

Validation of an Integrated Hydrogen Energy Station

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Project ID
#TV006

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Overview

Timeline

- Start – 30 Sept. 2001
- End – 31 Mar. 2011
- 89% Complete

Budget

- Total project funding
 - DOE share: \$5.95 million
 - APCI + Partners share: \$6.59 million
- Funding received in FY09: \$0.5 million
- Funding for FY10: \$0.25 million

Barriers

- H₂ Fueling Infrastructure
- H₂ & Power Coproduction

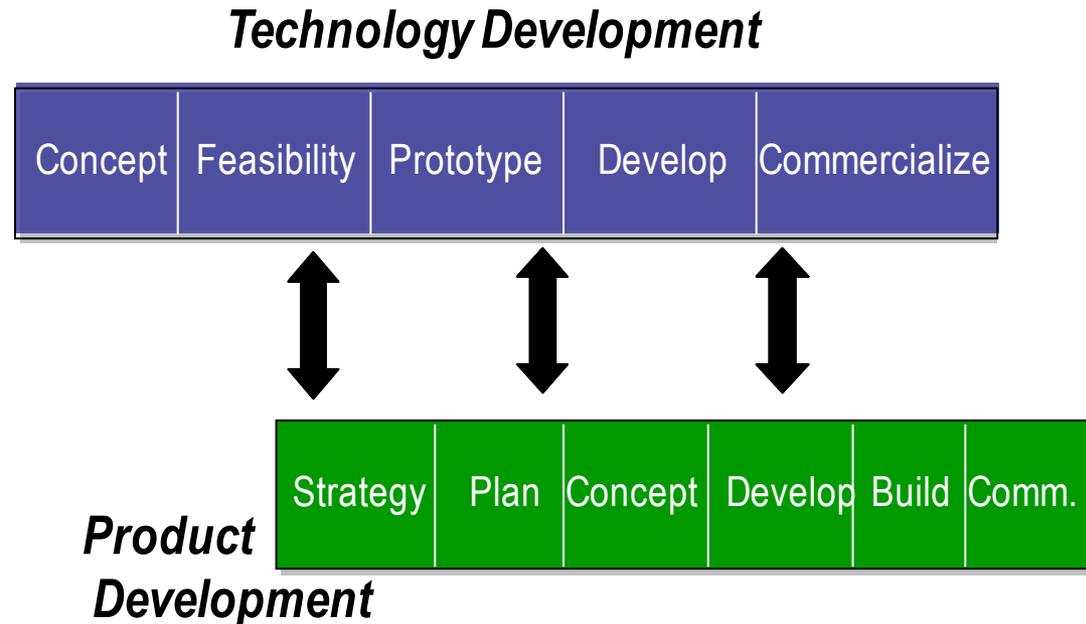
Partners

- FuelCell Energy
 - MCFC, Fuel Prep, WGS
- OCSD – Host Site (CA)
- CA – ARB, AQMD
 - UC Irvine

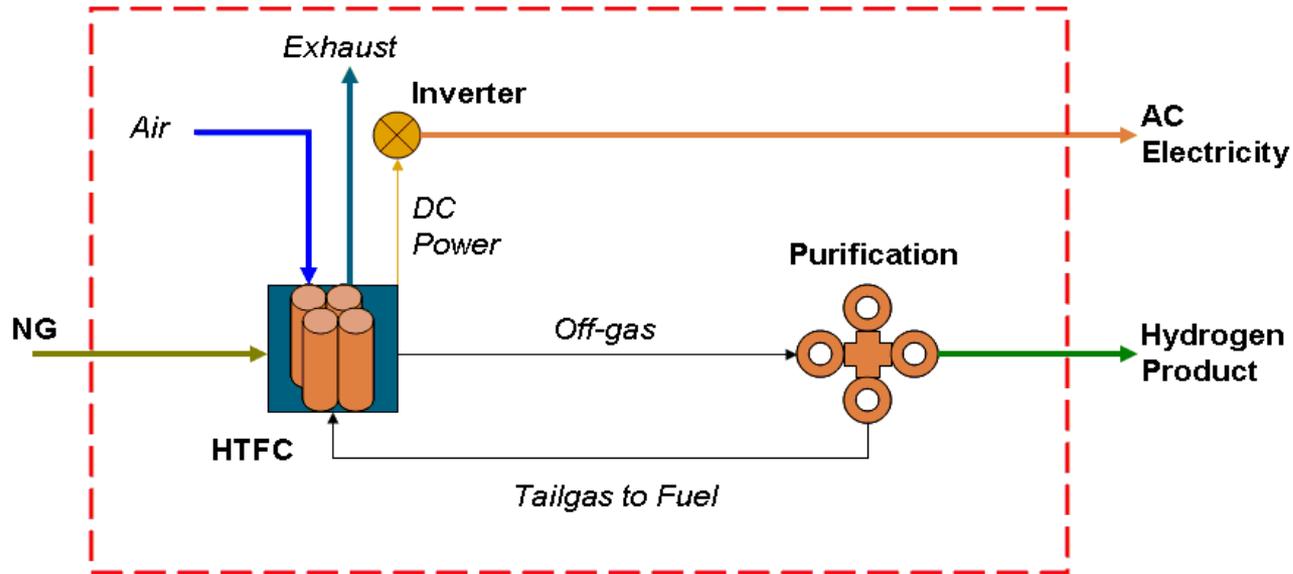
Objectives - Relevance

- Determine the economic and technical viability of a hydrogen energy station designed to co-produce power and hydrogen

Utilize technology development roadmap to provide deliverables and go/no-go decision points



Hydrogen Energy Station Concept



Potential Co-Production Efficiency (LHV): 55 - 60%

Fuel Cell Outlet at High Temperature and Low Pressure

- H₂: 10%
- H₂O: 40%
- CO: 5%
- CO₂: 45%

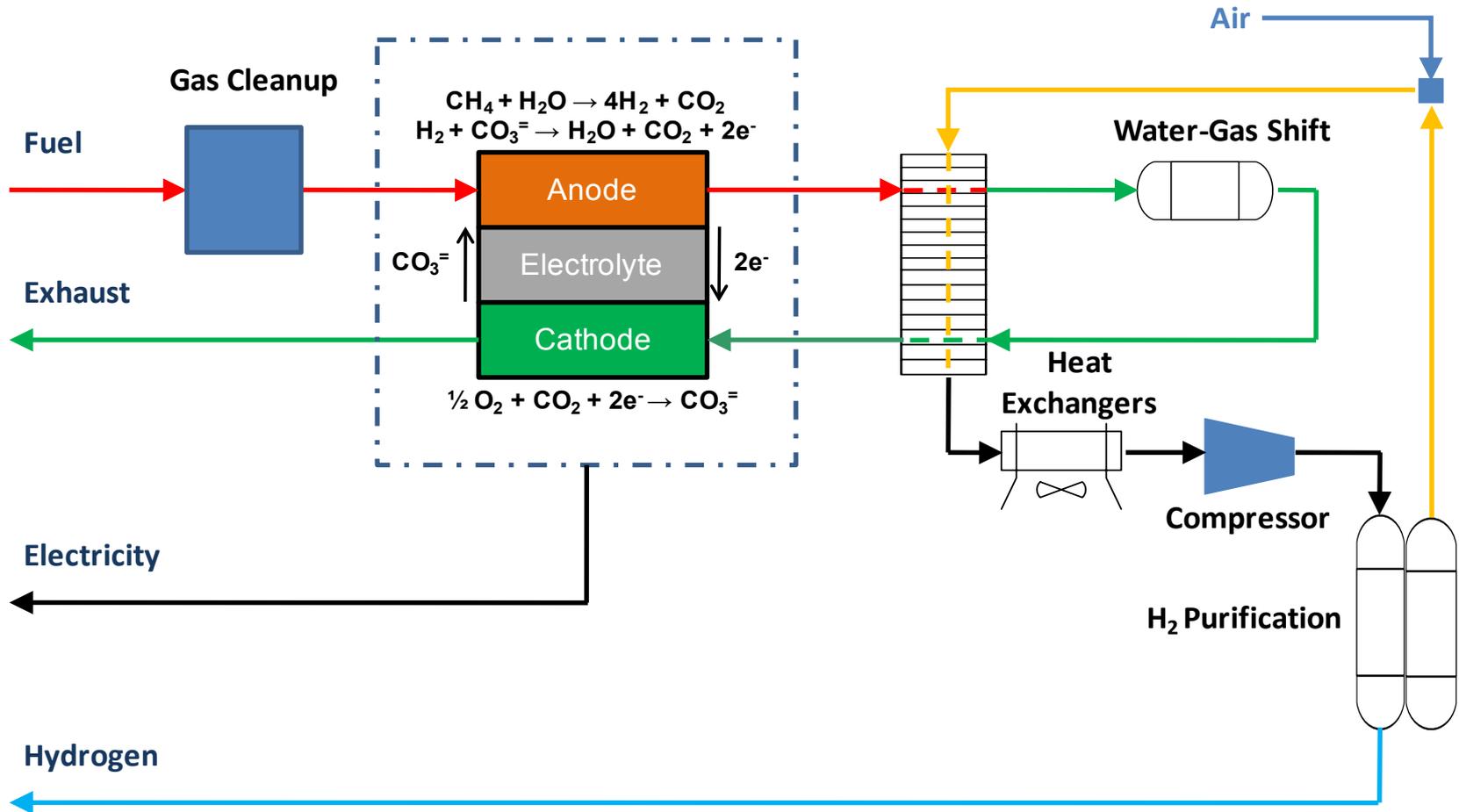
Hydrogen Product at Low Temperature and High Pressure

- H₂: 99.99%
- H₂O: Rejection and Recycle
- CO: < 0.2 ppm
- CO₂: < 2 ppm

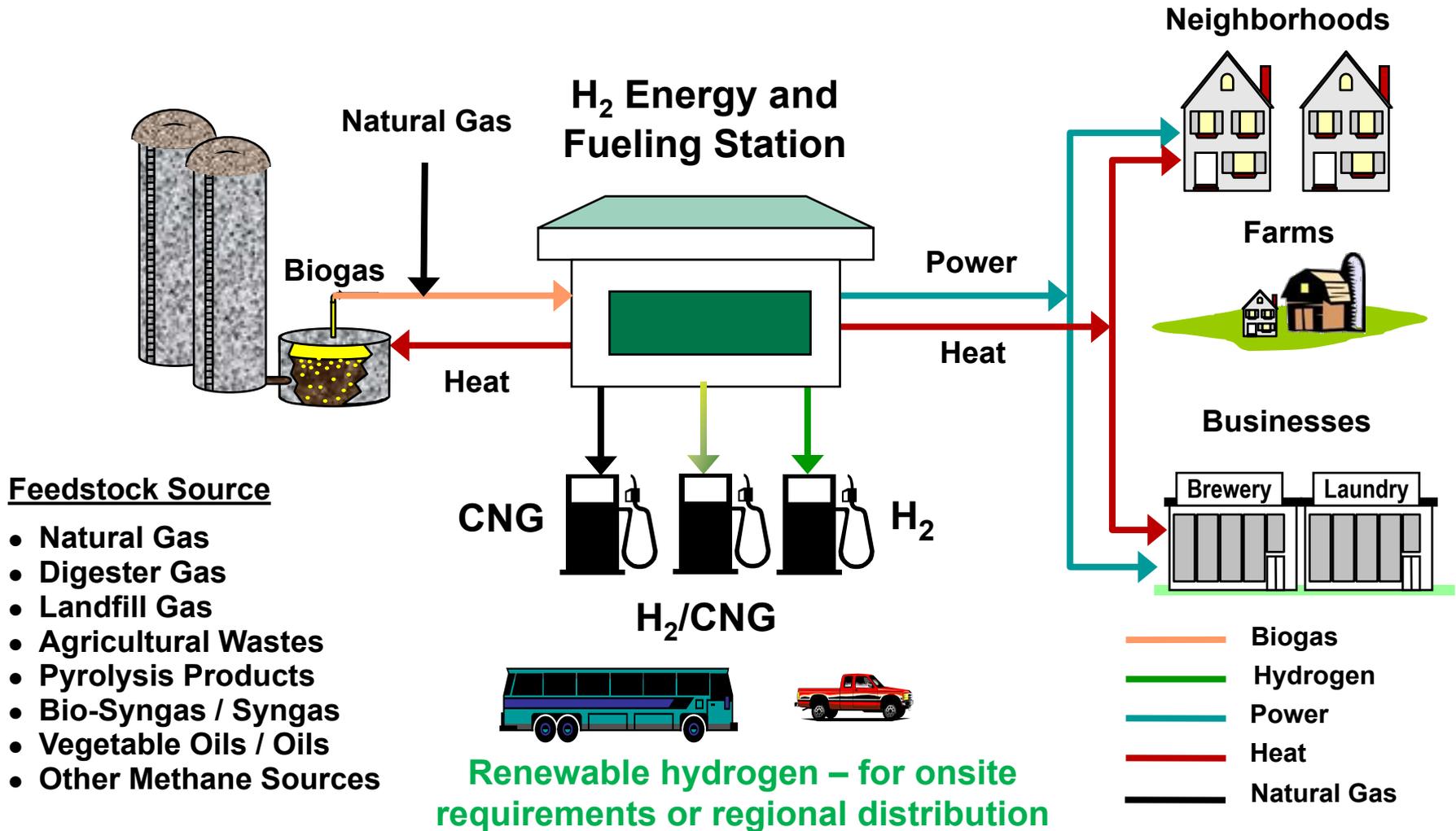
Approach

- **DOE Program defined 4 phases:**
 - **Phase 1 – Feasibility: Evaluate PEM and HTFC**
 - **Completed FY04**
 - **Phase 2 – Preliminary System Design**
 - **Completed FY06**
 - **Phase 3 – Detailed Design and Construction**
 - **Design/Fabrication Completed March 2009**
 - **Shop Validation Test Completed March 2010**
 - **Phase 4 – Operation, Testing, Data Collection**
 - **Deployment in CA Summer 2010**

Hydrogen Energy Station



Hydrogen Energy Station Vision



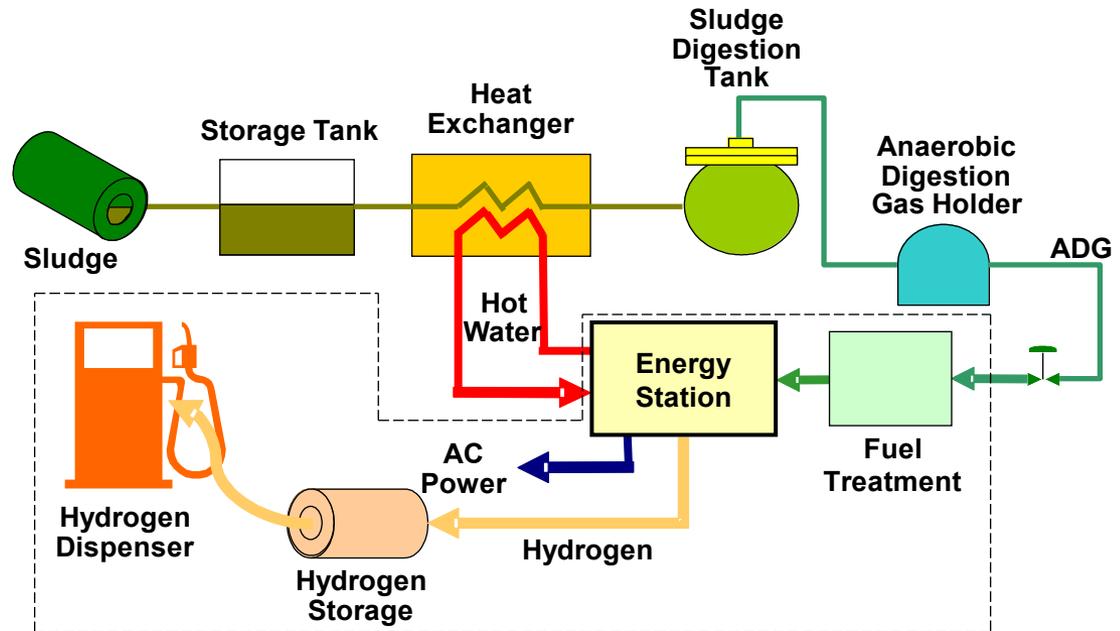
Demonstration of Hydrogen Energy Station Vision

- DOE Program – Natural Gas Feed
- Potential Host Site Identified - **OCSD**
 - Orange County Sanitation District, Fountain Valley, CA
 - Municipal Wastewater Treatment
 - Existing CNG Refueling Station
 - **Ability to Achieve Production of both Renewable Hydrogen and Electricity**

California Air Resources Board Grant

Fountain Valley Station

- 100 kg/day capacity, renewable hydrogen supply
- 350 and 700 bar fueling capability
- Host site: Orange County Sanitation District
- Anaerobic digestion of municipal wastewater
- Funding for fuel treatment and fueling station from DOE California Hydrogen Infrastructure Program with Air Products (Cooperative Agreement No. DE-FC36-05GO85026)
- Key subcontractors: FuelCell Energy, Inc. and National Fuel Cell Research Center, University of California, Irvine



Hydrogen Energy Station Shop Validation Test

2009: Equipment installed at FuelCell Energy's facilities



**Hydrogen Ready
Fuel Cell Module**

**Anode Exhaust
Processing
and H₂ Purification
System**



**Mechanical
Balance of Plant
(MBOP)**

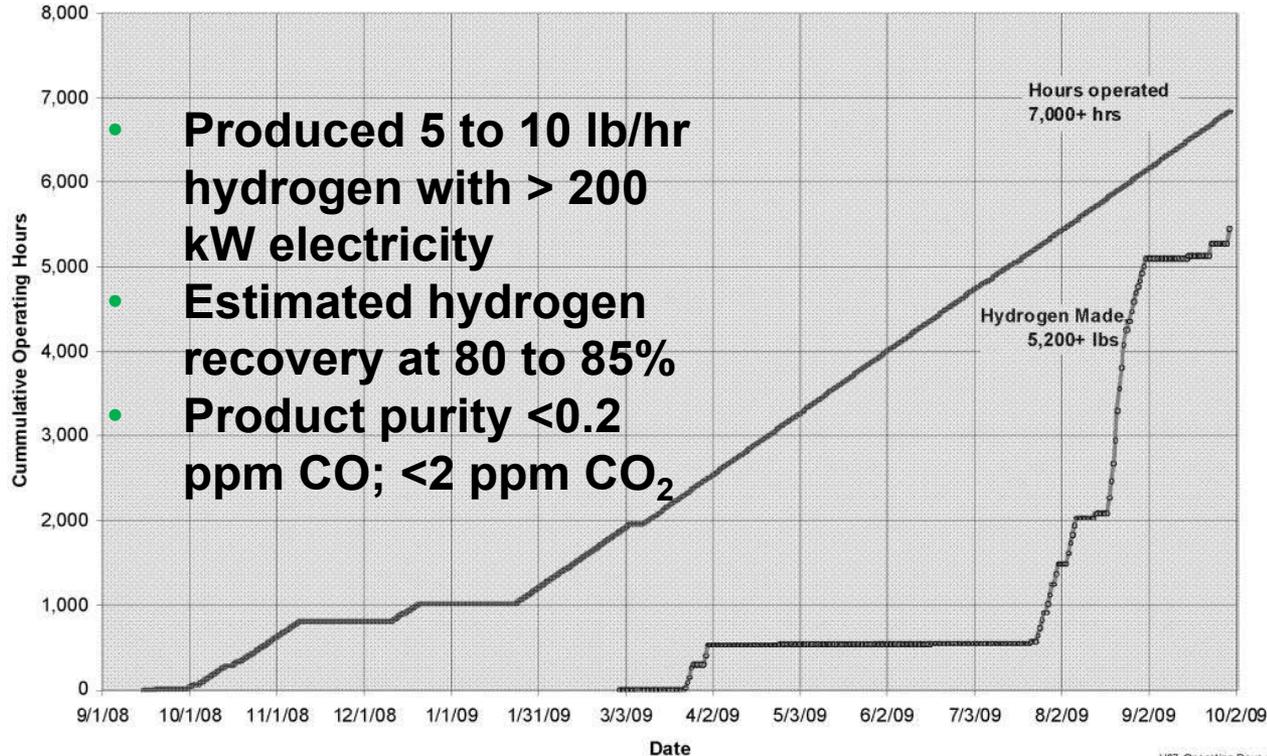


Objectives of Shop Validation Test

- **System installation, commissioning, start-up**
- **Demonstrate variable production of both electricity and hydrogen**
- **Optimize control system and controls philosophy**
- **Test and further develop response to upset conditions**
 - **Rapid de-integration procedure**



Successful Completion of Hydrogen Energy Station Shop Validation Test (2010)

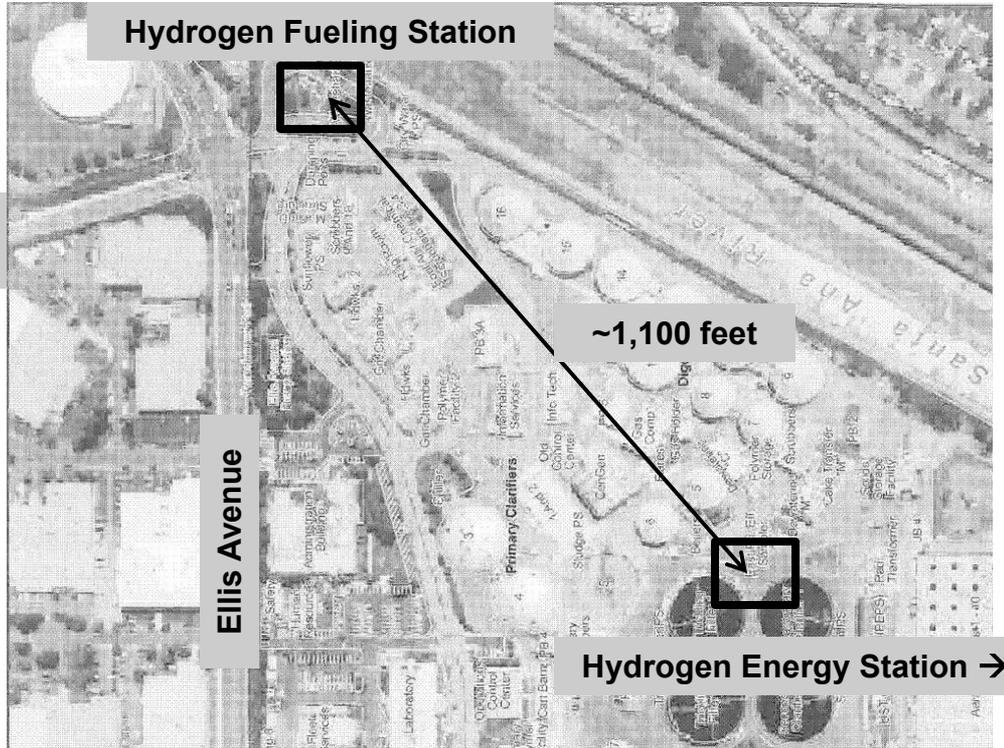


Other Accomplishments:

- Operation with simulated digester gas feed
- PSA operating map developed (cycle time vs. feed rate)
- Implemented automated integration/deintegration



Orange County Sanitation District Site



- Anticipated onstream Summer 2010



Collaboration

- **Industry**
 - FuelCell Energy, Inc. – Subcontractor, Fuel Cell Supplier
 - Southern California Gas Co. – Funding to FuelCell Energy
- **Government/Municipal Entities**
 - U.S. Department of Energy
 - California Air Resources Board
 - South Coast Air Quality Management District
 - Orange County Sanitation District – Host Site, Site Improvements)
- **University**
 - University of California, Irvine – Data Analysis, Education/Outreach Activities within CARB Program

Future Work

- Installation at Orange County Sanitation District – Lessons learned from shop test, field trial
- Validation of process economics
- Following DOE Program:
 - Product development activities – Process improvements for second generation system
 - Scale-up based on existing fuel cell products –
 - DFC[®]1500 – 400 to 500 kg/day H₂ plus 1.0 to 1.2 MW and 2 MMBTU/hr heat
 - DFC[®]3000 – 800 to 1,000 kg/day H₂ plus 2.0 to 2.4 MW and 4 MMBTU/hr heat

DFC[®]300



DFC[®]1500

Summary

- **Determine the economic and technical viability of a hydrogen energy station designed to co-produce power and hydrogen**
 - **Concept defined – FuelCell Energy’s molten carbonate fuel cell plus Air Products’ hydrogen purification system**
 - **Design and fabrication of demonstration unit completed**
 - **Shop test successfully completed at FuelCell Energy’s facilities**
 - **Demonstration operation beginning mid-2010 on renewable feedstock at Orange Co. Sanitation District**
 - **Hydrogen refueling station under DOE’s California Hydrogen Infrastructure Project**
 - **Other funding: California Air Resources Board, South Coast Air Quality Management District, SoCal Gas**
 - **Validate process economics based on system performance**

Thank you

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Acknowledgement & Disclaimers

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