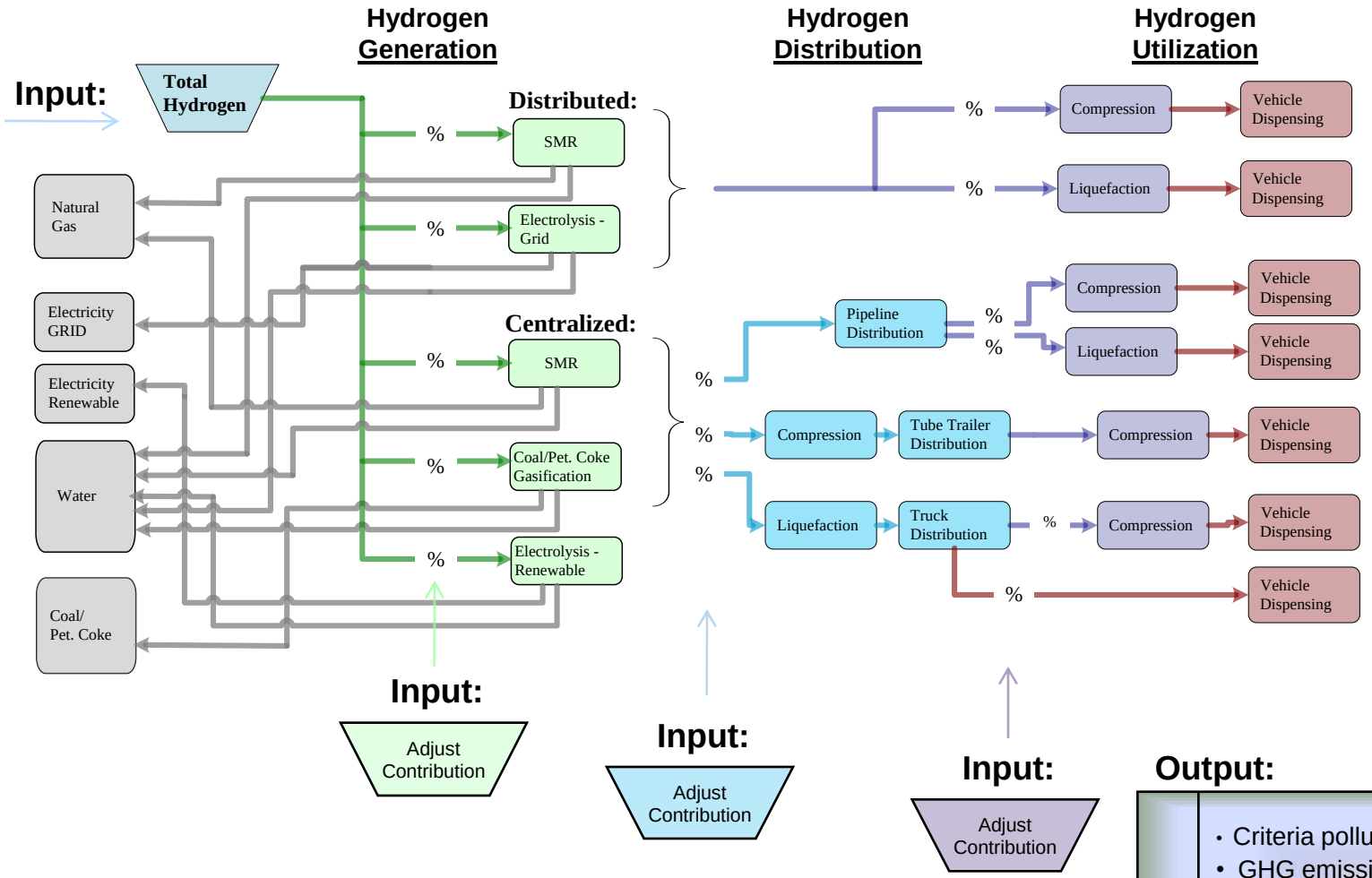
Goal -

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 H2 Infrastructure



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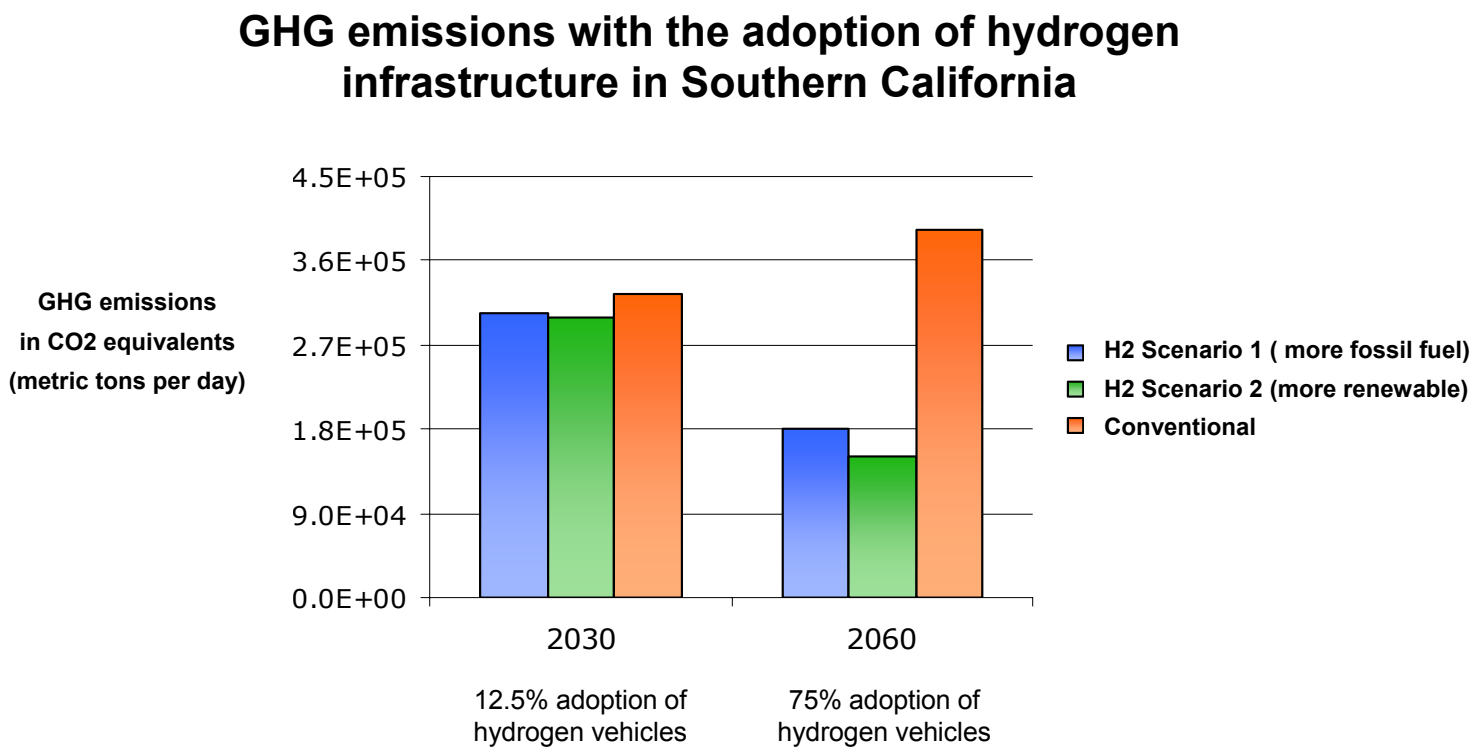
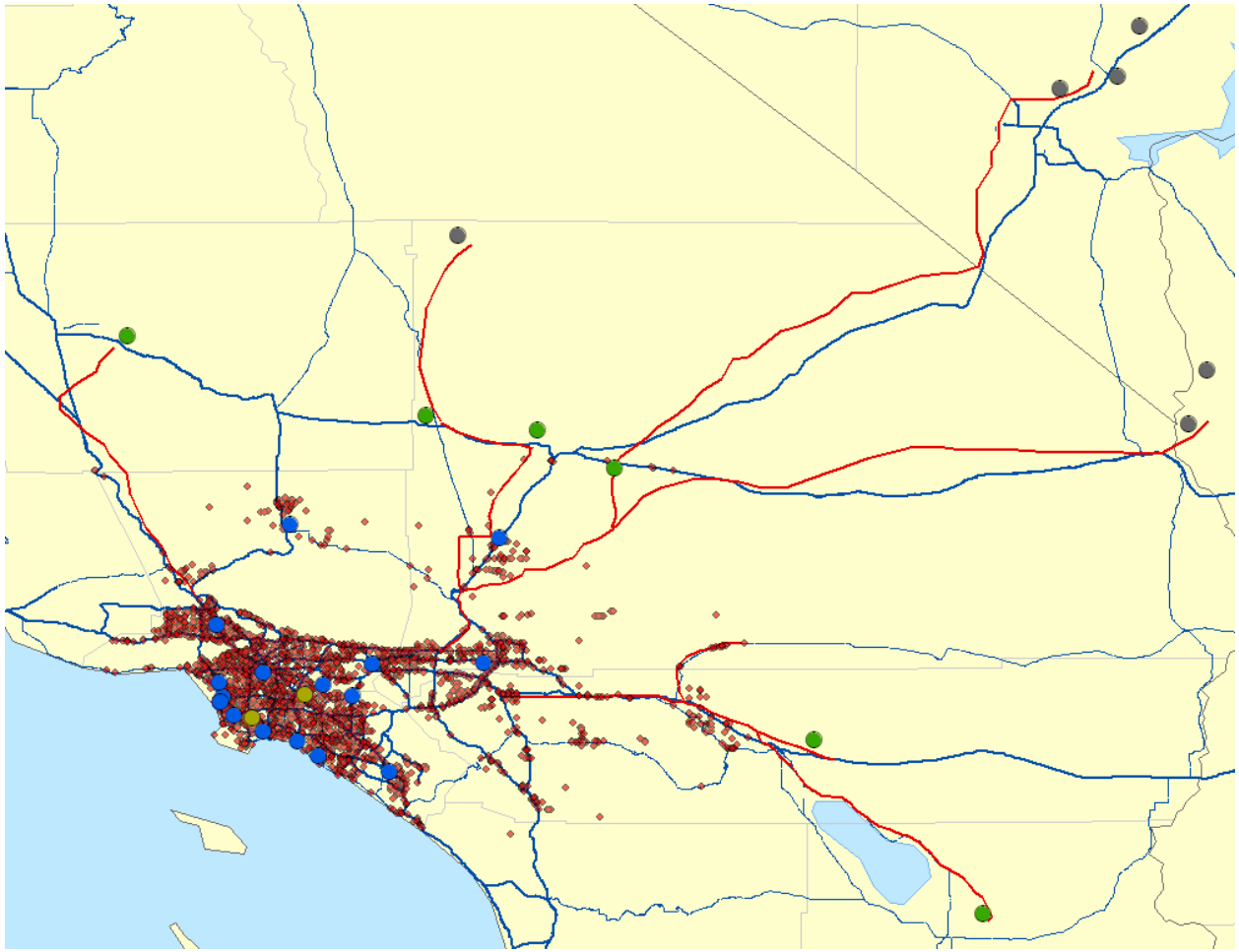


2. Simulating Air Quality Impacts



Southern California
Year: 2060

- Interstates & Freeways
- H2 fueling stations
- Central SMR facilities
- Petroleum coke
- Coal
- Renewable (Solar, Wind, Geo)
- H2 Pipelines

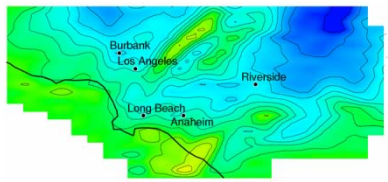
2. Simulating Air Quality Impacts

Output:

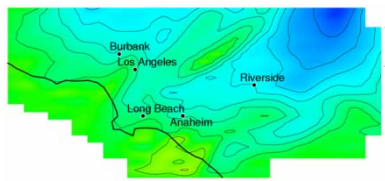
- Criteria pollutant emissions
- GHG emissions
- Energy consumption
- Water consumption

Air Quality Simulation

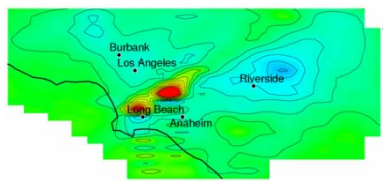
Ozone: peak



Ozone: 8-hour average

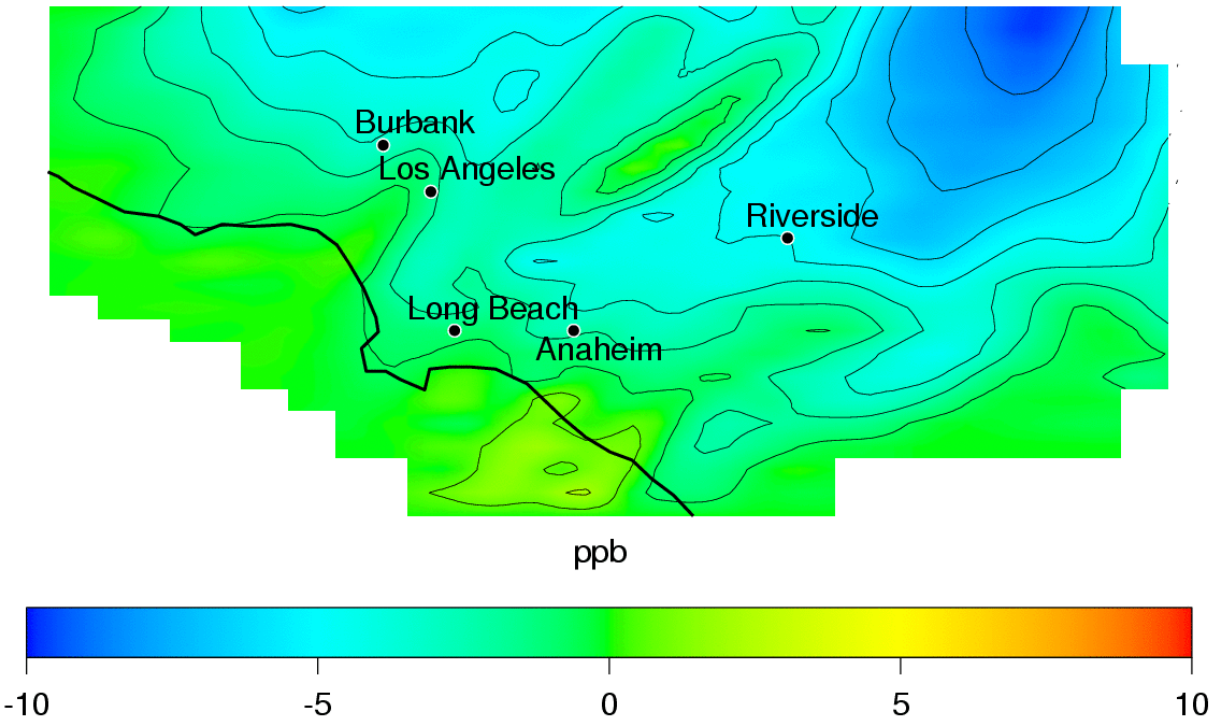


Particulate Matter



2. Simulating Air Quality Impacts

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



Southern California
Year: 2060

Future Work

- UCI Fueling Station – Finalize LHy 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 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

Thank you

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Acknowledgement & Disclaimers

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