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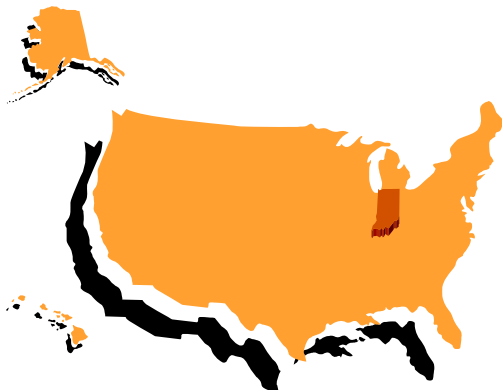
**SCHOOL OF ENGINEERING  
AND TECHNOLOGY**

A PURDUE UNIVERSITY SCHOOL  
Indianapolis



# Research in Fuel Cells and Related Energy Technologies

An Urban/Health Care Focus Complementing  
two Great Parent Universities  
*2012 1<sup>st</sup> Quarter Update to HTAC*



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# Focus Areas – Renewable Energy

- Batteries
  - Li-metal
  - Anode/cathode/electrolyte chemistry
- Fuel Cells
  - Non-Pt catalyst for PEM
  - Hydrogen storage
  - Hydrogen generation
  - SOFC for APU and home energy
- Combustion Engines
  - Gas turbines
  - Internal combustion engines
  - Power and propulsion systems
- MSW Energy from Waste
  - Heat, oils for refining, electricity
  - Advanced gasification
- Policy & Economics
  - Urban, State, Federal
  - Energy forecasting
  - Environment & Human health
- Commercial/Institutional & Buildings
  - Sustainable hospitals
  - Energy recovery
  - Skyscrapers, paper waste
  - Cafeteria waste
  - Fats, Oils, Greases



- Installation & Maintenance
  - Training
  - Automation
  - Diagnostics
- Manufacturing Science
  - PV
  - EV, PHEV
  - FC
  - Switchgear
- Efficiency
  - Industrial assessment
  - Curriculum development
  - Combustion engines and HVAC
  - Sustainable Technologies Certificate
- Entrepreneurism
  - Economic pro forma & business plans
  - Incubators and mentoring
  - Raising capital
- Sustainability & Lifecycle Analysis
  - Electric vehicles
  - Energy storage
  - Urban environment
- Switchgear, Diagnostics & Cybersecurity



# The Case for Renewable Energy

ENVIRONMENT  
& HUMAN  
HEALTH



PRESERVE  
FINITE  
RESOURCES



DIVERSIFIED  
PORTFOLIO



NATIONAL  
ENERGY  
SECURITY



*\* In Indiana, much as in D.C., climate change is not well-accepted, and is a politically divisive topic*

# Status of Major Initiatives – Q1 2012

- Li-ion Battery Safety Project (\$2.5M, 3 yrs)
  - Crane NSWC as prime
  - Delphi Electronics & Safety as partner
  - Project completed March 2012
- Industrial Assessment Center (\$1.33M, 4 yrs)
- Power for Future Soldiers (\$1.02M, 2 yrs)
- Transportation Electrification (\$0.6M, 3 yrs)
- Pew Enviro. Group report due June
- Hydrogen from Butanol (\$0.1M – industrial)

# Activities in Energy

- Attendance at:
  - Gordon Research Conference – Battery
  - NATTBatt – Li-ion safety for traction batteries
- Grant proposals to:
  - ARPA-E AMPED with Battery Innovation Center
  - ACS Petroleum Research Fund
  - DOE SBIR – hydrogen generation
  - EPA SBIR – waste to energy
- ABET accreditation for **Energy Engineering** major awaits graduation of 1<sup>st</sup> cohort.



# Advances in Waste to Energy

- Lugar Center Spring Forum – May 18
  - “Waste to Energy, Chemicals, Fuels, and Heat”
- Compendium of WtE Suppliers Worldwide
  - Provided to Maltese Minister of Resources
- MSW gasifier donation pending site approval
- Negotiations with major development firm for industrial park centered on WtE
- IUPUI partnered with SAIC on Army proposal
- International consulting in Mali and Camargo, MX
- Poster presented at NAWTEC – Portland, ME

THE LUGAR CENTER INVITES YOU TO ATTEND

**6<sup>TH</sup> ANNUAL  
LUGAR CENTER RENEWABLE ENERGY FORUM**  
“Waste to Energy, Chemicals, Fuels, and Heat”

**Friday, May 18, 2012**  
University Place Hotel and Conference Center  
850 W. Michigan St., Indianapolis, IN 46202

**KEYNOTE SPEAKER**  
David Gair, CEO, Pacific Oil Products

**ALSO FEATURING**  
John Hazlett, Director, Indianapolis Office of Sustainability  
and  
The new Lugar Center Director, Dr. Peter J. Schubert

**REGISTRATION IS NOW OPEN!**  
*Click here to register!*

Take advantage of discounted Early Bird Registration available for a short time!

Optional bus tour and site visit to the Indianapolis South Side Landfill Gas Facility to the first 50 registrants to sign up!  
(Space is limited. First come first served basis.)

  
*One man's trash is another man's treasure.*  
- Tom Zart



Also check out Greening the Heartland, [www.greeningtheheartland.org](http://www.greeningtheheartland.org), May 16-18 in Indy!

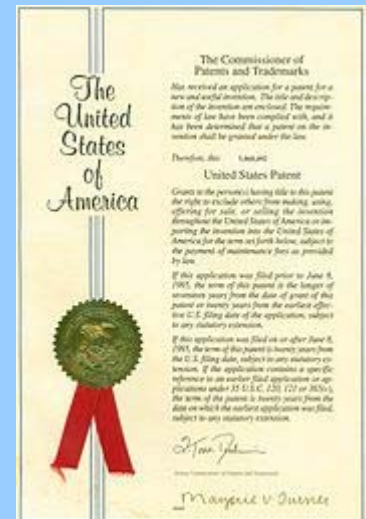
# Invited Talks

- Energy
  - ACS Spring Meeting & Expo – non-Pt alkaline FCs
  - IEEE Central Section annual conference - keynote
- Built Environment
  - Council of Deans – Thailand – keynote speaker
- International
  - Technology education conference – Hawaii
  - Malta visit sponsored by US Dept. of State



# Fresh Intellectual Property

- Battery technology – 5 inventions recorded
- Health care – 1 invention recorded
- Superconductivity – 1 invention recorded
- Direct ethanol production – 1 invention
- Hydrogen generation – 1 invention



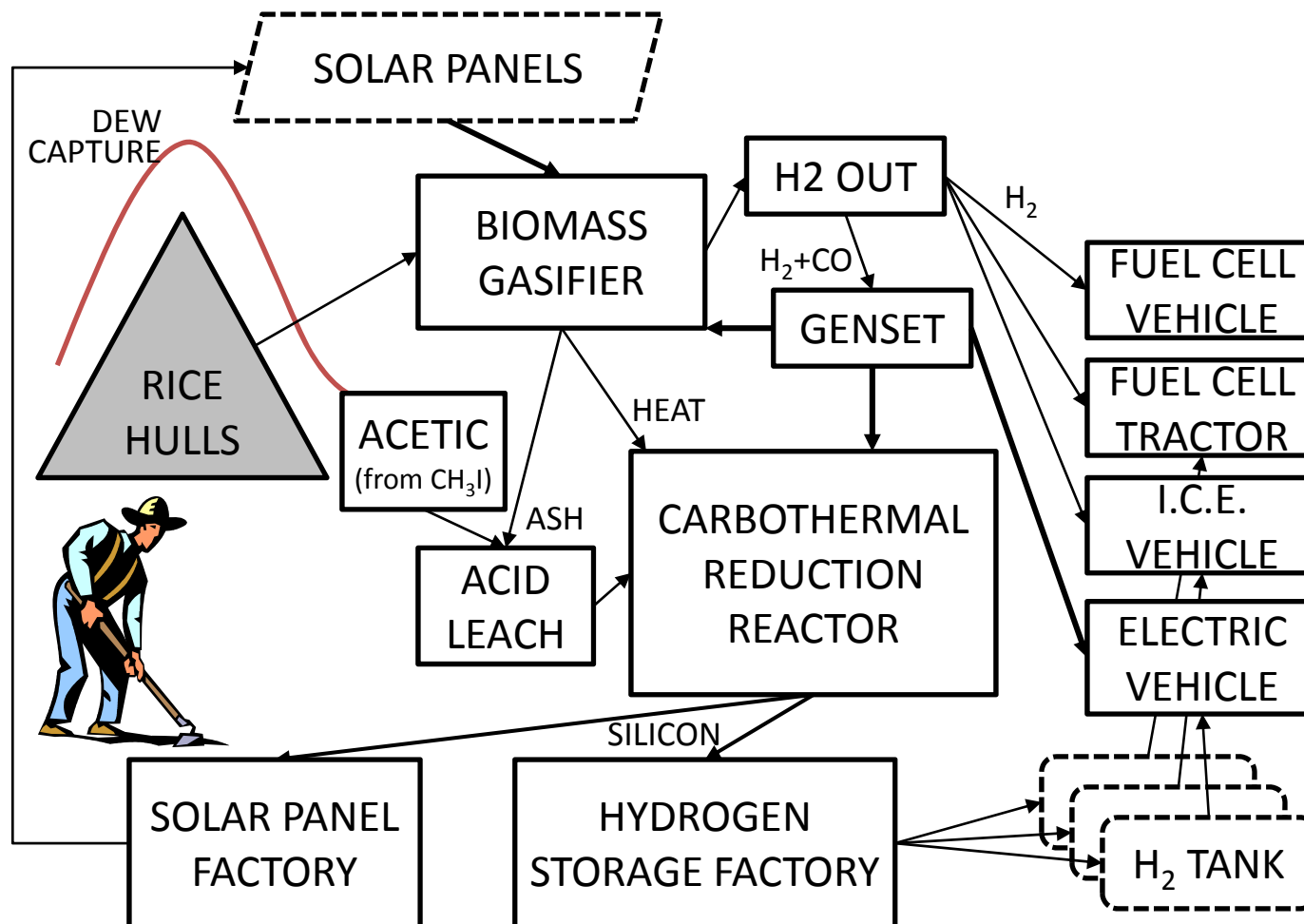


# Collaborations, Special Events

- Visit by Sec'y Chu – 5 March, IAC kick-off
- Visit by Thai government and university officials
- Central Indiana Ethanol – EtOH in Alkaline FC
- Argonne National Labs – 3 projects brewing
- GM R&D, Rolls Royce, Aerodyne Engineering
- Entrepreneurs-in-residence
  - 1 SBIR submitted so far
  - 2 spin-Up companies formed



# Energy Self-Sufficiency for Farms



# Outdoor R.E. Lab

**IUPUI** GREEN GATEWAY GARAGE



# Publications Q1 2012

- P. Schubert, J. Paganessi, A. D. Wilks, M. Murray “Distributed Hydrogen Generation and Storage from Biomass,” ACerS, Matls Challenges in Alt. and Renew. Energy, Clearwater, FL, Feb 2012.
- H. He, Y. Lei, C. Xiao, D. Chu, R.Chen\* and G. Wang\*, “The Molecular and Electronic Structures of Transition Metal Macrocyclic Complexes as Related to Catalyzing Oxygen Reduction Reactions: A Density Functional Theory Study”, submitted to Journal of Physical Chemistry C, 2012.
- L. Ma, R. Chen, H. He and A. Hsu, “Carbon-Supported PdRu as a Highly Active Ethanol Oxidation Catalyst for Anion-Exchange-Membrane Direct Ethanol Fuel Cells”, submitted to Electrochemistry Communications, 2012.
- J. Guo, H. He, D. Chu and R. Chen\*, “OH<sup>-</sup>-binding effects on metallophthalocyanine catalysts for the O<sub>2</sub> reduction reaction in anion-exchange-membrane fuel cells”, Submitted, Electrocatalysis, 2012.
- L. Ma, A. Hsu, D. Chu and R. Chen\*, “Comparison of ethanol electro-oxidation on Pt/C and Pd/C catalysts in alkaline media”, accepted, International Journal of Hydrogen Energy, 2012.
- L. Sun, J. Guo, J. Zhou, Q. Xu, D. Chu and R. Chen\*, “Novel nanostructured high-performance anion exchange ionomers for anion exchange membrane fuel cells”, Journal of Power Sources, 202, 70-77, 2012.
- A. Karimi, M. Rajagopal and M. R. Nalim, “Turbulence-Chemistry Interaction in Co-axial Methane Diffusion Flame: Effect of Reaction Mechanisms and Combustion Models,” Central States Section Spring Technical Meeting, Dayton, Ohio, April 2012.
- Abdullah Karimi, Sameera D Wijeyakulasurya, M. Razi Nalim, “Numerical Study of Supersonic Flow over Backward Facing Step for Scramjet Application,” 48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit”, Atlanta, Georgia, July-August 2012.
- Sameera D Wijeyakulasurya, M. Razi Nalim, “Fuel Proximity Effect on Hot-Jet Ignition in a Wave Rotor Constant Volume Combustor,” 48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit”, Atlanta, Georgia, July-August 2012.
- Keith Smith, M. Razi Nalim, “Coupled Analysis of the Inlet and Fuel Systems of a Wave Rotor Constant-Volume Combustor,” 48th AIAA/ASME/SAE/ASEE Joint Propulsion Conference & Exhibit”, Atlanta, Georgia, July-August 2012.
- R. Chen, “Novel Catalysts with Tunable Oxygen Reduction Activity in Alkaline Media”, 243rd ACS National Meeting & Exposition American Chemical Society meeting, March 25- 29, 2012, San Diego, California.
- Cowan, J. (2012). Green: Building Information Modeling. Council of Deans of Architecture of Schools of Thailand Conference (CDAST). Bangkok, Thailand. May 19-20, 2012.
- Cowan, J. (2012). Sustainable Architecture: Conceptual Approaches. King Mongkut Institute of Technology Ladkrabang, Thailand. May 16, 2012.
- Fox, P., Goodman, D., Cowan, D., Hundley, S. How to Establish Successful International Experiences for Engineering and Technology Students. Proceedings from the Hawaii International Conference on Education, CD-ROM, Honolulu, Hawaii, January, 2012.
- Cowan, J., Fox, P., Goodman, D. (2012). Educating Engineers and Technologists for a Green/Sustainable Future. Journal of Engineering Technology (accepted, in-progress for publication)
- Nina Mahootcheian Asl, Joshua Keith, Cheolwoong Lim, Likun Zhu, Youngsik. Kim, “Inorganic Solid/Organic Liquid Hybrid Electrolyte for Use in Li-ion Battery” Electrochimica Acta, (2012) Accepted.
- Nina Mahootcheian Asl, Seong Shen Cheah, Jason Salim, Wen Chao Lee, Youngsik. Kim, “Li-Liquid Flow Battery for Stationary Energy Storage: Harvesting Li from Waste Li-ion Batteries and Discharging with Water” Energy & Environmental Science, (2012) Submitted.
- Hui. Hu, W. Niu, Nina Mahootcheian Asl, Jason Salim, Rrongrong Chen, Youngsik Kim, “Effects of Aqueous Electrolytes on the Voltage Behaviors of Rechargeable Li-Air Batteries”, Electrochimica Acta, 67 (2012) 87-94 .
- Sen, A. K. (2012): Streamflow Variability in the Southern Appalachians and Atmospheric Teleconnections, River Research and Applications (in press).
- Ceviz, M. A., Sen, A. K., Kuleri, A. K., and Oner, I. V. (2012): Engine Performance, Exhaust Emissions, and Cyclic Variations and in a Lean-Burn SI Engine Fueled by Gasoline-Hydrogen Blends, Applied Thermal Engineering 36, 314-324.
- E. Dannenmaier, “Environmental Law Spring Symposium”, IUPUI, 8 April 2012.
- P. Schubert, “When Everything is Electric,” IEEE Electro-Information Technology, 8-10 May, 2012, Indianapolis. Invited keynote speech.

# THANK YOU



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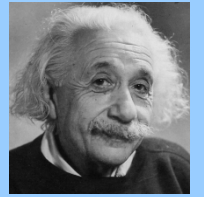
# Thinking ahead quotes



- Chinese proverb: “Dig the well before you are thirsty”.
- Iroquois Nation: “In every deliberation, we must consider the impact on the seventh generation”.
- Benjamin Franklin: “a stitch in time, saves nine”.
- John Perry Barlow: “We don’t own this place, though we act as if we did; it’s a loan from the children of our children’s kids”.

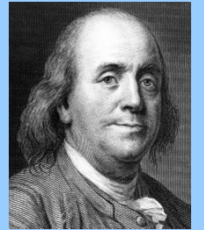
“It’s not that I’m smart, it’s just that I stay with the problems longer.”

- ALBERT EINSTEIN



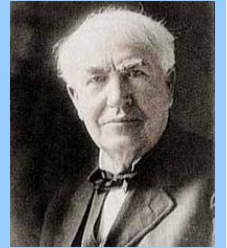
“Genius is the ability to hold one’s vision steady until it becomes reality.”

- BENJAMIN FRANKLIN



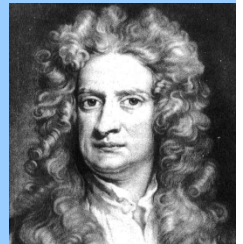
“Sticking to it is the genius.”

- THOMAS EDISON



“I developed the calculus and the laws of gravity by simply thinking about it, constantly.”

- ISAAC NEWTON



“Let me tell you the secret that has led me to my goal.  
My strength lies solely in my tenacity.”

- LOUIS PASTEUR

