

UC Davis Fuel Cell, Hydrogen, and Hybrid Vehicle (FCH²V) GATE Center of Excellence

**Primary Investigator:
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UC Davis

***Presentation to the DOE Merit Review Committee
May 12, 2011***



**Project ID#
TI007**

Overview

Timeline

- Starting Date: October 01, 2005
- Completion Date: May 31, 2012
- Percent Complete 97%

Budget

Govt. Share: \$581,468.00
Cost Share : \$154,644.00
Total : \$736,112.00

Barriers

- Building a coherent Automotive Program across the Engineering College and ITS
- Laboratory Space

Partners

- Green Transportation Lab (MAE)
- STEPs Program ITS
- Hydrogen Production and Utilization Laboratory (MAE)

Outline – UC Davis GATE Center

- Brief History
- Main Goal & Objectives
- Focus research areas
- Classes
- Outreach and Publications
- Application Process
- Graduate Research Projects
- Summary

The Merging of the GATE Centers at UC Davis

GATE Fuel Cell Center of Excellence 1999-2004

GATE Hybrid Electric Vehicle Center of Excellence 1999-2004



**Fuel Cell, Hydrogen,
& Hybrid Vehicle
(FCH2V) Center of
Excellence**

2005-2011

FCH²V Goals & Objectives

Goals:

- *Train future engineers to ensure the United States remains competitive*
- *Conduct research in the area of advanced automotive technology*

Objectives:

- Support research of FCH²V technology (graduate fellowships, selected with a *competitive* proposal process)
- Support dissemination of FCH²V research results & knowledge (publications, outreach and workshops)
- Support curriculum development around FCH²V technology (expand and enrich course offerings)
- Support industrial/government collaboration of FCH²V technology (workshops, graduation placement, internships)

Cross Training for Transportation Leaders

Energy and Transportation Policy

Emissions Control

Hydrogen Production

Aerodynamics

Energy Efficiency

Transmissions

Life-Cycle Analysis

Internal Combustion

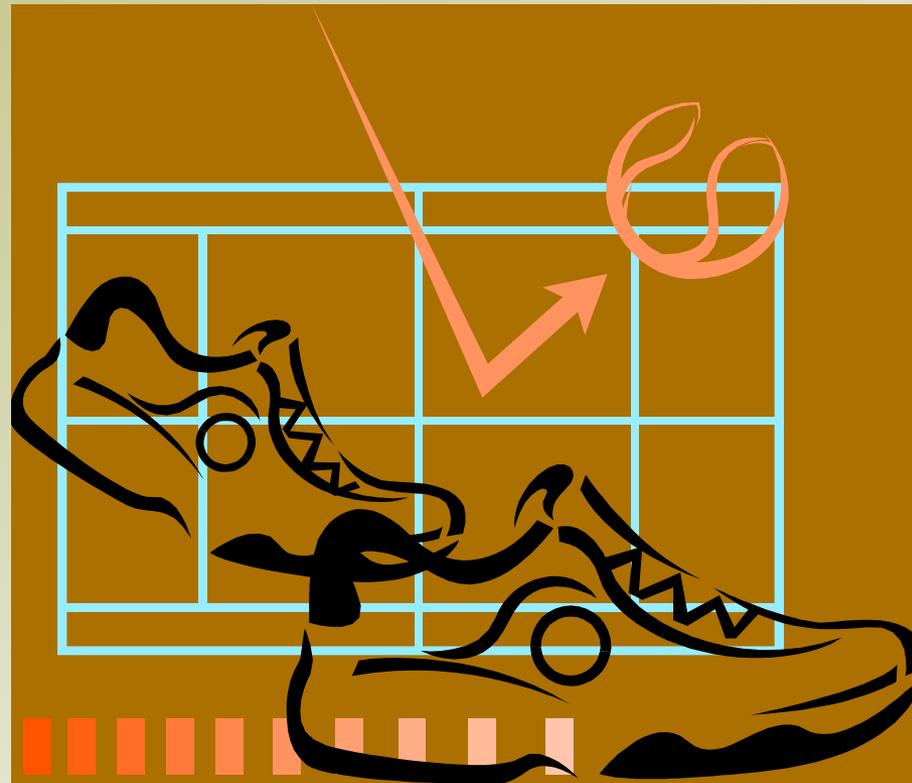
Instrumentation

Advanced power cycles

Fuel Cell Chemistry

Batteries and Capacitors

Hybridization



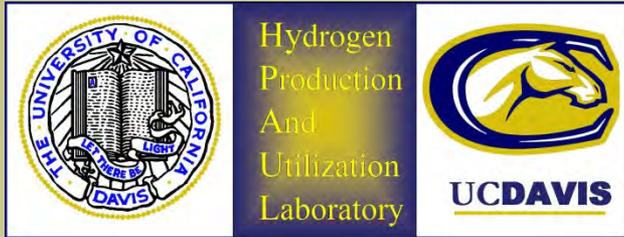
Collaboration of Departments:
ITS and College of Engineering

FCH²V Center Research Areas

- Fuel Cell and Hybrid Component Level Research
 - Energy storage (batteries, ultracapacitors)
 - Continuously variable transmissions (CVT)
 - Emissions reduction with hybrid and hydrogen enabled technologies
 - Electronic Control systems
- Vehicle and Energy Systems Research
 - Vehicle systems modeling
 - Fuel cell auxiliary power units
 - System Integration
 - DOE Challenge X competition (Trinity)
- Fuel Pathway Analysis (STEPS Program)
 - Infrastructure economics
 - Environmental analysis



Leverages Existing Programs & Partners



H2 Production & Utilization Laboratory
<http://mae.ucdavis.edu/hypaul/index.htm>



H2 Pathways and STEPS Programs
<http://steps.its.ucdavis.edu/>



UC Davis Challenge X Team
<http://www.team-fate.net/>



FC Auxiliary Power for Trucks

Research and Training Facilities



- *Hybrid Vehicle Power Systems Lab (ITS-Davis)*



- *Hybrid Vehicle Design, Assembly and Test Labs (MAE)*



- *Hydrogen Production and Utilization Lab (MAE)*
- *On-campus Hydrogen Refueling Station (ITS-Davis)*

FCH²V Center Curriculum



- Advanced Energy Systems (Course and Lab)
- Vehicle Systems Lab
- Hydrogen Pathways – Technology, Pathways, Economics and Policy
- Fuel Cell Systems (Course and Lab)
- FCH²V Center Electives, 40 classes available:
 - Mechanical and Aeronautical Engineering (MAE)
 - Chemical Eng. and Materials Science
 - Biological Systems Engineering
 - Electrical Engineering
 - Transportation Technology and Policy (ITS-Davis graduate group)

Outreach and Publications

Comprehensive website for outreach purposes and as a research collaboration tool

The screenshot displays the homepage of the Institute of Transportation Studies (ITS) at UC Davis. The header features the ITS logo, the text 'INSTITUTE OF TRANSPORTATION STUDIES', and 'Fuel Cell, Hydrogen, and Hybrid Vehicle GATE Center of Excellence'. A search bar and a 'log in' link are also present. A navigation menu includes links for Home, Academia, Research, Education, Enrollment, Sponsors, and Alumni. The main content area is divided into two columns. The left column contains a 'News from the Center' section with three items: 'Five New Fellows Awarded in the GATE Center, August 2006', 'Application for fellowship 2006 - 2007, July 2006', and 'New Super-Efficient Plug-in Hybrid Unveiled, May 2006', along with a link to 'Archived News'. Below this is a 'Current Fellows at the Center' section listing Nils Johnson, Eddie Jordan, Wayne Leighty, Andrew Shabashevich, David Vernon, and Jonathan Woolley. The right column features a section titled 'TRAINING THE NEXT GENERATION OF AUTOMOTIVE ENGINEERS' with a paragraph describing the center's focus on research, education, and outreach. Below this is another paragraph detailing the center's systems integration philosophy and its funding by the Department of Energy. The footer includes the GATE Center of Excellence logo and contact information for the ITS at UC Davis, dated 2005.

<http://gate.its.ucdavis.edu>

Fellowship Application Process

1. An updated CV
2. Current academic transcript
3. Complete twelve month research plan
4. Letter of sponsorship from a participating professor

Research Plan Components

1. *Research plan description*
2. *Expected contributions*
3. *Research Methodology*
4. *Literature review*
5. *Timeline and Deliverables*
6. *Interim publications*
7. *Interaction with other researchers*
8. *Personal Education Plan (as it relates to the research)*
9. *List of advisors and role each one will play in your research, including outside (non-academic) contacts*

GATE Graduate Fellowships

Competitive Award 2010 - 2011

- Scott Varnhagen - The Wankel Engine as a Range Extender for Electric Vehicles: an Experimental and Simulation Study
- Zach McCaffrey - *Converting Biomass to Fuel Cell Grade Hydrogen via Gasification*
- Adam Same - In-situ Neutron Radiography as a Method of Analysis of Lithium Ion Batteries for Electric Vehicles

Also partially supported in 2011

- Nadia Richards - Hydrogen Production through Stratified Reformation: Simulation and Experimental Analysis
- Shahla Mammadova - Enhanced heat transfer for EGR systems via flow impingement and deflection structures

Competitive Award 2009 – 2010

- Alexander Allan - Characterizing the environmental, economic and energy demand impacts attributable to interactions between electric-drive vehicles and the California electricity grid
- William Marin – The Effect of Hydrogen on the Diesel cycle
- David Kashevaroff - An Investigation of Hybrid Mode Reformation for Fuel Cell Applications

GATE Graduate Fellowships

Competitive Award 2008 - 2009

- Doug Saucedo - Improving Fuel Economy for Hybrid Electric Vehicles using Electric Turbo-Compounded Internal Combustion Engines through Control System Modeling
- Jason Greenwood – Utilization of Hydrogen Enrichment to Enhance Combustion and Reduce Emissions of Mixed Alcohols in Ultra-Lean Conditions
- David Kashevaroff - The Potential of Using Autothermal Reformation With Copper-based Catalysts in Vehicle Applications

Competitive Award 2007 - 2008

- Andrew Shabashevich – Analysis of Waste Heat Recovery from Light-Duty Hybrid Electric Vehicles
- David Vernon – Thermal integration and system design for utilizing waste heat and exhaust gases
- Eddie Jordan - Hydrogen enriched ethanol combustion in IC engines
- Wayne Leighty - Structural Econometric Modeling of the Investment Timing Game in Alaska Oil and Gas Exploration and Development

GATE Graduate Fellowships

Competitive Award 2005 - 2006

- David Vernon - Hydrogen Enrichment Via Chemical Recuperation to Increase Efficiency and Reduce Emissions in Engines.
- Brett Williams - Light-Duty Hydrogen-Fuel-Cell Vehicle Adoption in California: Early Markets, Vehicle-to-Grid Power, and “Mobile Energy” Innovation.
- Bryan Jungers - Improving the ITS-Davis Fuel Cell Vehicle Modeling Program (FCVMP): Incorporating Scalability, Transient Effects and Environmental Impact Analysis.
- Matt Caldwell – Hydrogen Production from Unpurified bio-derived alcohol mixtures: fundamental investigation of ATR and economic and infrastructure pathway analysis

Competitive Award 2006 - 2007

- Eddie Jordan - Hydrogen enriched ethanol combustion in IC engines
- Nils Johnson - Potential for coal-derived hydrogen with CCS
- Brett Williams – Hydrogen-Fuel-Cell Vehicle Adoption: Early California Markets, Vehicle-to-Grid Power, and “Mobile Energy” Innovation
- David Vernon – Thermal integration and system design for utilizing waste heat and exhaust gases
- Jonathan Woolley - Characterizing the hydrogen conversion trends associated with auto thermal reformation of octane ethanol mixtures.

UC Davis GATE Students

GATE Center (Year)	M.S. Candidates	Ph.D. Candidates
1999-2010	33	19
2011 (expected)	3	2

Organizations that hired graduates:

UTC Fuel Cells, Ballard[®], Daimler, General Motors, Ford, Nissan, Toyota, Volkswagen, Agilent, ISE[™] Corp., Aerojet, Electric Power Research Institute (EPRI), United Defense, Eaton, California Fuel Cell Partnership (CaFCP), California State University System, I-Tron, REII, IDE, Oorja Protonics, UC Davis Energy Efficiency Center, Efficient Drivetrain Inc.

Summary / Key Lessons

- GATE program has expanded and strengthened the automotive technology research and education programs at UC Davis
- Leveraging with other programs allows for increased resources for research and strong interaction with other researchers
- Competitive process for student research awards works well
- GATE builds human infrastructure

FCH²V GATE Center - Building human infrastructure

