



2009 DOE Hydrogen Program and Vehicle Technologies Program AMR

HYDROGEN AND FUEL CELL EDUCATION AT CALIFORNIA STATE UNIVERSITY, LOS ANGELES

Dr. David Blekhman

California State University, Los Angeles

March, 2009

Project ID
ed_03_blekhman



Overview

Timeline

- October/November, 2009
- July 31, 2010
- ~60 % complete

Budget

- Total project funding
 - DOE \$238,727
 - Contractor \$113,752
- Funding received in full in Nov 08.

Barriers

Workforce Development

- Curriculum development
- Laboratory development

Education and Outreach

- Outreach to community colleges and schools
- Partnerships including OEMs
- Program development into research

Hydrogen Production

Partners

- California Fuel Cell Partnership
- GM Corp
- Many more to be listed
- California State University, Los Angeles— [Project lead](#)



Project Objectives

- Implement a comprehensive set of curriculum development and training activities:
 - Developing and offering several courses in fuel cell technologies, hydrogen and alternative fuels production, alternative and renewable energy technologies as means of zero emissions hydrogen economy, and sustainable environment.
 - Establishing a zero emissions PEM fuel cell and hydrogen laboratory supporting curriculum and graduate students' teaching and research experiences.
 - Providing engaging capstone projects for multi-disciplinary teams of senior undergraduate students.
 - Fostering partnerships with automotive OEMs, energy providers, community colleges, government agencies and other stakeholders.



College Initiatives

- Redesigning the curriculum to implement an effective Alternative and Renewable Energy Technologies program including hydrogen economy and fuel cell applications.
- Building a hydrogen fueling station to serve the central Los Angeles area and become a focal point of research, educational and outreach activities. The station is being funded by several agencies and foundations.
- Establishing a research Center for Alternative and Renewable Energy and Sustainability. Funded by NSF programs and local partners.

Flashback: History of Innovation



to the Web Site for Cal State L.A.'s National Champion solar car, the Solar Eagle III



Sunrayce 97



A collage of images related to the Solar Eagle III solar car. It features a yellow and black solar car with the number 8, a group of four team members in white shirts, and a smaller image of the car. The text "Sunrayce 97" is written in a stylized font with a sun icon.





Milestones for 2-year Project

- Develop and offer fuel cell and hydrogen courses (Task 1.0) in the 2008-2009 academic year (*in progress*).
- Purchase and install the majority of the equipment for the hydrogen laboratory in the 2008-2009 academic year and summer 2009 (*in progress*).
- Install solar panels in the 2008-2009 academic year and summer 2009 (*in progress*).
- Design and build “Hydrogen Safety” senior project in the 2008-2009 academic year (*in progress*).
- Suggest improvements and complete courses listed in Task 1.0 in the 2009-2010 academic year.
- Complete experiments setup in the hydrogen laboratory in the 2009-2010 academic year and summer 2010.
- Complete wiring of solar panels and connect to the electrolyzer in the 2009-2010 academic year and summer 2010.



Key Personnel and Functions

Dr. David Blekhman, PI — teaches courses, supervises research assistants and laboratory development, and provides overall coordination.

Dr. Crist Khachikian — integrates current grant into college grant initiatives and energy center.

Dr. Darrell Guillaume — organizes ME department and advisory board, grant execution experience.

Dr. Trinh Pham — teaches course.

Dr. Virgil Seaman — curates outreach efforts: government and community colleges, hydrogen station, TECH 250 coordination.

Dr. Chivey Wu — teaches course and contributes to laboratory development.



Course Development

- ME 454-Renewable Energy and Sustainability—undergraduate, Dr. Pham, Spring'09
- ME 554-Fuel Cell Systems—graduate, Dr. Wu, Spring'09
- TECH 470-Electric, Hybrid and Alt. Fueled Vehicles—Dr. Blekhman, Winter'09 (Bonus course)
- TECH 474-Fuel Cell Applications—Dr. Blekhman, Spring'09



Curriculum-Larger Student Body

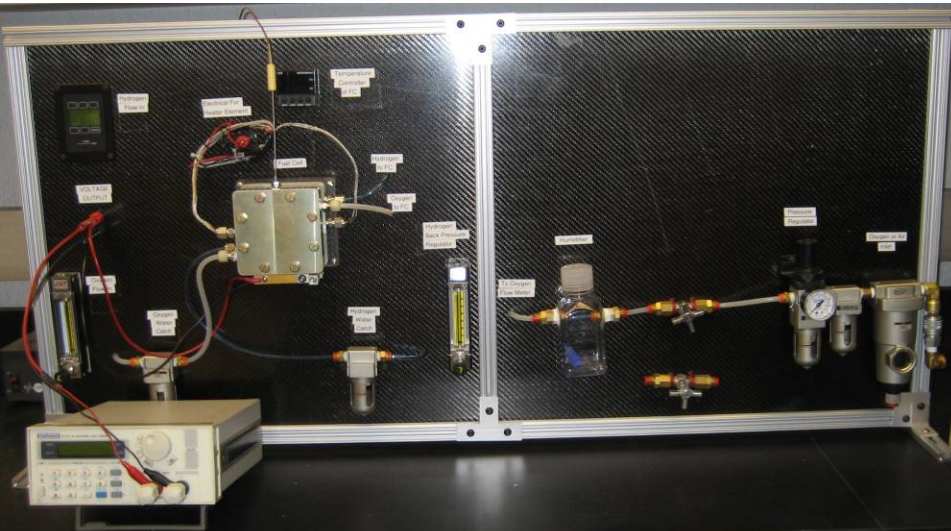
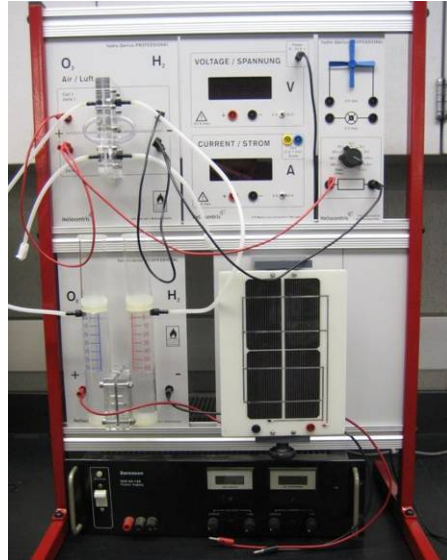
- The Impact of Technology on the Individual and Society (TECH 250)
 - is a general education required course. It is taught by the Technology Department faculty. It is open to all majors in the university and is selected to deliver our message to the university-wide student body.
- Faculty training complete. PPT and video lectures provided.
 - 1. Title: Prof._Blekhman-Fuel Cells, Duration: 00:34:08,
Link: <http://ess-msite.calstatela.edu/Mediasite/Viewer/?peid=10b36466-a786-43a7-9bfc-142ebc51f5fb>
 - 2. Title: Prof._Blekhman-Hydrogen Economy, Duration: 00:35:24
Link: <http://ess-msite.calstatela.edu/Mediasite/Viewer/?peid=c39fd43a-c9c8-4e95-b799-48ebbf5116f>
- Enrollment
 - Fall 2008 – 31, 33, 30, 32 (4 sections were offered)
 - Winter 2009 – 35
 - Spring 2009 – 17 enrolled so far (will go to 25+)
 - Summer 2009 – the course is being offered



Equipment Acquisition

Zero Emissions Fuel Cell and Hydrogen Lab

Two grad assistants



FC Test station

Heliocentris: Dr. Fuel Cell, Nexa Training System Complete, Nexa Integration Kit

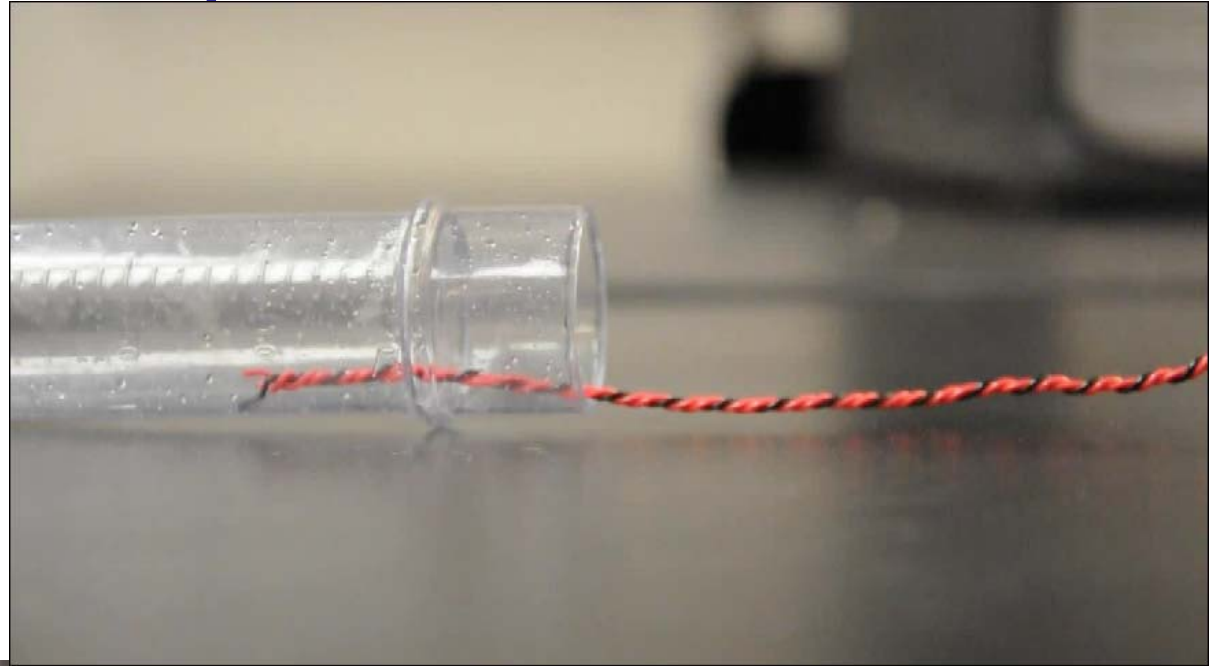
Proton-Hogen GC600 Electrolyzer



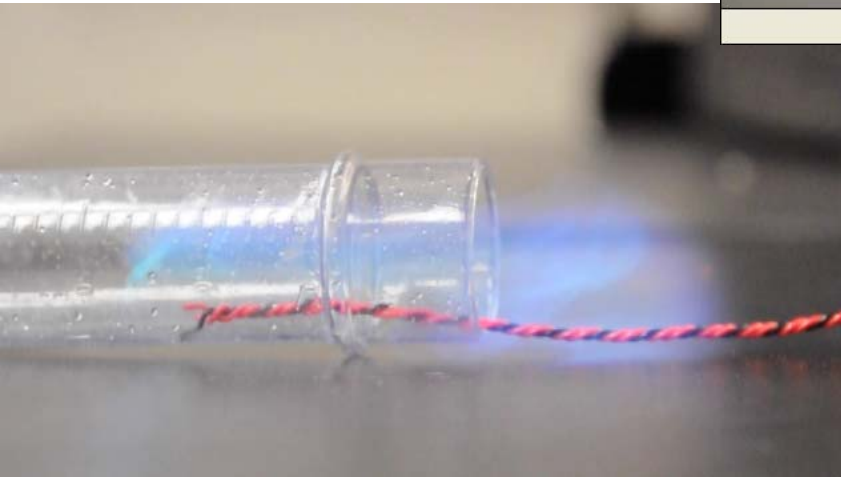


Senior Design—H₂ Safety Experiment

Proof-of-concept experiments:
Ignition in Air

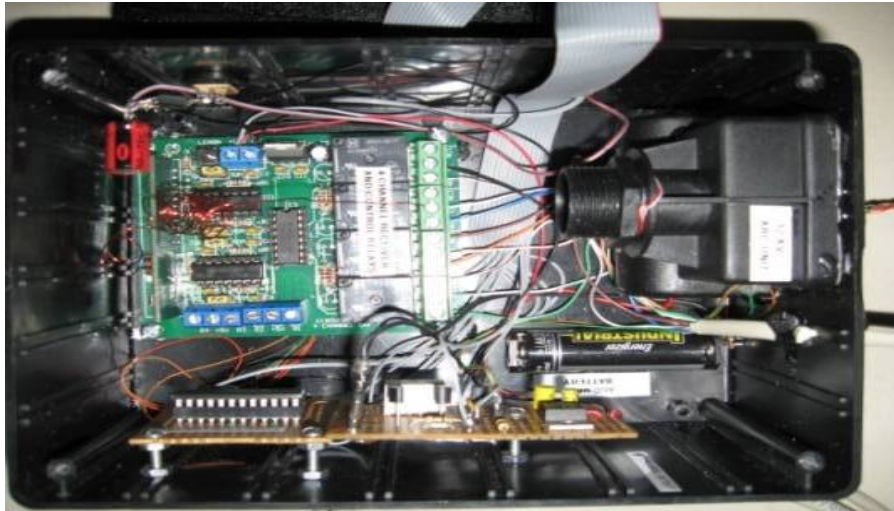


Hydrogen_safety_Explosions_CSULA_reduced.avi



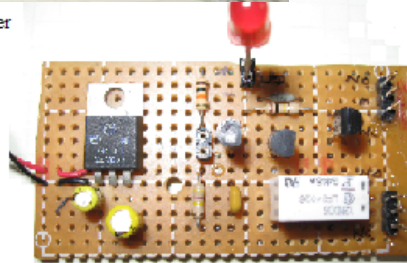
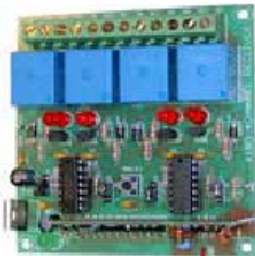
2 ME and 2 EE students

H2 Safety Electrical Control Unit



- List of Applications
 - Test to detect System Short
 - Sensor to Detect Water in Chamber
 - Sensor to Detect Open Gas Valve
 - Sensor to Purge Gas during Water Purge
- Switch for Spark Ignition
- Switch for Electrical Valves

4 channel momentary contact receiver



Water Level Detect & Disable

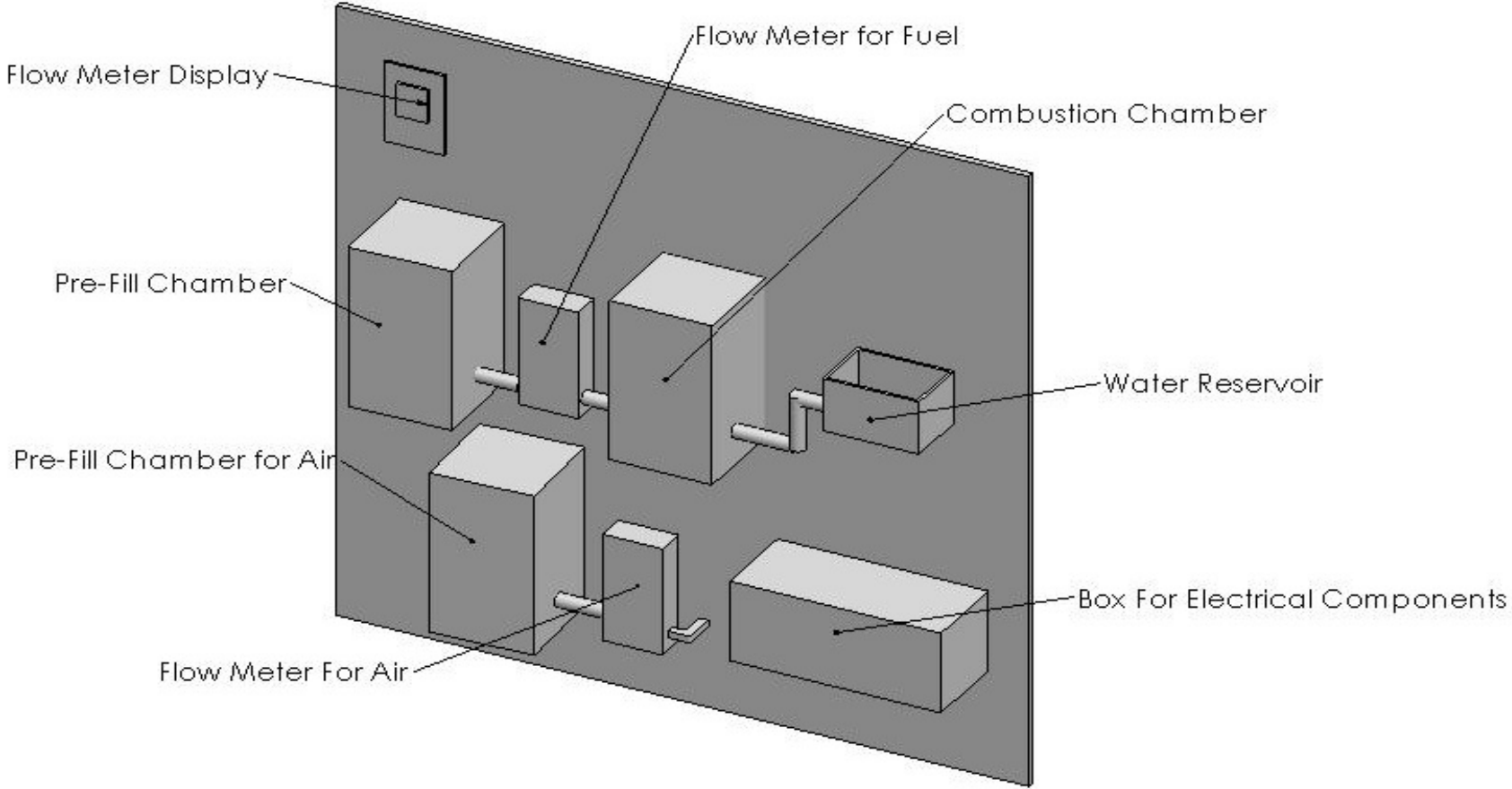


4 Channel remote Control



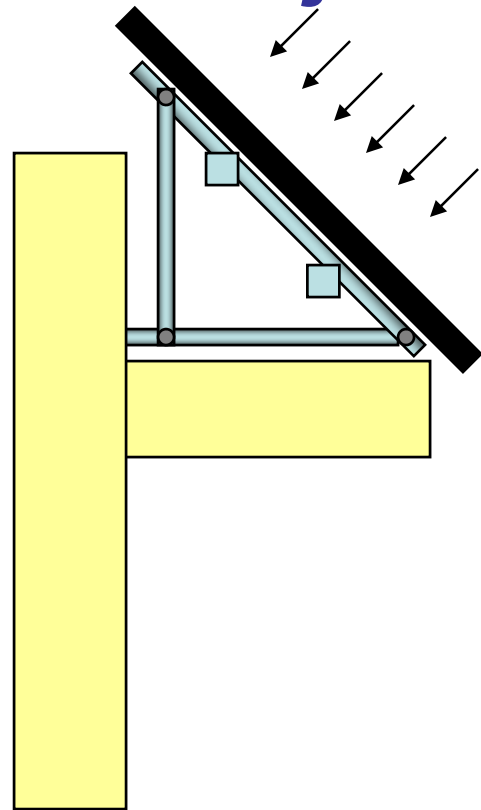
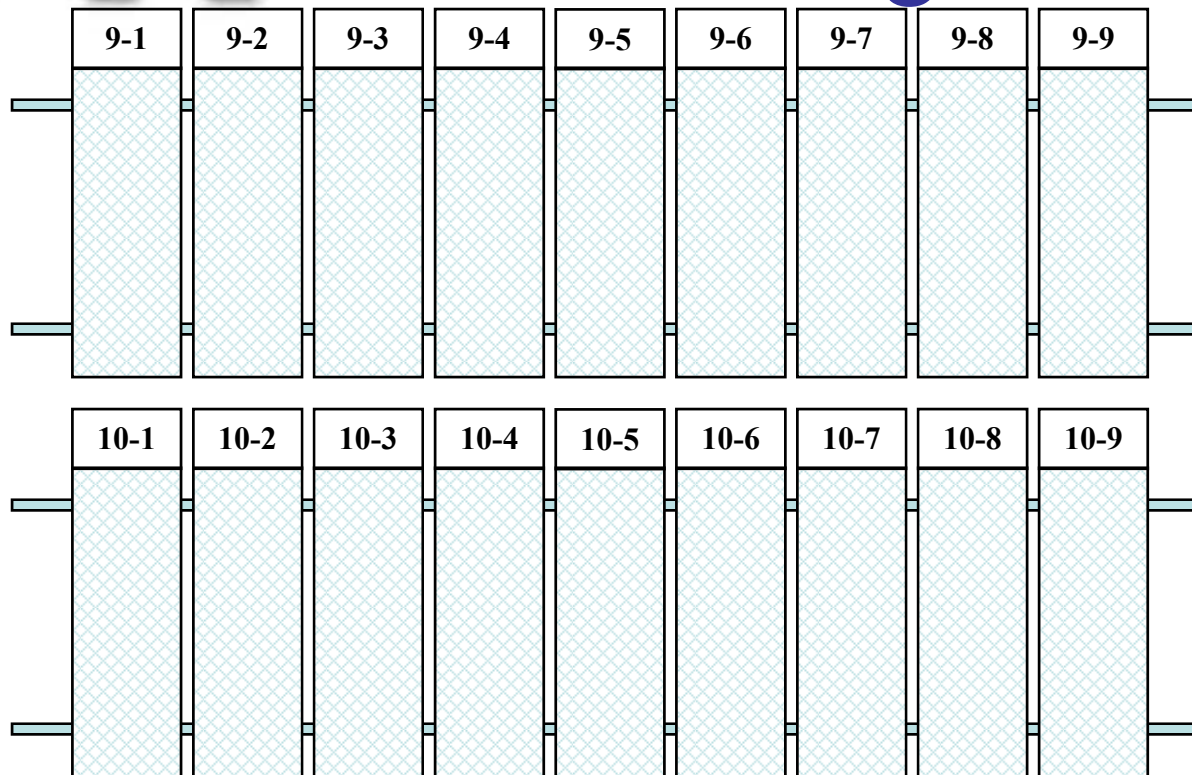
Multifunction Disable Unit

H2 Safety: Test Stand Layout





Emissions Free Lab : Senior Design—Solar Project



Solec Panel Specifications
Operating Voltage = 17.10 V
Operating Current = 5.26 A
Nominal Power = 90 W

18 Panels in Parallel Specifications
Operating Voltage = 17.10 V
Operating Current = 94.68 A
Total Power = 1619.03 W

2 TECH, 4 EE and 2 CS students

Solec Solar Panels (Total 18)



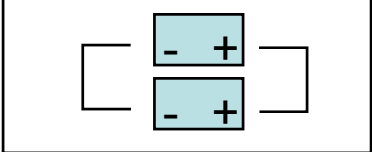
Solar Project -2



Array 9 [1-9]

Solec Panels
 $V_{pm} = 17.10V$
 $I_{pm} = 5.26A$

Two Panels in Parallel

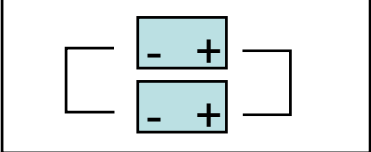


$I_{pm} = 10.52A$
 $V_{pm} = 17.10V$

Array 10 [1-9]

Solec Panels
 $V_{pm} = 17.10V$
 $I_{pm} = 5.26A$

Two Panels in Parallel



$I_{pm} = 10.52A$
 $V_{pm} = 17.10V$



Array 9
 $V_{pm} 17.10V$
 $I_{pm} = 47.34A$

Array 10
 $V_{pm} = 17.10V$
 $I_{pm} = 47.34A$

Wind Turbine 1
 $V_{pm} = 24V$
 $I_{pm} = 41.66A$

Wind Turbine 2
 $V_{pm} = 24V$
 $I_{pm} = 41.66A$

Group C

Group C (2 Array's 9 panels each)



Outreach



- August 2008 Hydrogen Road Tour Day at the California Science Center in Los Angeles
- September 2008 Santa Monica Alternative Car Show

- Fall 2008, college hosted two open house events for middle and high-school students, about two hundred of whom toured the Zero-Emissions Fuel Cell laboratory
- February 2009, the stand will be taken to the Southern California Edison Black History Month event
- March 2009, Advanced Energy and Transportation Building Groundbreaking—Cerritos Community College
- April 2009 Looking Green Magazine Expo



Partnerships

Quantum Sphere Inc—two grants
filed together

GM—student tours

Honda—guest lecture



CA Fuel Cell Partnership

- Hydrogen Day Tour
- Invited to Multiple Hydrogen Operators Meetings
- Two Hydrogen Station Permitting workshops at CSULA (Aug'08 and Mar'09)
- Provided input to CAFCP Educational Activities





Partnerships

- Community Colleges
- Los Altos High School through H2-ICE
- Partners through hydrogen station
 - CARB
 - Southern California Edison
 - Sempra—Gas Company
 - AQMD
 - SCAMD
 - AAA California
 - OEMS vehicles using station : GM, Hyundai, Daimler, Toyota
- In Development
 - Clean Cities Initiative
 - ISE Corp
 - Ebus
 - LA Metro



Synergistic Grants

- Establishing a Demonstration Hydrogen Fueling Station at Cal State L.A.----California State Award
 - CARB No. 06-618
 - \$4,400,000 (\$2,200,000-cost share)
 - Seaman, Blehman
- Platinum-Free Alloy Nano-Catalysts for Low Cost, High Performance PEMFCs
 - DOE DE-PS36-08GO98009
 - Pending: \$1,540,000 (subcontract)
 - Blehman
 - Partner—Quantum Sphere Inc. Nano (Santa Ana, CA)
- Energy Frontier Research Centers
 - DOE DE-PS02-08ER15944
 - Pending: \$22,000,000
 - Khachikian, Pham, Guillaume, Blehman etc
- Centers of Research Excellence in Science and Technology
 - Instrument Number: NSF09-510
 - Pending: \$5,000,000
 - Khachikian, Pham, Guillaume, Blehman etc



CalStateLA Hydrogen Station Where to Start?



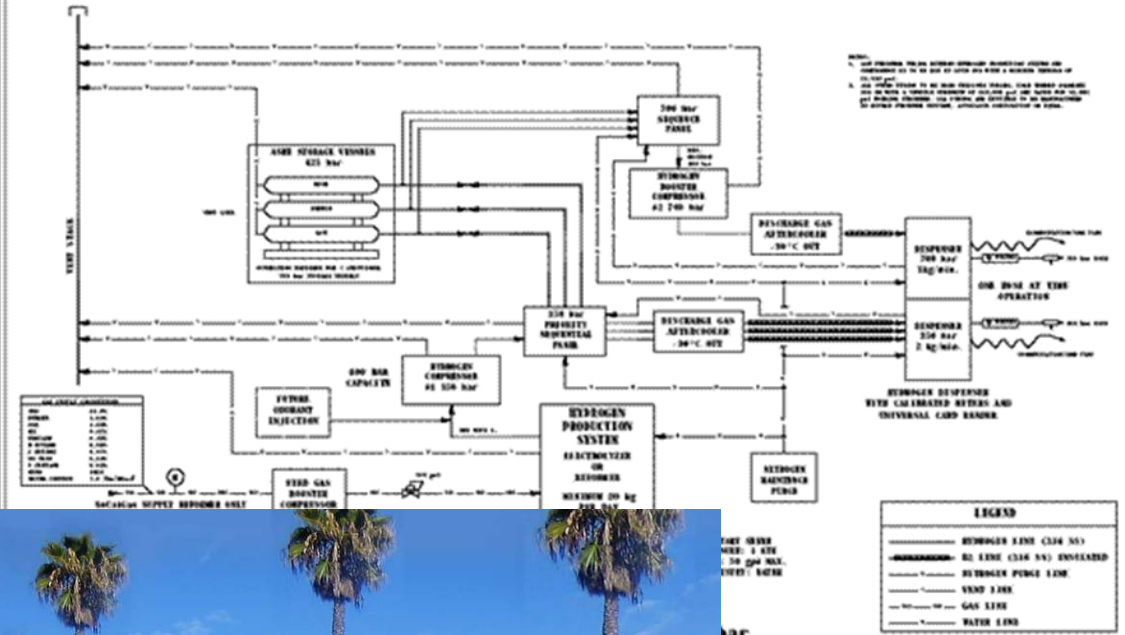
CARB No. 06-618

Value: \$4,400,000, 100%
renewables



Station Design

Electrolyzer, 60 kg/day, 350 bar—700 bar, publicly accessible



University of California, San Diego	HYDROGEN HIGHWAY FUELING FACILITY	Rev. 01/07
San Diego, CA 92162-0001	UNIVERSITY OF CALIFORNIA, SAN DIEGO	H-2



Future Work

- Suggest improvements (improve scheduling, EE department elective) and complete courses in the 2009-2010 academic year.
- Complete setup of experiments in the hydrogen laboratory in the 2009-2010 academic year and summer 2010.
- Complete wiring of solar panels and connect to the electrolyzer in the 2009-2010 academic year and summer 2010: effectively Zero-Emissions Fuel Cell and Hydrogen Laboratory.
- Continue efforts for sustained presence of fuel cell and hydrogen topics in the college curriculum.
- Continue efforts in developing partnerships and research grants.



Summary

- Work is underway addressing all tasks and objectives for current year.
- Grant demonstrates solid progress toward completing all tasks.
- Majority of future effort will be spent in lab development—experiments and manuals—to effectively support course offerings.
- Grant accomplishments are a coherent effort among many collaborators and is a congruent element in college Alternative and Renewable Energy initiatives.
- Publications might result on curriculum and lab development, preferably in collaboration with other DOE H2FC Curriculum groups.