

# Hydrogen and Fuel Cell Education Program Concentration

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Co PI: A. K. Sleiti  
University of North Carolina Charlotte  
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Project ID: ED006

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# Overview

## Timeline

- **Project start date: 08/2008**
- **Project end date: 03/2011**
- **Percent complete: 75%**

## Budget

- **Total project funding**
  - DOE share: \$399K
  - Contractor share: \$99,765
- **Funding received in FY09**
  - \$199K
- **Funding received in FY10**
  - None
- **Funding for FY11**
  - None

## Barriers

- **Technical barriers**
  - A. Lack of Readily Available, Objective, and Technically Accurate Information
  - B. Mixed Messages, confusion about technology readiness
  - D. Lack of Educated Trainers and Training Opportunities
- **Technical targets**
  - Develop concentration in HFCT
  - Outreach plan and recruiting
  - Industrial collaboration
  - Program sustainability

## Partners

- **Florida Solar Energy Center (FSEC)**
- **University of Central Florida (UCF)**
- **University of North Carolina Charlotte (UNCC)**



# Background

- Project initially was part of Engineering Technology program at UCF
- Due to budget constraints, ET program at UCF was discontinued in August 2009
- Project PI (Dr. A. Sleiti) left UCF and began work at UNCC
- UCF assigned new project PI – Dr. David Block of FSEC
- Program objectives to be completed at UNCC
- UNCC working under sub-contract to UCF (March 2010)
- No problems with new administration of contact



# University of North Carolina, Charlotte

## Facilities:

### Lee College of Engineering at UNCC:

- A total enrollment of more than 4,000 students
- Scholarships, more than 30 student chapters repres. Profes. organizations
- Co-Op, work-study, and internships available with industry leaders
- Department, college and faculty labs
- Hydrogen and fuel cell lab



### Energy Production and Infrastructure Center (EPIC):

- "EPIC is about regional growth and advancement in the energy industry,"
- Regional energy corporations include AREVA, Duke Energy, the Electric Power Research Institute (EPRI), The Shaw Group, URS Washington Group, Westinghouse, Siemens and Metso Power.



### North Carolina Motorsports and Automotive Research Center (NCMARC)

- One of the most innovative "hands-on" educational experiences
- Alternative transportation energy



### Infrastructure, Design, Environment and Sustainability Center (IDEAS):

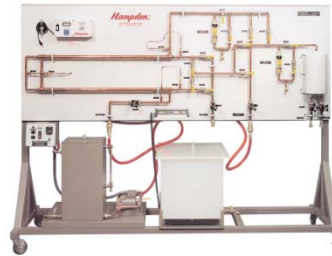
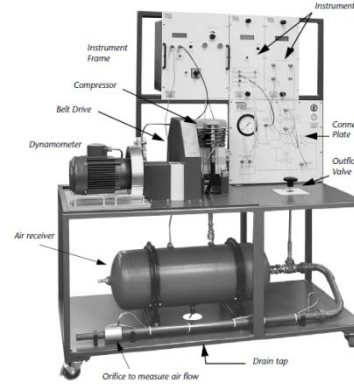
- Mission is to help frame the challenges; provide the leadership, and create solutions that will accelerate the technological and cultural shifts needed to make our built environment more sustainable.



# University of North Carolina, Charlotte

## Labs for HFCT concentration

### Fluid Dynamics Lab and Thermodynamics & Heat Transfer Lab



Hands on experience for HFCT students

# University of North Carolina, Charlotte

## Senior design projects

### USES OF HYDROGEN

Hydrogen is the most abundant element on earth. The future of renewable energy lies in making this element available for energy use.

#### Progress Energy H<sub>2</sub> Bus Project

Progress Energy has teamed up with Ford to produce a V-10, E-450 bus designed specifically for internal combustion of H<sub>2</sub>. These 12-passenger shuttle busses transport visitors around the Orlando airport and get a range of up to 150 miles and near-zero emissions.



#### Ford PEM Fuel Cell Vehicle

Through innovation of Progress Energy and Ford Motor Company, a fuel cell vehicle was born. This car features a 4 kg H<sub>2</sub> tank giving it a range of 200 miles with H<sub>2</sub>O as the only emission.



### Reverse Hydrogen Fuel Cell Group

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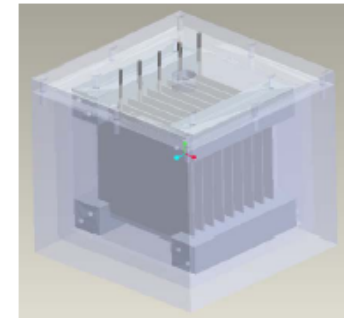
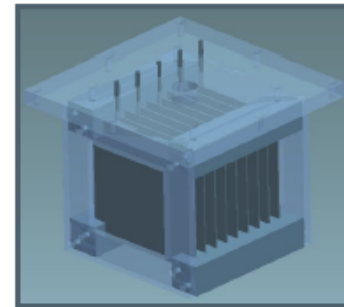
Technical Advisor:  
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This work is based on material supported by Progress Energy and the US Department of Energy, Office of EERE, under Award Number [DE-FG36-08GO18109].

### REVERSE HYDROGEN FUEL CELL GROUP

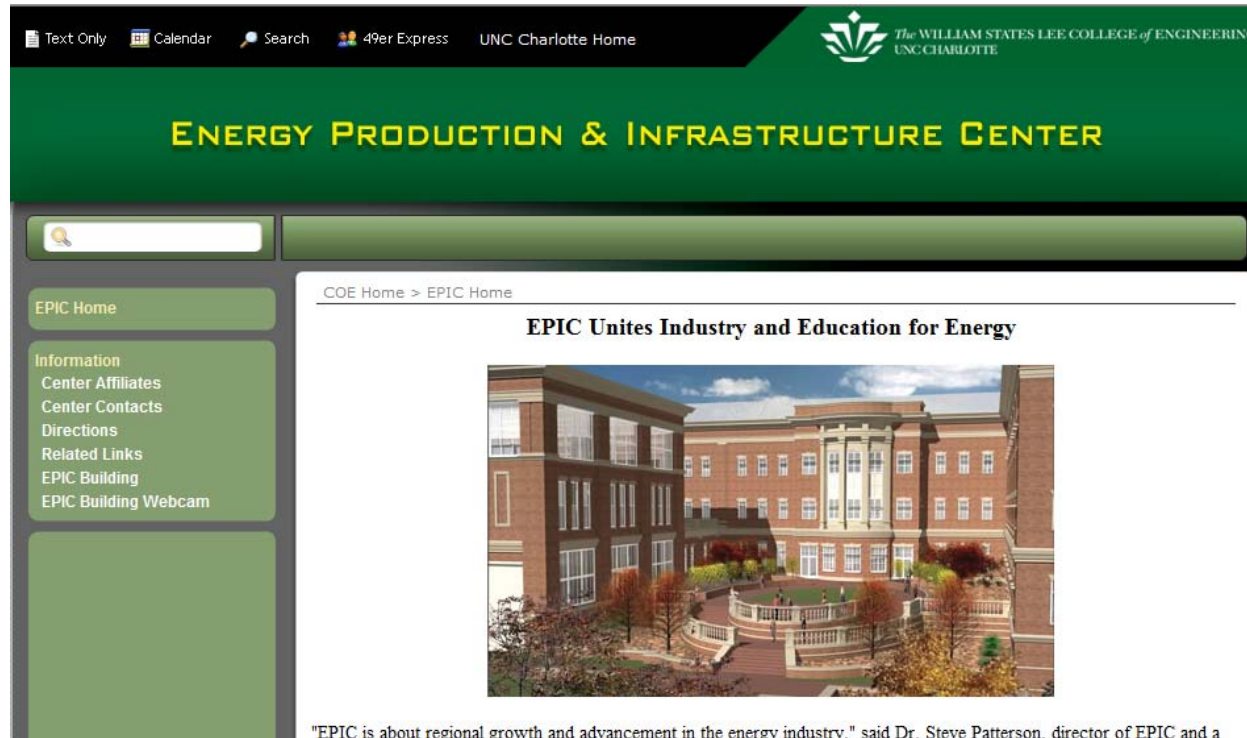
#### AMMONIA ELECTROLYSIS CELL (AEC) SYSTEM





# Energy Production & Infrastructure Center

- HFCT courses are available to EPIC
- More than \$400K provided by EPIC for HFCT lab and Thermophysics lab
- Funding support for 2 graduate students to work on HFCT
- Outreach through EPIC website and activities




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The WILLIAM STATES LEE COLLEGE of ENGINEERING  
UNC CHARLOTTE

## ENERGY PRODUCTION & INFRASTRUCTURE CENTER

COE Home > EPIC Home

### EPIC Unites Industry and Education for Energy



"EPIC is about regional growth and advancement in the energy industry," said Dr. Steve Patterson, director of EPIC and a

# Objectives / Relevance

## Project Objectives

- Develop and sustain Hydrogen and Fuel Cell Technology (HFCT) education concentration
- Prepare students who can successfully work as HFCT professionals in government, industry, and academia.
- Program graduates will demonstrate knowledge, techniques, skills, and modern tools related to HFCT.
- Program graduates will be able to apply current knowledge and adapt to emerging applications of HFCT.

## Relevance to DOE H2 Program

DOE H2 Program	Relevance	
<b>Task 5:</b> Facilitate Development and Expansion of College and University Hydrogen Technology Education Offerings	Developed HFCT concentration in 2008	Future expansion to MS program
<b>Milestone 20:</b> Update database of university education programs and database of available hydrogen and fuel cell textbooks to support university programs. (4Q, 2007)	Our program, courses and research were added to the database in 2009	Updated regularly
<b>Milestone 21:</b> Launch new university hydrogen education program. (4Q, 2009)	Our HFCT program was launched in 2009	Updated regularly



# ... Objectives / Relevance

## Objectives over the past year (June 09 - May 10)

- **Offering courses for the HFCT program**
  - **Analysis of Renewable Energy Systems** Spring 2010
  - **Hydrogen Production and Handling** Summer 2010
  - **Fuel Cell Technologies I** Fall 2010
  - **Thermodynamics** Spring 2010
  - **Energy Management** Spring 2010
  - **Applied Heat Transfer** Fall 2010
  - **Applied Fluid Dynamics** Fall 2010
  - **Applied Fluid Dynamics Lab** Spring 2010
  - **Applied Thermodynamics and Heat Transfer Lab** Fall 2010
  - **Senior design project** Fall 2010
- **Establishing Hydrogen and Fuel Cell Lab**
- **Recruiting students and outreach plans**
  - **Visits to community colleges, High schools, Seminars, Information sessions**
- **Establish collaborations:**
  - **Collaboration initiatives with EPIC, IDEAS, NCMARC, EPRI, SRNL, NCHEAT, Clean Cities**
  - **Meetings with AREVA, SHAW GROUP, DUKE ENERGY, SRNL**



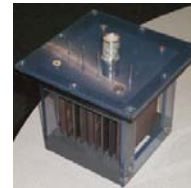
# Approach/Milestone

## Students:

- Freshmen , A.S. and A.A. graduates of community colleges.
- Current students in Engineering and Engineering Technology
- Existing articulation agreements with area community colleges and UNCC

## Courses and labs:

- Offered for engineering, engineering technology and science students
- Both undergraduate and graduate
- Face-to-face and on-line offering
- Hands-on experience and field visits
- Include HFCT term projects
- Senior design project: a unique experience, teams include students from all engineering disciplines.
- Hydrogen and Fuel Cell Lab



# Technical Accomplishments and Progress

## Courses for HFCT concentration

Course	FY09	FY10	# of students	Comments
<b>Analysis of Renew. Energy Systems</b>	Developed at UCF,	Developed and offered at UNCC, SP10	21	Offered to engineering and science students
<b>Hydrogen Production</b>	Developed at UCF,	Developed and offered at UNCC, SU10	Expected 20	Offered to engineering and science students
<b>Fuel Cell Technology</b>	Developed at UCF,	Developed and will be offered at UNCC F10	Expected 45	Offered to engineering and science students
<b>Thermodynamics</b>	NA	offered at UNCC, SP10	42	Existing in ET and ME programs
<b>Energy Management</b>	NA	offered at UNCC, SP10	34	Existing in ET program
<b>Applied Heat Transfer</b>	NA	Offered in Fall	~ 45	Existing in ET program
<b>Applied Fluid Dynamics</b>	NA	Offered in Fall	~ 40	Existing in ET program



# ...Technical Accomplishments and Progress

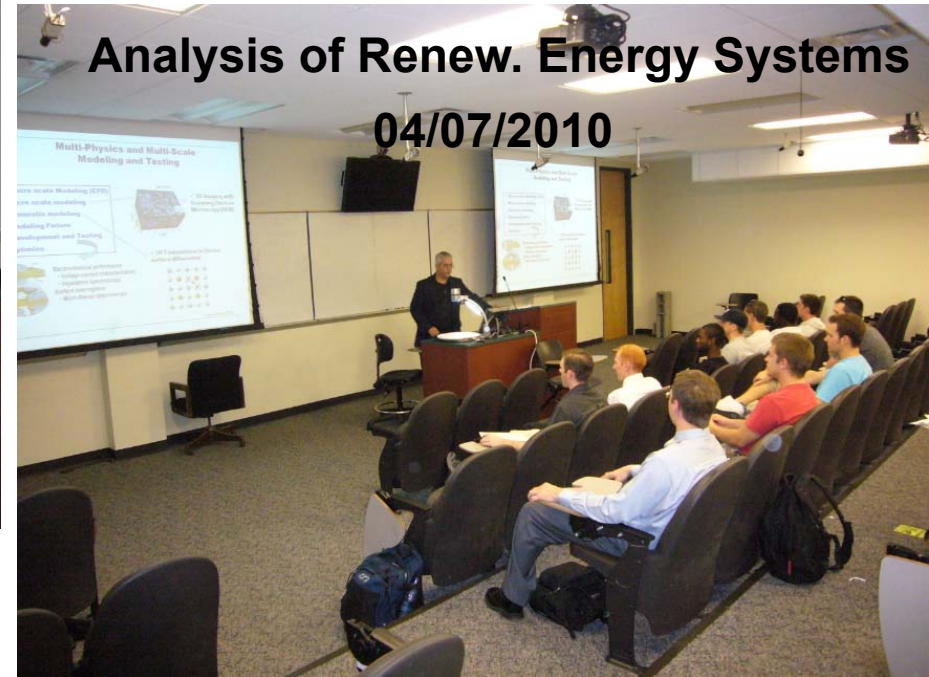
## ... Courses for HFCT concentration

### Sustainable Energy Production Course 04/05/2010



### Analysis of Renew. Energy Systems

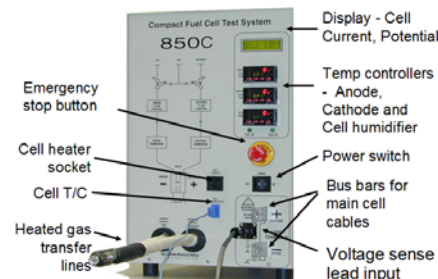
04/07/2010



# ...Technical Accomplishments and Progress

## Labs for HFCT concentration

### Hydrogen and Fuel Cell Lab



Hydrogen Laboratory Schedule
Introduction and Hydrogen Laboratory Safety
Gas Cylinder Safety & Handling
Instrumentation – Gas Chromatograph (GC), Thermo Gravimetric Analyses (TGA) and others
Instrumentation – Gas Chromatograph (GC), Thermo Gravimetric Analyses (TGA) and others II
Material Balance (calibration of mass flow controller & humidifier)
Characterization of Chemical Hydride Materials
Hydrogen Liquefaction Experiments
Student Project

Fuel Cell Laboratory Schedule
Introduction and Laboratory Safety
Fuel Cell Chemistry and Efficiency
Electrochemistry
Fuel Cell Components and Assembly
Operating Conditions (pressure, temperature, humidity, flow rates)
Operating Conditions II (pressure, temperature, humidity, flow rates)
Fuel Cell Diagnostics
Student Project



# ...Technical Accomplishments and Progress

## Promoting the program, recruiting students and outreach plans

- **UNC Charlotte Fifth International Hydrail Conference 11-12 June 2009 | focuses on three featured subjects: (1) mass carbon-free hydrogen production technologies to fuel hydrail trains and other vehicles; (2) the economic importance of avoiding commitment to new externally powered rail lines - especially for streetcars; and (3) hydrogen fuel cell streetcars: the hydrolley and its revolutionary significance for urban transportation planning.**

**Site Menu**

- 2010 Conference
- Stay Informed
- FUTURE LOCATIONS
- fifth hydrail conference
- fourth hydrail conference
- third hydrail conference
- second hydrail conference
- first hydrail conference
- Hydroleils
- Contact

**Hydrail Project Links**

- International Conference on Hydrogen Production
- HyRail, EU

**Fifth International Hydrail Conference**  
11-12 June 2009 | Charlotte, NC USA

Local Media Coverage  
Conference Presentations  
Presenter Biographies  
About the Conference  
Prior International Hydrail Conferences

News Coverage  
**Multimedia**

- WBTV, Channel 3
- WCNC Channel 36
- Charlotte Talks Radio

**Print Media**

- Charlotte Observer
- WCNC 36 website
- WBTV 3 website

Conference Presentations [All presentations in PDF format]  
Thursday June 11, 2009

- **Community Colleges**  
Central Piedmont Community College,  
Wake Tech Spring Fling,

- **High School Competition – March 2010 at UNCC**
- **Program Information Sessions – Each semester at COE**



# ... Collaboration

## □ Collaboration with Savannah River National Lab (SRNL)

- **UNCC – SRNL Meeting on Hydrogen and Fuel Cells, February 18, 2010**
- **Potential opportunities for HFCT graduates including internships, jobs and research**

**THE UNIVERSITY OF NORTH CAROLINA AT CHARLOTTE**  
**The William States Lee College of Engineering**

### **SRNL Visit to UNCC**

February 18<sup>th</sup>, 2010

#### **Agenda**

- Introduction and Welcome of Dr. Summers, Dr. Motyka and Dr. Colon-Mercado from SRNL.
- Lee College of Engineering at UNCC, Dr. Ronald E. Smelser, Professor and Associate Dean.
- Energy Production and Infrastructure Center (EPIC). Dr. Steve Patterson.
- Department of Electrical Engineering. Dr. Ian Ferguson.
- Charlotte Research Institute. Dr. Barry Burks.
- NC Motorsports and Automotive Research Center. Dr. Ahmed Soliman.
- Senior design at COE. Dr. Bill Heybruck Director, Industrial Solutions Lab and Dr. Peter Schmidt.
- Department of Chemistry, Dr. Bemadette Donovan-Merkert.
- Infrastructure, Design, Environment and Sustainability (IDEAS) Center. Dr. Helene Hilger.
- Hydrogen and Fuel Cell Activities at UNCC. Dr. Ahmad Sleiti.

#### **Facilities Tour:**

#### **Presentation by SRNL Visitors**

- SRNL Overview - Dr. Bill Summers, Energy Security Program Manager.
- Hydrogen Programs - Dr. Ted Motyka, Hydrogen Program Manager.
- Fuel Cell R&D - Dr. Hector Colon-Mercado, Lead Fuel Cell Researcher.

#### **Collaboration plans**

- Discussion and Action Items



# ... Collaboration

## Other Collaboration (Sub., Industry, outside DOE H2 Program)

- NC Hydrogen Economy and Advancement Team (HEAT)
- NC Fuel Cell Alliance
- The Advanced Vehicle Research Center of North Carolina
- North Carolina Energy Office Programs
- Duke Energy
- AREVA
- EPRI
- Shaw Group
- Siemens



# Proposed Future Work

Future work	FY10	FY11	Key milestones	Risk mitigation
<b>Course offering</b>	- Hydrogen - Fuel Cell Tech	periodic offering courses	H2, SU10 FC, F10	R. Low enrollment M. Recruiting
<b>Complete HFC Lab</b>	Equipment installation, Lab manuals	More experiments	Complete by SP 11	R. Not complete M. Hire more stud.
<b>Recruiting students</b>	Reach 40 HFCT students	Reach 60 HFCT students	40 students by SP 11	R. Less students M. More recruiting
<b>Extend to MS program in HFCT</b>	Prepare internal proposal	UNCC approval	MS by Fall 2011	R. No resources M. Sponsors
<b>Industrial Collaboration</b>	Duke, Siemens, Shaw, others	Extend to more outside NC	Action items by SP2011	R. Lack of resources M. Sponsors
<b>Dissemination, publications</b>	HFCT website Presentations	Conferences, meetings, schools, CC	Website and diss. events sch. by SP11	R. Lack of resources M. UNCC Internal
<b>New Senior design projects</b>	One team	Two teams	Complete by SP 11	NA
<b>Research component</b>	Plan for TEA research	Plan for FC alternative fuels	Proposal by F10	R. Not funded M. Resubmit



# Summary

**Relevance:** Develop, present and continue Hydrogen and Fuel Cell Technology (HFCT) education concentration.

**Approach:** Develop new HFCT courses and labs, teach courses, integrate HFCT option into existing engineering programs, recruit freshmen, AS and AA students, use existing labs and resources, engage other UNCC centers in program, disseminate and publish HFCT results, conduct HFCT research.

**Technical Accomplishment and Progress:** HFCT courses are offered successfully, student enrollment is good, Hydrogen and Fuel Cell lab is developed and equipped, Thermodynamics and Heat Transfer labs are used by HFCT program, senior design projects are planned and offered, established internal and external collaborations, conducted visits to community colleges, schools, students are recruited, dissemination and publications are ongoing.

**Collaboration:** Partnering and collaborating with other UNCC centers; EPIC, NCMARC, IDEAS. Established collaboration with SRNL, EPRI and with industry and others; HEAT, NC Fuel Cell Alliance, AVRC, NC Energy Office, Duke Energy, AREVA, EPRI, Shaw Group, Siemens.

**Future Work:** Continue course offerings, complete HFC lab, recruit students, extend to MS program in HFCT, develop industrial collaborations, disseminate information, publish, conduct new senior design projects and develop research component.



# Summary Table

Project Milestones	% Complete	Comments	Progress Notes
Developing courses for HFCT concentration	100%	All new courses were developed, including syllabi, textbooks and schedule	The new courses were integrated in the program and HFC lab is under development
Offering courses for HFCT concentration	90%	All courses are available for engineering students and campus wide	The labs are part of the courses and other existing labs
Promoting the program and outreach plan and recruiting	75%	Ongoing activities	Central Piedmont Community College, Wake Tech Spring Fling, Information sessions,
Course delivery for HFCT concentration	75%	Ongoing as planned	All courses were delivered at least one time but the Fuel Cell Technology is scheduled for Fall 10.
Establish collaboration	70%	Continuous process	Internal: COE, EPIC, NCMARC, IDEAS. External: SRNL, AREVA, EPRI, SHAW, Duke Energy,...



# Supplemental Slides





# ... Objectives / Relevance

## Impact on addressing the barriers and other targets and milestones

Barriers, targets and milestones	Impact	
A. Lack of Readily Available, Objective, and Technically Accurate Information	Availability of information about HFCT through our concentration	Trained specialists
B. Mixed Messages, confusion about technology readiness	Raise public awareness, clarify conflicting messages and confusion about tech. readiness	Partnership with industry leaders
D. Lack of Educated Trainers and Training Opportunities	In-person training, workshops and seminars	Prepare future trainers
F. Difficulty of Measuring Success	Student evaluation, knowledge surveys	After graduation survey
<b>Task 5:</b> Facilitate Development and Expansion of College and University Hydrogen Technology	HFCT concentration will graduate about 20 students a year starting from 2011	Future expansion to MS degree
<b>Milestone 20:</b> Update database of university education programs and database of available hydrogen and fuel cell textbooks to support university programs. (4Q, 2007)	4 new courses and HFCT research were added to the database in 2009	HFCT senior design projects
<b>Milestone 21:</b> Launch new university hydrogen education program. (4Q, 2009)	More HFCT graduates from the region	Potential for new small business



# ...Technical Accomplishments and Progress

## Participation in national and international conferences:

- American Society for Engineering Education 117th Annual Conference & Exposition, June 20 - 23, 2010, Louisville, Kentucky.
- 2008 Campus and Community Sustainability Conference, UCF from 10/19/2008 to 10/21/2008: Hydrogen and Fuel Cell Technology Education Program at UCF.
- 2008 Summer Faculty Conference, UCF: Engineering Technology Concentration on Hydrogen and Fuel Cells.

