2009-2010 ANNUAL REPORT

Notre Dame Energy Center

HELPING TO BUILD A BETTER ENVIRONMENT WITH

ENERGY RESEARCH EDUCATION AND OUTREACH

AND THE SUSTAINABLE ENERGY INITIATIVE

MISSION

Recognized as a College Institute by the University in 2009, The Notre Dame Energy Center focuses on five key areas in developing new technologies to meet the global energy challenge: energy efficiency; safe nuclear waste storage; clean coal utilization; carbon dioxide separation, storage, sequestration, and use; and solar and other renewable resources. The Notre Dame Energy Center is housed in the College of Engineering, and it is committed to playing key roles in energy education and literacy, the development of energy policy, and the exploration of the ethical implications associated with energy.

Contents

Please share our annual report with your colleagues and other individuals who are interested in energy education and research. For a copy of the report and to learn more about energy education and research at the University of Notre Dame, please visit our website at http://energy.nd.edu.

Letter from the Director

Dear Friends and Colleagues,

I am pleased to present to you the 2009-2010 Annual Report of the Notre Dame Energy Center. This report highlights energy related research and education activities over the past fiscal year, from June 30, 2009 through July 1, 2010.

Once again, it has been a year of much growth and progress in the areas of energy education and research. With the relocation of our offices and laboratories to the newly constructed Stinson-Remick Hall, our focus has been on developing new programs and services that will include the use of this state-of-the-art research facility. We are especially grateful to the University donors who gave so generously toward the construction of our new Energy Center offices and laboratories. A heartfelt thank you goes to Edward and June Prein and Family, John and Lori Kelly, and the Patrick and Jana Eilers Family. We truly appreciate their generosity and continued support of our efforts.

As a result, the laboratories on the first floor and the analytical laboratory on the third floor are now known as The James P. Kohn Energy Center in honor of Dr. Kohn for his work in energy research. Dr. Kohn passed away in 2003 at the age of 78. He was a professor in the Department of Chemical Engineering for 48 years and was believed to have taught chemical engineering at Notre Dame longer than anyone in the department's history. Throughout his career, he received numerous awards including the Presidential Award, which is the highest honor bestowed upon any faculty at the University of Notre Dame. He was best known for his research in phase equilibrium and amassing the largest set of data in the United States on solar energy.

Lastly, I am pleased to announce that the University has recognized our achievements in energy research and the need for additional support in broadening our research efforts in the area of materials separations. Funds have been allocated for six new Teaching and Research faculty positions over the next two to three years that will specialize in materials engineering and science. Additionally, the Sustainable Energy Initiative (SEI) was selected as one of the University's Strategic Research Investments (SRI) for 2010. Funds will be received over a three-year period to support the SEI and its research thrust areas: Cleaner Fossil, Safer Nuclear, and Transformative Solar. More information and details about the SEI will be introduced later in the report. We are grateful to you, our friends and colleagues, for your continued support and outstanding contributions to making these new and important endeavors realities for the Energy Center.

I hope you will enjoy learning more about the University of Notre Dame Energy Center and its many accomplishments over the past fiscal year.

Sincerely,

Joan F. Brennecke

Joan F. Brennecke
Keating-Crawford Professor of Chemical and Biomolecular Engineering
Director, Notre Dame Energy Center

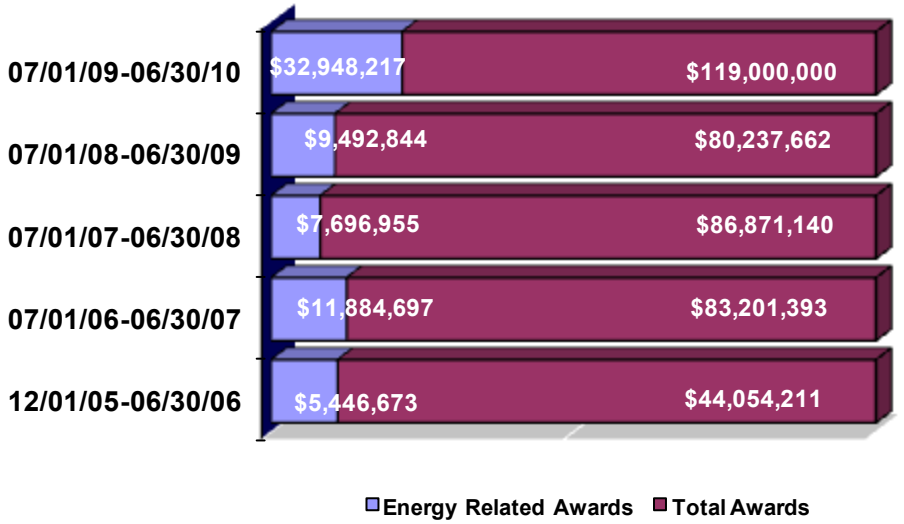
Research

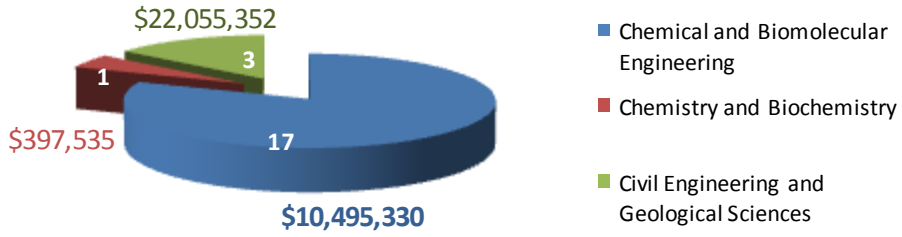
Faculty Research

Energy related research conducted by faculty at the University of Notre Dame is a primary function of the Center's mission to develop new technologies to address the global energy challenge. Since its inception in 2005, the Center has highlighted energy related projects that have been funded by external sponsors. This year, the University received almost $33 million in external funding in support of 21 energy related research projects. These projects are listed alphabetically by principal investigator on the following pages.

Overall, the University has received more than $67 million in external funding for energy related research projects since the beginning of the Energy Center. The bar graph shows the total amount of external research funding received by the University for each fiscal year, and of this amount, the total received for energy related projects. The pie chart provides a breakdown of the total number of projects and awards by department for the current fiscal year.

Energy Related Research Awards vs. Total Awards Received Since the Inception of the Notre Dame Energy Center





Note: Of the total awards received in the Department of Civil Engineering and Geological Sciences, $21,689,039 was granted to the Energy Frontier Research Center (EFRC) for Materials Science of Actinides.

FACULTY RESEARCH *(CONTINUED)*

Principal Investigator	Co-Principal Investigator(s)	Department	Project Title	Sponsor	Award
Albrecht-Schmitt, Thomas		Civil Engr and Geological Sciences	Understanding the Subsurface Reactive Transport of Transuranic Contaminants at DOE Sites	Auburn University	$231,313
Albrecht-Schmitt, Thomas		Civil Engr and Geological Sciences	Toward an Improved Understanding of Structure and Magnetism in Neptunium and Plutonium Phosphonates and Sulfonates	Office of Science, Department of Energy	$135,000
Brennecke, Joan	Stadtherr, Mark	Chemical and Biomolecular Engr	CO_2 Separations with Ionic Liquids	Kyung Hee University	$30,000
Brennecke, Joan	Maginn, Edward; McCready, Mark; Schneider, William; MATRIC	Chemical and Biomolecular Engr	CO_2 Capture with Ionic Liquids Involving Phase Change	Department of Energy	$2,559,569
Brennecke, Joan	Maginn, Edward; McCready, Mark; Paolucci, Samuel; Sen, Mihir; Stadtherr, Mark	Chemical and Biomolecular Engr	Notre Dame Geothermal Ionic Liquids Research: Ionic Liquids for Utilization of Geothermal Energy	Department of Energy	$951,500
Burns, Peter	Albrecht-Schmitt, Thomas; Cahill, Christopher; Clearfield, Abraham; Ewing, Rodney; Fein, Jeremy; Hobbs, David; Lian, Jie; Maginn, Edward; Navrotsky, Alexandra; Nyman, May; Soderholm, Lynda; Weber, William	Civil Engr and Geological Sciences	EFRC: Materials Science of Actinides	Department of Energy	$21,689,039
Lappin, Alexander G.	Hartland, Gregory; Huang, Libai; Kamat, Prashant; Kuno, Masaru; Lappin, Alexander	Chemistry and Biochemistry	CRIF:MU Construction of an instrument for ultrafast absorption and emission studies of single nanostructures	National Science Foundation	$397,535
Maginn, Edward		Chemical and Biomolecular Engineering	(revised budget) GOALI - Atomistic Simulations of the Physical Properties and Phase Behavior of Ionic Liquid/Gas Mixtures	National Science Foundation	$10,690

Research

FACULTY RESEARCH *(CONTINUED)*

Principal Investigator	Co-Principal Investigator(s)	Department	Project Title	Sponsor	Award
Maginn, Edward		Chemical and Biomolecular Engr	Thermally-stable Ionic Liquid Carriers for Nanoparticle-based Advanced Heat Transfer in Concentrating Solar Energy Applications	Savannah River National Laboratory, Department of Energy	$245,667
Maginn, Edward	Brennecke, Joan; Schneider, William; Trimeric Corporation	Chemical and Biomolecular Engr	Breakthrough Technology for Post-Combustion CO_2 Capture	Department of Energy	$1,244,683
Maginn, Edward		Chemical and Biomolecular Engr	Molecular Simulation of Ionic Liquids: Physical Properties, Melting Points, and Droplet Collision Dynamics	Air Force Office of Scientific Research, AFOSR-AFRL-DOD	$350,271
McGinn, Paul	Bauer, Peter	Chemical and Biomolecular Engr	Indiana Advanced Electric Vehicle Education & Training Consortium	Purdue University-West Lafayette	$349,580
McGinn, Paul		Chemical and Biomolecular Engr	Application of a Glass Catalyst Coating by Sol-gel Processing	Tenneco	$11,750
Schneider, William	Brennecke, Joan; Stadtherr, Mark; McCready, Mark; Maginn, Edward; Sen, Mihir; Schmid, Steven; Dometic, Inc.	Chemical and Biomolecular Engr	Compact, Efficient Air Conditioning with Ionic Liquid Based Refrigerants	Department of Energy	$2,817,926
Schneider, William		Chemical and Biomolecular Engr	GOALI: Collaborative Research: Understanding Perovskite-Based NO Oxidation Catalysts via Coupled Experimental and Computational Analysis	National Science Foundation	$241,752
Schneider, William		Chemical and Biomolecular Engr	Towards Realistic Reaction Environments in Catalysis Simulations	Department of Energy	$568,000

Principal Investigator	Co-Principal Investigator(s)	Department	Project Title	Sponsor	Award
Schneider, William	Ribeiro, Fabio	Chemical and Bio-molecular Engr	Passive NO_x Removal Catalyst Research	Department of Energy	$900,000
Schneider, William		Chemical and Bio-molecular Engr	Catalyst Design by Discovery Informatics	Purdue University-West Lafayette	$195,692
Schneider, William	Beres, Martin	Chemical and Bio-molecular Engr	Collaborative Research: Predictive Modeling of Surface Catalysis with Multiple Adsorbate Species	National Science Foundation	$6,250
Wolf, Eduardo	Kumar, Anand	Chemical and Bio-molecular Engr	Catalytic nanodiode	National Science Foundation	$6,000
Wolf, Eduardo	Kumar, Anand	Chemical and Bio-molecular Engr	GOALI: Novel Impregnated Layer Combustion Synthesis for Catalysts Preparation: Hydrogen Production from Methanol	National Science Foundation	$6,000
				TOTAL	**$32,948,217**

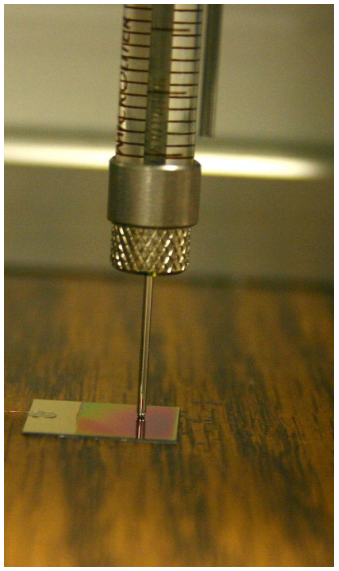
Research

Research Highlights

Solid State Electrolytes for Improved Li-ion Batteries

Prof. Paul McGinn
Undergraduate Students, Priscilla Cavazos, Kevin Goldsmith (Purdue visitor), and Kevin Sallah
Department of Chemical and Biomolecular Engineering

Solid-state Li-ion batteries hold the most promise for safety and reliability, as inorganic solid electrolytes offer advantages over liquid and organic polymer electrolytes such as being free of hazards of leakage and non-flammability. However, better solid electrolytes are needed for bulk solid state batteries to become a reality. One project in Paul McGinn's lab is aimed at developing improved solid electrolytes Li-ion batteries through a combinatorial thin film approach. This relies on depositing a thin film "library" comprised of hundreds of compositions which are characterized in automated way.



A collaboration of three undergraduate students (Priscilla Cavazos-CBE, 2011, Kevin Goldsmith (Purdue summer researcher) Kevin Sallah, CBE 2011) has led to the development of a novel scanning probe instrument for performing the characterization. The instrument uses a syringe filled with mercury to establish electrical contact through a drop at the tip of the syringe. The syringe is connected to an impedance spectroscopy system for the electrical characterization of the film, and is scanned over the sample by a robotic platform. Continued development and use of this system is the focus of the research project of one of the Slatt fellows (Kevin Sallah).

Success Story

Department of Energy honors Notre Dame professor

Joan F. Brennecke, the Keating-Crawford Professor of Chemical and Biomolecular Engineering and director of the University of Notre Dame Energy Center, was chosen to receive the Ernest Orlando Lawrence Award from the United States Department of Energy (DOE). Presented by the secretary of energy, the Lawrence Award honors scientists and engineers at mid-career for their exceptional contributions in research and development supporting the DOE and its mission to advance the national, economic and energy security of the United States. The award is given in each of the following categories: chemistry, materials research, environmental science and technology, life sciences (including medicine), nuclear technologies (fission and fusion), national security and non-proliferation and high-energy and nuclear physics.

Brennecke, who was recognized for her work in environmental science and technology, and the other honorees each received a citation signed by the secretary, a gold medal bearing the likeness of Lawrence, and a $50,000 honorarium during a ceremony on April 28, 2010.

Internationally known for her research in the development of solvents, specifically supercritical fluids and ionic liquids, Brennecke's research interests also include thermodynamics, environmentally benign chemical processing, and carbon dioxide separation, storage and usage.

Throughout her career, Brennecke has received numerous awards for her research, as well as for her contributions in the classroom. Most recently, she was selected as the 2008 Julius Stieglitz Lecturer Award by the American Chemical Society (ACS). She also has received the 2007 John M. Prausnitz Award for outstanding achievement in applied chemical thermodynamics from the Conference on Properties and Phase Equilibria for Product and Process Design, the Professional Progress Award from the American Institute of Chemical Engineers (AIChE), and the 2001 Ipatieff Prize from the ACS in recognition of her high-pressure studies of the local structure of supercritical fluid solutions and the effect of this local structure on the rates of homogeneous reactions. In 1991, the National Science Foundation honored her with the Presidential Young Investigator Award.

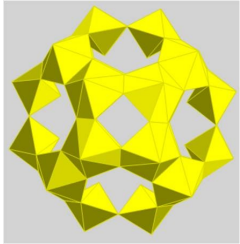
A member of AIChE, the ACS and the American Society for Engineering Education, Brennecke is past chair of the Council for Chemical Research and currently serves on the editorial board of the journal Green Chemistry.

A graduate of the University of Texas, Brennecke earned her master's and doctoral degrees in chemical engineering from the University of Illinois. She has served as a Notre Dame faculty member since 1989.

Success Story

University of Notre Dame What Would You Fight For Nuclear Energy

At Notre Dame's Energy Frontier Research Center, led by Peter C. Burns, Massman Chair and Professor in the Department of Civil Engineering and Geological Sciences, researchers are laying the scientific groundwork for fundamental advances in such areas as solar energy, biofuels, clean coal and nuclear energy.



Notre Dame's EFRC is titled "Materials Science of Actinides." The focus of this center, which includes participants from several other universities and national laboratories, is the elements that are the basis of nuclear energy (uranium, plutonium and other actinides). Research in the center will seek to understand and control materials that contain actinides at the nanoscale, which is about one-millionth of the size of the tip of a ball-point pen. This research is intended to lay the scientific foundation for advanced nuclear energy systems that may provide much more energy while creating less nuclear waste.

EFRC researchers will take advantage of new capabilities in nanotechnology, high-intensity light sources, neutron scattering sources, supercomputing and other advanced instrumentation, much of it developed with DOE Office of Science support over the past decade, in an effort to lay the scientific groundwork for fundamental advances in solar energy, biofuels, transportation, energy efficiency, electricity storage and transmission, clean coal and carbon capture and sequestration, and nuclear energy.

Aired as one of the featured videos by NBC during the Notre Dame 2009 football season, Dr. Burns, and Meehan Lenzen, Class of 2011, explain the benefits of nuclear energy. The video can be viewed at:

http://www.youtube.com/watch?v=HKpK8vVUpMs

Waste Heat Recovery Using Environmentally Opportunistic Computing at the University of Notre Dame

Eric M. Ward Jr., Ryan Jansen, Michal Witkowski, Paul Brenner[2,3], David B. Go, PHD[1]

The cost to operate and cool IT equipment is a growing concern in the United States. While improvements are being made in the overall efficiency of operating computational equipment, the increased demand for high performance computing devices will lead to growth in the size of such systems. As a result, the power consumption of computing equipment is expected to increase dramatically. One approach taken at the University of Notre Dame to operate IT equipment more efficiently is Environmentally Opportunistic Computing (EOC). The main goal of EOC is to distribute computing resources over multiple locations where the thermal byproduct of the computational equipment can be used to reduce the heating demands of an adjacent facility. Additionally, EOC removes the energy consumption associated with using air conditioning to cool the machines. This work focuses on developing the first EOC prototype with computer servers used by the University of Notre Dame Center for Research Computing. The prototype is a custom made container housing one hundred computer servers that is located next to the South Bend Botanical Gardens and Greenhouse (BGG). Air used to cool the servers in the container is ducted into the BGG to provide heat. Temperature sensors in the container measure the temperature difference between the air on the front side of the servers and the air on the back side of the servers. Preliminary measurements suggest that while operating 30-50% of the servers in the container, approximately 10 kW of heat is recovered from the container and exhausted in the BGG. Additionally, a model is being developed to demonstrate the theoretical energy savings of implementing EOC at multiple locations. In the model, computer servers at each location are turned on or off based on the heating demands of the adjacent facility and a feedback control is used to manage the facility heating system based on the amount of heat recovered from the computer servers.

Eric Ward is a 2010 Vincent P. Slatt Fellowship recipient and presented his research findings at the University of Notre Dame's Undergraduate Research Symposium.

Research

RESEARCH HIGHLIGHTS *(CONTINUED)*

Energy Transport via Phonons in Small Non-Harmonic Systems

Scott W. Deakins, Aerospace and Mechanical Engineering

This project investigates the energy transport effect of phonon flow in a one-dimensional molecular system using a mathematical model. The model of the molecular system utilizes the non-harmonic Lennard-Jones potential and nearest neighbor coupling in deriving the position and velocity of each oscillator within the system. A cross-correlation method was employed for processing the position and velocity data generated in the model and for determining the speed the phonon travels through the molecular system. Through analysis of the energy transport effect of phonons in a small, one-dimensional molecular system, a better understanding of the energy transport of waves in larger, multi-dimensional molecular systems was gained. The popular Green-Kubo method, which is used for analyzing the heat transfer of Fourier's law of conduction in large molecular systems, calculates the energy transport coefficients from the diffusive, particle nature of molecular systems and ignores the additional energy flow due to wave motion.

Scott Deakins is the recipient of a 2009 Vincent P. Slatt Fellowship award. He presented his research findings at the University of Notre Dame's Undergraduate Research Symposium.

Success Story

Maginn receives inaugural CoMSEF Early Career Award

Edward J. Maginn, professor of chemical and biomolecular engineering at the University of Notre Dame, was the recipient of the inaugural American Institute of Chemical Engineers CoMSEF (Computational Molecular Science and Engineering Forum) award for outstanding research. Maginn was cited for his "development of algorithms to use molecular simulation to study fundamental thermodynamics and transport behavior and his specific contributions to the understanding of nanoporous materials and ionic liquids."

Maginn's research focuses on computational statistical thermodynamics, in which atomistic-level computational methods are developed and utilized to obtain a fundamental understanding of the link between the physical properties of materials and their chemical constitution. Much of his work is devoted to environmental and energy-related applications.

He has been principal investigator or co-principal investigator for more than 35 externally funded grants totaling approximately $14 million. He holds two patents and is the author or co-author of more than 80 peer-reviewed articles and five book chapters.

Maginn currently is on the editorial board of the journal Fluid Phase Equilibria. He has won a number of teaching and research awards, including the BP Outstanding Teaching Award for the College of Engineering, two Kaneb Awards, two AIChE student chapter teaching awards, the American Society for Engineering Education New Faculty Award and the National Science Foundation CAREER Award.

A member of the Notre Dame faculty since 1995, Maginn also serves as associate dean for academic programs for the University's Graduate School. He earned his bachelor's degree in chemical engineering from Iowa State University and his doctorate from the University of Califor-

Quantum Mechanics Gets a Grip on CO_2

Prof. Bill Schneider
Graduate Student, Elaine Mindrup
Undergraduate Student, Tom Senftle
Department of Chemical and Biomolecular Engineering

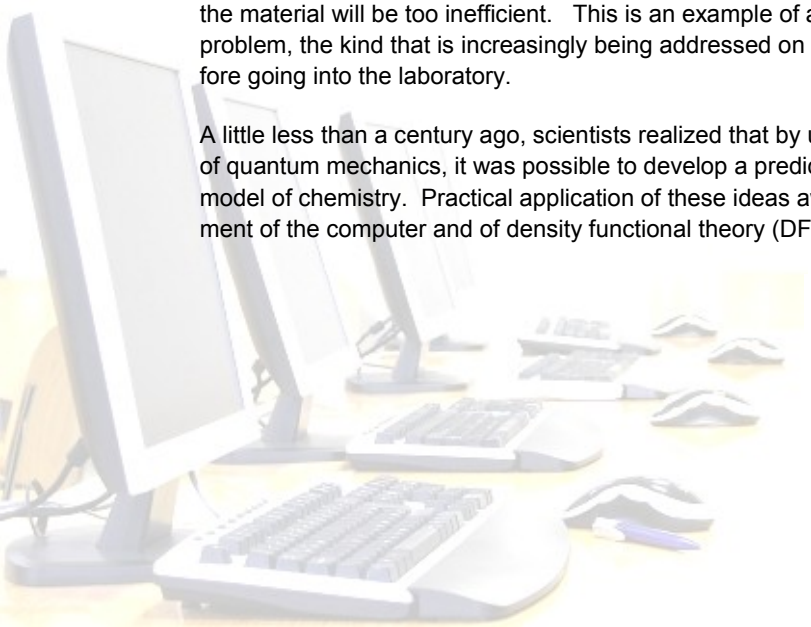
Fossil fuels are an abundant and convenient energy source, but burning this fuel invariably produces carbon dioxide (CO_2), a greenhouse gas whose steadily increasing concentration in the atmosphere raises concerns about its effects on the global climate. Many strategies have been proposed for dealing with this CO_2 problem, from sequestering it underground to using it in chemical processes to converting it back to fuel using solar energy. These approaches invariable need CO_2 to first be separated from some mixture of gases, a process that today consumes a large amount of energy.

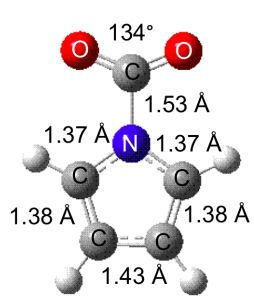
What is needed is a material that selectively and reversibly makes chemical bonds with CO_2. This bonding is a careful balancing act—if too strong, it will cost too much energy to get the CO_2 back off; but if the bonding is too weak, the material will be too inefficient. This is an example of a molecular design problem, the kind that is increasingly being addressed on the computer before going into the laboratory.

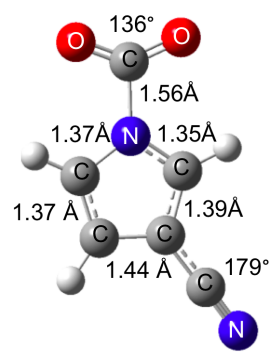
A little less than a century ago, scientists realized that by using the equations of quantum mechanics, it was possible to develop a predictive mathematical model of chemistry. Practical application of these ideas awaited the development of the computer and of density functional theory (DFT)—a particularly convenient framework for applying quantum mechanics to chemistry. The result is that today many chemical problems can be solved with surprising reliability on relatively affordable clusters of high performance computers.

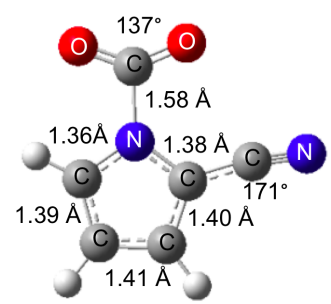
At Notre Dame, we are using these tools to design molecules that combine with CO_2 with any strength desired. The basic design framework is called an "AHA"—an aprotic, heterocyclic anion. The approach takes advantage of the intrinsic "Lewis acidity" of CO_2—its desire to accept a pair of electrons from a donor molecule—and the complementary basicity of the AHA structure. Students Mindrup and Senftle performed many DFT calculations to identify promising candidates. The figure shows DFT-computed structures of CO_2 bound to three of these candidate structures, in decreasing order of bond strength. These anions have been fashioned into ionic liquids in the lab of Prof. Joan Brennecke, where experiments confirm the theoretical predictions.

Larger-scale experiments to test the CO_2 separating capability of these materials are under way. These novel anions are now being incorporated into possible solid absorbent materials, and they may find use in membranes that selectively allow CO_2 to pass through. Their tunable properties make them good candidates for other applications as well. For instance, a Notre Dame team of researchers recently received a major grant from the Department of Energy ARPAe program to test the ionic liquid AHA-CO_2 mixtures as high efficiency refrigerants. Whatever the application, DFT modeling will be there to make sure just the right "grip" is gotten on CO_2.









Fellowships

Undergraduate Student Research

The 2010 recipient of **The Forgash Fellowship for Undergraduate Research in Solar Energy** was Dr. Hsueh-Chia Chang, Professor of Chemical and Biomolecular Engineering, in support of undergraduate researcher, David Riehm. Dr. Chang has been working with David since fall 2009 on a dye and quantum dot sensitized solar cell project, with the basic conjecture that the low efficiency of such cells stems from transport limitation of the regenerating redox agent. For more information about Dr. Chang's research, visit his website at http://cbe.nd.edu/faculty/show/hchang/.

The Vincent P. Slatt Endowment for Undergraduate Research in Energy Systems and Processes provides financial support to undergraduate students who are interested in conducting research in the field of energy systems and processes. Awards are made annually up to $5,000 per recipient. Slatt awards for 2010 totaled $37,000.

Slatt Scholars are:

Ross Degenhardt, Junior, Chemical and Biomolecular Engineering. Advisor: Dr. Paul McGinn. Project: "Processing Pouch-Type Batteries for Testing of Electrolytes and Electrode Materials." Award: $5,000.

Picture Not Available

Michael Glaser, Senior, Chemical and Biomolecular Engineering. Advisor: Dr. Joan Brennecke. Project: "Zone-Melting Purification of Solid Ionic Liquids." Award: $2,150.

Kyle Hakanen, Senior, Chemistry and Biochemistry. Advisor: Dr. Kenneth Henderson. Project: "Utilization of Metal Organic Frameworks to Sequester Carbon Dioxide." Award: $5,000.

Matthew Kiener, Senior, Aerospace and Mechanical Engineering. Advisor: Dr. Mihir Sen. Project: "Utilization of Molecular Dynamics to Model Solid-State Phonon Conduction." Award: $3,750.

Jason Kopec, Junior, Chemistry and Biochemistry. Advisor: Dr. Seth Brown. Project: "Development of a Bis (aminophenolate) Complex of Molybdenum to Mediate the Redox Processes Involved in Fuel Cell Chemistry." Award: $5,000.

Serena Mathews, Sophomore, Chemical and Biomolecular Engineering. Advisor: Dr. Joan Brennecke. Project: "Synthesis of Ionic Liquids." Award: $2,110.

Picture Not Available

Kameron Mayne, Senior, Civil Engineering and Geological Sciences. Advisor: Dr. Chongzheng Na. Project: "Analysis of the Effect of Weathering on Bituminous Coal Using Atomic Force Microscopy Coal." Award: $5,000.

Douglas Pernik, Junior, Chemical and Biomolecular Engineering. Advisor: Dr. Prashant Kamat. Project: "Kinetic Analysis of CdSe Adsorption to TiO2 Electrode." Award: $2,300.

Robert Powers, Senior, Aerospace and Mechanical Engineering. Advisor: Dr. Bill Goodwine. Project: "Energy Storage Technologies: Dealing with Electrical Load Shedding in Rural Bangladesh." Award: $2,470.

Miriam Shakalli, Senior, Chemical and Biomolecular Engineering. Advisor: Dr. Joan Brennecke. Project: "Measurements of Various Properties of Synthesized Ionic Liquids." Award: $2,110.

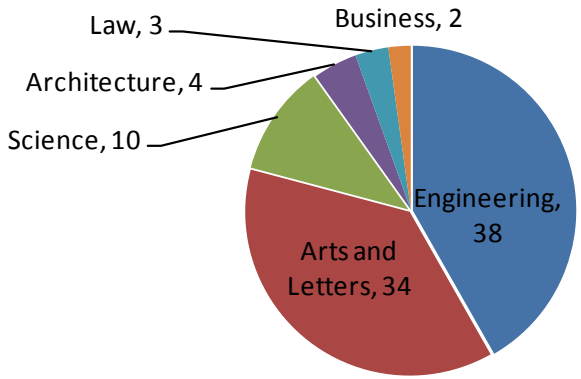
Eric Ward, Jr., Senior, Aerospace and Mechanical Engineering. Advisor: Dr. David Go. Project: "Building-Integrated Information Technology: A Unified Engineering and Architectural Framework for Sustainable Design." Award: $2,110.

Education and Outreach

EDUCATION COURSES IN ENERGY

The University of Notre Dame offers a total of 91 energy focused and energy related courses throughout each of the colleges. There are 22 energy focused courses offered in the Colleges of Arts & Letters, Engineering, Law, and Science, and 69 energy related courses offered in the Colleges of Architecture, Arts & Letters, Business, Engineering, Law, and Science.

The total number of energy focused and energy related courses in each of the colleges is shown graphically here along with an alphabetical listing of course titles.



Advanced Embedded Systems Design
Advanced Topics: Integrated Engineering and Business
Agricultural Law
Alternative Energy Devices & Materials
Building America
Chemical Engineering Thermodynamics
Chemistry of Lanthanides and Actinides
Chemistry, Environment, and Energy
Concepts of Energy and the Environment
Conscience in the Crossfire: Enviro Ethics
Control Systems
Current Topics in Environ Science
Deciding to be Green
Directed Readings in Sustainable Energy
Ecology , Ethics & Economics
Ecology and Environmental Issues
Economic and Environmental Sustainability of Biofuels
Economics of Public Policy
Economics of Science
Electric and Hybrid Vehicles
Electrical Energy Extraction
Electrical Machinery and Power Systems
Energy & Climate
Energy and Environment: Current Policy Issues
Energy and Society
Energy Law
Energy Policy, the Environment and Social Change
Energy Systems
Energy-Constrained Devices and Circuits
Environmental Chemistry
Environmental Economics
Environmental Ethics
Environmental Geosciences
Environmental Justice
Environmental Politics
Environmental Systems I
Environmental Systems II/System Integration
Envrmntl Impact of Resource Utilization
Ethics of Energy Conservation
Fuel Cells Sci & Technology
Future of Energy/Energy and Society
Gas Turbines and Propulsion
Global Issues and the UN
Global Sustainability
Heat Transfer
Independent Research: Urban Housing, Construction Technologies and Energy Use
Inorganic Geochemistry of Lanthanides and Actinides
International Environmental Politics
International Political Economy
International Relations
Intro Environmental Engineering
Intro to Chemical Engineering
Intro to Electrical Engineering
Intro to Entrepreneurship
Is there an Environmental Crisis?
Jr Seminar: Environmental Politics
Minerals Law
Modeling Ecology & Environment
Nature and the built Environment
Nonlinear Control Systems
Physics of Computation
Principles of Management
Problems in Political Economy
Science/Environ Policy in US
Self, Society & Environment
South America: Concurrent Projects and Integration
Special Studies in Energy Systems
Sr Seminar: Sustainable Development
The Congress: SC and Tech Policy
The Global Economy
Thermal Physics
Thermodynamics
U.S. Environmental History

Education and Outreach

EDUCATION MINORS IN ENERGY

Energy Engineering Minor

The Energy in Engineering Minor is open to all undergraduate engineering majors. Five, three-credit, courses are required from a list of energy courses offered in Aerospace & Mechanical Engineering, Electrical Engineering, and Chemical & Biomolecular Engineering. This minor is designed to enable students to gain a stronger background and be better prepared for professional jobs or higher studies in energy technology.

Energy Studies Minor

The Energy Studies Minor will be offered to all undergraduate majors at the University of Notre Dame beginning Fall 2011, after College and University approval. The proposed program will require two, three-hour courses (listed below) and three, three-hour courses selected from a technical or non-technical list, as well as a capstone project to be determined by the student and his/her advisor. This minor will prepare students to become successful leaders from all disciplines who understand the complexity of the energy challenge. They will be better prepared to provide goods and services that allow an acceptable quality of life in a more energy efficient manner. In addition, students will be able to develop alternative energy sources and draw from technical and non-technical resources to move our country and the world towards a sustainable energy future.

The required courses are:
- ENER 0101: fundamental technical skills needed to understand energy systems (taught by Physics).
- ENER 0202: survey of energy resources, global climate change, basics of energy business and finance, energy economics, national and global energy policy, the psychology and ethics of energy consumption and behavior, and new urbanism (organized through the Mendoza College of Business).

Success Story

Notre Dame joins Indiana energy consortium

The University of Notre Dame Energy Center has joined the Indiana Consortium for Research in Energy Systems and Policy (CRESP). The center joins founding partners Indiana University, Purdue University and Indiana University-Purdue University at Indianapolis in this multidisciplinary organization designed to promote energy focused collaborative investigations and educational opportunities among faculty and researchers at the partner universities.

CRESP's goals include facilitating the formation of multi-institution research teams, securing funding for those teams and conducting research that targets solutions to energy issues. The consortium's scope encompasses both renewable and fossil energy, specifically focusing on issues relevant to the economies of Midwestern states, particularly Indiana, where about 96 percent of the state's electricity is generated in facilities fueled by coal. The state also is a large producer of renewable energy resources, such as ethanol and biodiesel from corn and soybeans.

Each university partner offers a different strength for CRESP, from electric vehicles and battery technology to global warming. The Notre Dame Energy Center provides expertise in the development of CO_2 separation for cleaner fossil fuel utilization, the safe storage and use of nuclear fuel byproducts, and the creation of new solar energy technologies.

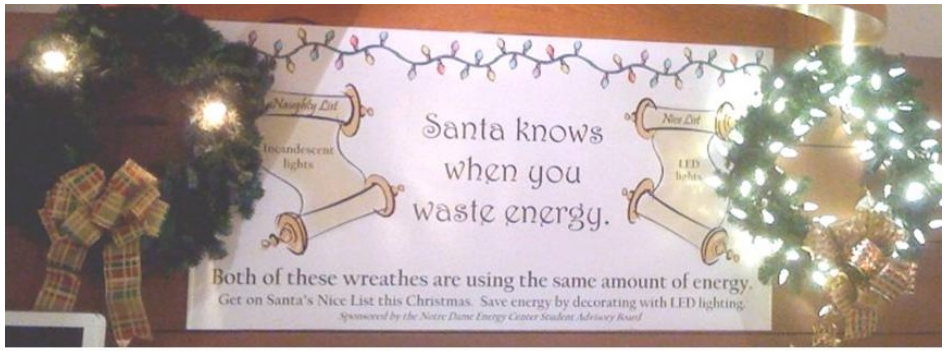
Education and Outreach

Student Advisory Board Christmas Light Display

December 2009

The Notre Dame Energy Center Student Advisory Board created two light displays for the holiday season, demonstrating the energy efficiency of LEDs over incandescent light bulbs. The displays were hung in DeBartolo Hall and outside the Engineering Library in Fitzpatrick Hall. The display is pictured below. Both wreaths are using about 7 watts of electricity. However, the LED wreath has 150 light bulbs while the incandescent wreath has only 2!

Santa knows when you waste energy. Get on Santa's Nice List and save energy by decorating with LED light bulbs.



Statewide Energy Curriculum Workshop

January 13, 2010

ENERGY CENTER PANEL

Patrick Murphy, Managing Director of the NDEC, joined Dr. Jay Gore of Purdue University and other statewide universities in a discussion on energy related programs for the purpose of exploring current and emerging energy related career opportunities, the requirements to prepare for these careers, and gaps and requirements for curriculum development.

Institute for Theoretical Sciences Workshop

January 27-30, 2010

CATALYTIC MATERIALS BY DESIGN

Co-sponsored by Argonne National Laboratory, this workshop brought together senior experimentalists and theorists, young researchers, and graduate students from around the world to focus on cutting-edge science in catalysis and materials that can make a difference in today's urgent challenges like energy sustainability. Bill Schneider, member of the Energy Center faculty, discussed (exploiting?) surface ordering effects in catalysis. *For more information about the workshop, visit http://theoryinstitute.org/catalysis/*

Civil Engineering and Geological Sciences Seminar

March 31, 2010

GROUNDWATERS ASSOCIATED WITH COALBED METHANE: GEOCHEMISTRY AND ENVIRONMENTAL ISSUES

Presented by Dr. James Drever, Emeritus Professor, Department of Geology and Geophysics, University of Wyoming. *For more information about the Department of Geology and Geophysics at the University of Wyoming, visit: http://geology.uwyo.edu/*

Regional Development Office—NYC

June 15, 2010

THE PATH TO SUSTAINABLE ENERGY: WHAT WILL THE WORLD LOOK LIKE IN 2020, 2050 AND BEYOND?

Co-sponsored by the Notre Dame Energy Center, Patrick Murphy, Managing Director of the NDEC, joined other panelists in a discussion centered around the opportunities and challenges in meeting the world's increasing demand for energy in the face of climate change policies, energy security, and "peak oil" estimations. More than 50 alumni from the New York City area participated in the energy discussion. Joined by Patrick Murphy '92 were other distinguished panelists: Anne Thompson '79, Patrick Eilers '89, Michael Dudas '86, and Dr. Danielle Merfeld '94.

Education and Outreach

Distinguished Lecture Series 2009

Thursday, September 17

SPAIN: BRINGING RENEWABLE ENERGY TO THE U.S. AND BEYOND, Enrique Alejo, Economic and Commercial Counselor of Spain for the Midwest Trade Commission of Spain in Chicago

Why is Spain home to some of the world's largest, most successful producers of renewable energy? Keys to Spain's success in the renewable energy sector include strong government backing, profitable investments and availability of natural resources. From advanced photovoltaics and high-yield solar farms to state-of-the-art wind turbines and biofuels, Spanish companies are generating solutions to make renewable energy available for everyone. Read more at: http://www.nd.edu/~ndenergy/news-and-events/Alejo.shtml

Monday, October 5

GRIM FAIRY TALES: MYTHS THAT ENABLE OUR ADDICTION TO COAL, Michael Hogan, Power Programme Director for the European Climate Foundation

There's too much scientific uncertainty about climate change to justify drastic action. "Business as usual" with "incremental change" is the low-cost option. Coal is plentiful and cheap. Renewables are intermittent and unreliable. "Clean coal" technology will solve coal's "climate" problem. China won't act, so it doesn't matter what we do. For the foreseeable future there is no alternative to coal if we want to maintain our standard of living. Read more at: http://www.nd.edu/~ndenergy/news-and-events/Hogan.shtml

Thursday, October 15

CARBON CAPTURE AND SEQUESTRATION: PROGRESS, CHALLENGES, AND OPPORTUNITIES, Dan Connell, Research and Development Engineer, CONSOL Energy, Inc.

It is likely that some form of climate change legislation will soon be enacted in the United States, with major implications for the nation's energy industry. The American Clean Energy and Security Act of 2009, which was passed by the U.S. House of Representatives in June 2009 and is now before the Senate, calls for U.S. greenhouse gas emissions ultimately to be reduced by 83% from 2005 levels by 2050. Such a target would require drastic cuts in emissions from a variety of sources, including coal-fired power plants, which account for about a third of the country's total carbon dioxide emissions. Read more at: http://www.nd.edu/~ndenergy/news-and-events/Connell.shtml

Friday, November 6

HYDROTHERMAL ENERGY CONVERSION AND RECOVERY FROM BIOMASS AND GEOTHERMAL RESOURCES, Jefferson W. Tester, Croll Professor of Sustainable Energy Systems at Cornell University

Recent international focus on the value of increasing the supply of indigenous, renewable energy underscores the need for re-evaluating all alternatives, particularly those that are large and well-distributed on a national or global basis, to expand and diversify the portfolio of options we should be vigorously pursuing. Read more at: http://www.nd.edu/~ndenergy/news-and-events/Tester.shtml

Education and Outreach

Friday, November 20

ENERGY POLICY FORUM, **Guy Caruso**, Senior Adviser, Energy and National Security Program, Center for Strategic & International Studies; **Dr. Raymond Scheppach**, Executive Director, National Governors Association; and **Tom Gresik**, Professor of Economics and Econometrics, University of Notre Dame. See bios at: http://www.nd.edu/~ndenergy/news-and-events/EnergyPolicy.shtml

Guy Caruso

Raymond Scheppach

Tom Gresik

Thursday, December 3

FUTURE AUTOMOBILE FUELS: FILL UP OR PLUG IN?, Michael J. Desmond, Distinguished Advisor, Conversion Technology, BP America, Inc.

Concerns about climate change and energy supply security are likely to shape both government transportation policy and vehicle/fuel research and development. These concerns don't always collide as renewable fuels, and electric vehicles are being proposed as attractive options to address both climate change and supply security. Desmond suggests how vehicles and fuels may evolve over the next 20+ years, and which combinations make the most sense from a timing and cost/benefit perspective. Read more at: http://www.nd.edu/~ndenergy/news-and-events/Desmond.shtml

To view slide presentations from the 2009 lectures and the video from the Energy Policy Forum, visit: http://www.nd.edu/~ndenergy/news-and-events/distinguishedLectureSeries2009.shtml

Spring 2010 Lecture Series

February 16

SELF-ASSEMBLED BLOCK COPOLYMER THIN FILMS USED AS FILTRATION MEMBRANES, Dr. William A. Phillip, Department of Chemical Engineering, Yale University

Current ultrafiltration membranes are made using a phase separation technique. This standard technique results in a pore structure that consists of a polydisperse distribution of pore sizes. Among this distribution, the larger pores can comprise any desired separation of solutes from solution. The fabrication of filtration membranes with a monodisperse pore size will be discussed in this talk. Read more at: http://www.nd.edu/~ndenergy/news-and-events/PhillipAbstract.htm

February 23

NANOPOROUS INORGANIC MEMBRANES FOR ENERGY AND ENVIRONMENT APPLICATIONS, **Dr. Miao Yu**, Department of Chemical and Biological Engineering, University of Colorado, Boulder

Nanoporous membranes have shown great potential on separating mixtures in an energy-efficient way. Both energy-related mixture separations, such as natural gas purification and alcohol/water separation, and environment-related separations, such as CO2 capture and water treatment, have been widely investigated using membrane based separation processes. Very promising results have been obtained. Read more at: http://www.nd.edu/~ndenergy/news-and

Education and Outreach

SPRING 2010 LECTURE SERIES *(CONTINUED)*

MARCH 1

NANOCOMPOSITE MATERIALS FOR ENVIRONMENTAL APPLICATIONS, Dr. Mary Laura Lind, Civil and Environmental Engineering Department, University of California Los Angeles

Lind discussed recent work on advanced nanocomposite membrane materials. Understanding the effects of nanoscale interactions on bulk material properties enables the design of novel materials with advanced functionalities. Within the context of sustainable engineering, advanced nanomaterials allow improved industrial separations (sorbants, catalysts, membranes), advanced water purification (low energy desalination, non-toxic biocides), environmental remediation (CO2 sequestration, contaminant cleanup), and renewable energy production (fuel cells, photovoltaics, osmotic power). Read more at: http://www.nd.edu/~ndenergy/news-and-events/LindAbstract.htm

MARCH 17

MICROSTRUCTURAL CONTROL TO ACHIEVE HIGH PERFORMANCE MFI TYPE ZEOLITE INORGANIC MEMBRANES, Dr. Jungkyu Choi, Department of Chemical Engineering, University of California Berkeley

It has been addressed that a robust, reliable fabrication of defect-free zeolite membranes are critical to contribute considerably to energy-saving in separation processes as alternative to conventional cost-intensive counterparts (distillation, crystallization, etc.). Therefore, much research has been focused on the field of zeolite membranes with respect to control of pore orientation and film thickness on diverse supports. Read more at: http://www.nd.edu/~ndenergy/news-and-events/Choi_Abstract.htm

MARCH 31

ADSORPTION OF GASES IN NANOPOROUS MATERIALS: EQUILIBRIUM AND KINETICS, Dr. Maria Calbi, Department of Physics, Southern Illinois University Carbondale

Adsorption phenomena on surfaces have been extensively investigated based on the presence of thermodynamic equilibrium between the external gas in contact with the surface and the adsorbed film. In nanoporous structures, however, the actual observation of the expected equilibrium properties (such as the total gas uptake for example) may strongly depend on how and how fast that equilibrium is reached, generally referred to as adsorption kinetics. Read more at: http://www.nd.edu/~ndenergy/news-and-events/CalbiSeminar.htm

APRIL 6

MODELING THE INTERACTIONS OF ADSORBATES WITH METAL SURFACES AND THE DEVELOPMENT OF NEW SORBENTS FOR POST-COMBUSTION CO2 CAPTURE, Dr. John Kitchin, Chemical Engineering Department, Carnegie Mellon University

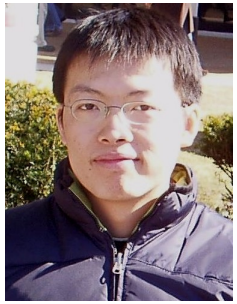
The interactions of molecules with metallic surfaces are fundamental to the ability of metals to catalyze reactions. One often thinks of a metal like platinum as the catalyst, but under reaction conditions the reactivity of the metal surfaces is modified by the molecules that adsorb on them. Read more at: http://www.nd.edu/~ndenergy/news-and-events/KitchinSeminar.htm

Education and Outreach

Spring 2010 Lecture Series *(continued)*

April 15

PORE-SCALE INVESTIGATION AND THE APPLICATIONS IN ENERGY AND ENVIRONMENAL SCIENCES, Dr. Cheng Chen, Department of Earth & Atmospheric Sciences, Purdue University



High-energy, synchrotron-based X-ray difference micro-tomography (XDMT) was used to resolve the pore structure of a granular porous medium, as well as colloidal deposits within the pore space, with six-micron resolution. After processed by sophisticated image processing methods, the detailed structural information was used to define internal boundaries for three-dimensional lattice Boltzmann (LB) simulations of the effects of the colloidal deposits on pore-scale fluid flow and solute transport. Colloid accumulation was observed to be highly heterogeneous at the pore scale. Read more at: http://www.nd.edu/~ndenergy/news-and-events/ChenSeminar.htm

April 20

ORIGINS OF SELECTIVITY IN ACTINIDE SEPARATIONS, Dr. Mark Jensen, Chemical Sciences and Engineering Division, Argonne National Laboratory

As a carbon-neutral energy source, nuclear energy accounts for about 20% of the electricity produced in the United States and around the world. Chemical separations of the radioactive actinide elements and their fission products have always played critical roles in the nuclear enterprise, but concepts under consideration for new generations of nuclear reactors that run on advanced nuclear fuels and produce less radioactive waste will require separations that far surpass the performance of the chromatographic and liquid-liquid extraction processes in use today. Read more at: http://www.nd.edu/~ndenergy/news-and-events/JensenSeminar.htm

Managing Director's Events, Presentations, and Outreach

ND Summer Science Camp presentation on Energy Past, Present and Future. July 13, 2009

Panel reviewer for DOE programs on "Mathematics for Complex, Distributed, Interconnected Systems". July 28, 2009

Boeing Visit, presentation on ND Energy Research and Education. September 9, 2009

ND Center for Social Concerns Energy Policy Seminar, presentation on "Energy Resilience". September 23, 2009

Notre Dame Navy Research Forum, breakout discussion with Crane on ND Energy Research. November 5, 2009

Invited attendee to ARPA-E/EERE workshop on "Advanced Building Energy Technologies". December 15, 2009

Stanley Clarke School visit to Hessert Labs and Wind Energy, hosted presentation by Prof. Bob Nelson. January 8, 2010

"Statewide Energy Curriculum Workshop" at Purdue, presented Notre Dame energy education activities and plans. January 14, 2010

George Washington University meeting with Science and Technology Policy and Systems Engineering Faculty, presented ND Energy Research Collaboration Opportunities. January 28, 2010

Participated in ND Silicon Valley Tech Forum Speed Learning session, along with other ND center and institute representatives. February 18, 2010

Presented ND Energy Research to SAIC team at Crane Naval Surface Warfare Center, Crane Indiana. April 12, 2010

Provided tour and discussion of solar energy and energy for buildings to Arielle Phillips Physics for Architects class. April 27, 2010

NYC Alumni Club Energy Panel, with Anne Thompson '79 - NBC Chief Environmental Affairs Correspondent, Patrick Eilers '89 – Managing Director at Madison Dearborn Partners, LLC – responsible for the firm's energy and power practice; Michael Dudas, CFA, '86 – Managing Director - Equity Research at Jefferies & Company – focuses on coal/natural gas/mining industries; Dr. Danielle Merfeld '94 – Director of Solar Technology Platform at General Electric's Global Research Center. June 15, 2010

Intro to Engineering Program, presentation on "Energy Resilience." June 22, 2010

Education and Outreach

Building on the success of last year's program, Notre Dame held its third annual Energy Week September 13-19 on Notre Dame's campus. Activities throughout the week focused on educating students about the world's energy crisis and informing them of the actions being taken by the University to address the most critical energy challenges through research and education at Notre Dame.

This year's theme "Green is the new Black" was designed by Notre Dame student Colin Hofman and donned the annual Energy Week T-shirt and other print and electronic media.

Major energy companies and energy related groups and organizations displayed the latest in energy technologies and explained best practices in creating a sustainable energy future. Lining the South Quad were representatives from major companies, groups, and organizations who met with more than 1000 students throughout the day: BP; General Electric; Honda Manufacturing of Indiana; Indiana Department of Environmental Management; Indiana Michigan Power; Just Goods; NiSource Energy Technologies; POET Biorefining-Alexandria; Sierra Club-Hoosier Chapter; St. Joseph County Parks; Office of Sustainability; ND Power Plant; ND Food Services; GreeND; and Students for Environmental Action.

NOTRE DAME energy week

Several lectures were held throughout the week that covered such topics as renewable energy sources and creating a sustainable energy future:

***"Solar Energy: Present Status and Challenges"* - Dr. Prashant Kamat**, Professor of Chemistry and Biochemistry; Senior Scientist, Radiation Lab; Concurrent Professor of Chemical and Biomolecular Engineering

"Issues in Energy Storage: Or, How Do You Use Solar Energy When It's Dark Outside?" - Dr. Seth Brown, Associate Professor of Chemistry and Biochemistry

***"Green Nuclear Power?"* - Peter Burns**, Massman Chair and Professor of Civil Engineering and Geological Sciences

***"Spain: Bringing Renewable Energy to the U.S. and Beyond"* - Enrique Alejo**, Economic and Commercial Counselor of Spain

***"Clean Energy and Climate Change"* - Bowden Quinn**, Conservation Program Coordinator, Indiana Sierra Club; **Steve Francis**, co-Chairperson, Hoosier Chapter Sierra Club and Chairperson of the Green Energy Committee, South Bend Green Ribbon Commission (appointed by Mayor Steve Luecke).

Other events included an Energy Career Luncheon, tours of the ND Power Plant and the New Energy Ethanol Plant, and screenings of documentaries and energy-focused movies, such as "Too Hot Not To Handle" and "Earth."

More information about Energy Week including slide presentations from each lecture can be found at: http://www.nd.edu/~ndenergy/news-and-events/EnergyWeekSchedule2009.shtml.

Energy Week is sponsored by the Notre Dame Energy Center Student Advisory Board.

Education and Outreach

Members of the Notre Dame Energy Center Student Advisory Board are shown here on top of the roof of Stinson-Remick Hall standing behind the solar panels donated by General Electric. This 50,000-kilowatt solar panel system generates energy that helps power the building. The solar panel array is monitored by a system in the College of Engineering's Learning Center, where undergraduate students are tracking the energy being generated.

Looking Ahead to 2010-2011

Sustainable Energy Initiative (SEI)

A Strategic Research Investment (SRI) of the University of Notre Dame, the SEI is a $10M research and education initiative that will establish Notre Dame's preeminence in three strategic areas – safer nuclear, cleaner fossil, and transformative solar – all focusing on the research and development of materials to help make clean energy more affordable and more readily available. Research toward new and improved sustainable energy technologies and systems will also provide educational opportunities for scientists, engineers, social scientists and citizens to be leaders in their disciplines and literate in the systems of energy production and use.

A core requirement for the needed technological innovations and advances in each of the research areas is the manufacture of novel materials. Chemical synthesis is a core strength in the Colleges of Engineering and Science at Notre Dame. Therefore, the design and synthesis of revolutionary new materials will form the basis of SEI research and will feed into all of the research thrusts described below.

- *Materials for gas separations* – the development of **cleaner fossil** fuel processes.
- *Actinide materials stabilization* – methods for the **safer** storage of **nuclear** fuel by-products.
- *Materials for the efficient conversion of solar to chemical energy* – the creation of **transformative solar** cell technologies.

In addition, four new research facilities will be constructed to house state-of-the-art instrumentation and equipment in the following locations:

Cleaner Fossil and Transformative Solar Lab—Stinson-Remick
Safer Nuclear Lab—Stinson-Remick
Chemical Simulations Lab—Fitzpatrick/Cushing
Materials Characterization and Synthesis Lab—Nieuwland Science

The SEI launches July 1, 2010. For more information, visit the SEI website at: http://energy.nd.edu. To learn more about other University Strategic Research Investments, visit: http://sri.nd.edu/.

Education and Outreach Programs

Saturday, September 25, 2010
10:00 a.m., 101 Jordan Hall of Science
"The Twelve Principles of Green Chemistry"
John Warner, co-founder, President, Chief Technology Officer, Chairman of the Board, Warner Babcock Institute for Green Chemistry

Saturday, September 25, 2010
11:00 a.m., 101 Jordan Hall of Science
"The Equinox House"
Ty Newell, Vice President, Newell Instruments, Inc.
Professor Emeritus, Department of Mechanical Science and Engineering
University of Illinois at Urbana-Champaign

Tuesday, September 28, 2010
3:30 p.m., 102 DeBartolo Hall
"Determination of Solar Energy Transition Potential of Department of Defense Facilities and Non-Tactical Vehicles"
Ariel Castillo, Ph.D. Candidate, George Washington University

Wednesday, September 29, 2010
7:30 p.m., 141 DeBartolo Hall
"The Future of Alternative Energy"
Professors Joan Brennecke, Seth Brown, Peter Burns, Tom Corke, Rob Nerenberg; and Patrick Murphy as moderator, University of Notre Dame

Friday, November 5, 2010
1:00 p.m., Nieuwland Science Hall
"Functional Metal-Organic Framework Materials"
Joseph Hupp, Professor of Chemistry, Northwestern University

Thursday, December 2, 2010
2:00 p.m., 258 Fitzpatrick Hall
"Smart Grid Security Analysis"
Jason Black, Systems Engineer, General Electric

February 7-9, 2011
1:00 p.m., Nieuwland Science Hall
Daniel Nocera, Professor of Chemistry, Massachusetts Institute of Technology

February 28, 2011
Michael Morris, President and CEO, American Electric Power

Looking Ahead to 2010-2011

EDUCATION AND OUTREACH PROGRAMS *(CONTINUED)*

Friday-Thursday, September 24-30, 2010
4th Annual Notre Dame Energy Week

The 2010 Notre Dame Energy Week will be held Friday, September 24, through Thursday, September 30. Celebrating its fourth year, Energy Week offers a variety of education programs and events that center around some of the most critical energy issues and topics facing the world today. Some of the programs already planned for the week are listed below.

Lectures

"Twelve Principles of Green Chemistry," by Dr. John Warner, co-founder, President, Chief Technology Officer, and Chairman of the Board of the Warner Babcock Institute for Green Chemistry.

"The Equinox House," by Dr. Ty Newell, Professor Emeritus, Department of Mechanical Science and Engineering, University of Illinois at Urbana Champaign.

"Determination of Solar Energy Transition Potential of Department of Defense Facilities and Non-Tactical Vehicles," by Mr. Ariel S. Castillo, Ph.D. Candidate at The George Washington University, and member of Operations Research, Business Transformation Agency, Department of Defense.

"The Future of Alternative Energy," by University of Notre Dame professors Joan Brennecke, Seth Brown, Peter Burns, Thomas Corke, and Rob Nerenberg.

"Energy Careers at GE," by Anthony Maiello, GM of Systems Engineering for GE Energy Services.

Film Screenings

"The 11th Hour," 2007 documentary from well-known activist and actor Leonardo DiCaprio examines the state of the global environment with renewed energy in the wake of recent natural disasters. Included are interviews with over 50 leading scientists, thinkers and leaders who discuss their visionary and practical solutions for restoring the planet's beleaguered ecosystems.

"No Impact Man: The Documentary," 2009 film follows the bold environmental project that Colin Beavan began to attempt to expunge his carbon footprint by giving up material consumption, electricity, non-local foods and basically all worldly pleasures in Manhattan for one full year – an inside look at the way this extreme idea effects Colin and his family.

Other Outreach Programs

The Quad Display — an outside event for students to talk with energy company representatives about the latest in energy technologies and best practices.

Tours of the Notre Dame Power Plant and Geddes Hall — guided tours to show first-hand how the power on campus is generated for the university, and the first building on campus to receive LEED Gold Certification.

Trivia Night at Legends — a game that tests your knowledge of energy related issues and topics.

The theme "Green is Gold" and the associated artwork, including the adjacent energy week sign, was created and designed by NDEC Student Advisory Board member, Rocio Miramontes.

Organizational Overview

Administration

Strategic planning and business operations for the Notre Dame Energy Center are provided by Dr. Joan Brennecke, Patrick Murphy, and Barbara Villarosa. Contact information for each is provided below:

Dr. Joan F. Brennecke
Keating-Crawford Chair in Chemical and Biomolecular Engineering
Director, Notre Dame Energy Center
(574) 631-5847
jfb@nd.edu

Patrick M. Murphy
Managing Director, Notre Dame Energy Center
(574) 631-1425
pmurphy8@nd.edu

Barbara A. Villarosa
Programs and Research Specialist, Notre Dame Energy Center
(574) 631-4776
villarosa.2@nd.edu

Stinson-Remick Hall

The Notre Dame Energy Center offices and laboratories were moved into the newly constructed Stinson-Remick Hall in December 2009. The offices are located in 115, while the labs are comprised of 11,800 square-feet in rooms 116, 120, and 314.

The College of Engineering's new Stinson-Remick Hall is a 160,000-square-foot building on Notre Dame Avenue near the campus entrance. The $70 million structure features an expanded, centrally located learning center, the McCourtney Learning Center, that is nearly four times the size of the experimental center that was originally located in Cushing Hall. The building also houses the Center for Nano Science and Technology, with its associated nano- and micro-device fabrication and processing facilities. Key laboratories of the Advanced Diagnostics and Therapeutics Initiative and the U.S. Department of Energy sponsored Energy Frontier Research Center focusing on the materials science of actinides are also housed in Stinson-Remick.

Center Financial Support

Each year, the Energy Center offers financial support for energy related programs and research at the University of Notre Dame. Either in whole or in part, the Center is committed to providing funds to help improve energy education for students, campus-wide energy awareness, and energy related research for students and faculty at the University of Notre Dame.

During Fiscal Year 2009-2010, the Center contributed nearly $50,000 toward these goals.

Organizational Overview

Industrial Advisory Board

The Industrial Advisory Board provides guidance and counsel to the Director and Managing Director of the Notre Dame Energy Center, its research initiatives and education programs in support of the Energy Center's mission and that of the University's. Members of the board are:

Thomas Degnan, Jr., ExxonMobil
Anthony Earley, DTE Energy
Patrick Eilers, Madison Dearborn Partners
Michael O'Sullivan, Florida Power and Light

Student Advisory Board

Each year, graduate and undergraduate students apply for membership to the Center's Student Advisory Board. Selected members serve a one-year term beginning in January and ending in December. Student Advisory Board members are involved in several activities throughout the year, including the annual Notre Dame Energy Week and other education programs and research initiatives. 2009 board members are listed here along with some interesting information about each of them.

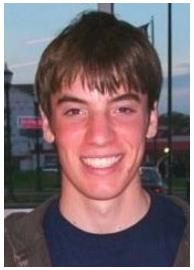
Thomas A. Catanach

Sophomore, Physics and Classical Languages
Hometown: originally from Allen, TX; now living in Trinity, AL
Favorite Energy Source: Nuclear because I believe that it can produce large amounts of clean energy, which is necessary to meet the world's growing need for energy and also protect the environment. *One Interesting Fact:* I have not touched food since I was in 6th grade.

Elizabeth Davis

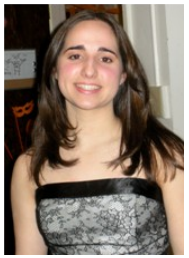
Sophomore, Political Science
Hometown: Bozeman, MT
Favorite Energy Source: Solar Energy because it provides energy for a multitude of life sources, from plant life to humans and the sun makes everyone happy! *One Interesting Fact:* My favorite food is grapes!

Jonathan Conway (Board Chairperson)



Junior, Chemical Engineering
Hometown: Lancaster, PA
Favorite Energy Source: Geothermal because it is readily available and only requires a capital investment to tap into it. *One Interesting Fact:* I drank water off the Mendenhall Glacier in Alaska.

Jessica DeLalio (Board Secretary)



Sophomore, Science-Business
Hometown: Wading River, NY
Favorite Energy Source: Wind is my favorite energy source. From ancient windmills to modern wind turbines, people have harnessed Earth's wind for centuries. Hopefully as we continue to improve upon this history, we will discover new ways to make wind a driving energy force. *One Interesting Fact:* To raise $1,000 to ship multi-vitamins to a poor village in Madagascar, I engaged my local community in a bottle and cans recycling drive.

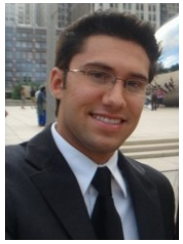
Organizational Overview

STUDENT ADVISORY BOARD *(CONTINUED)*

Radhika Dixit

Graduate, MBA
Hometown: Redondo Beach, CA
Favorite Energy Source: Toss up between Wind and Solar. Both technologies work great in their own niche applications. Both energy sources have made tremendous strides (technologically, and affordability) have been made in both. *One Interesting Fact:* Helped make the Gap, the Limited, and Express more energy efficient through lighting.

Shawn Durrani



Graduate, Law
Hometown: Westmont, IL
Favorite Energy Source: Solar, because there is an abundant amount of sunlight. Plus, it has so much potential with just some more investment to make the equipment more energy efficient and cost-effective for individuals. *One Interesting Fact:* Nestle Crunch is my favorite Candy Bar.

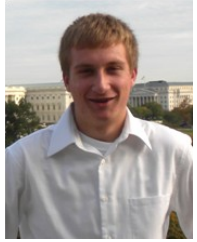
John Paul Foley

Graduate, Law
Hometown: Northville, MI
Favorite Energy Source: Nuclear, because it is the most scalable, steady, and efficient source currently available. While the magnitude of damage from accident or waste storage can be great, these risks are mitigated by low accident probability and remote geographic positioning. Thus, I believe nuclear energy is our most ready option right now and offers relatively acceptable risk. *One Interesting Fact:* I've been bungee jumping in New Zealand.

Jennifer Kovacs

Junior, Chemical Engineering
Hometown: Houston, TX
Favorite Energy Source: Solar because if I were in a place where we could use solar energy, it would mean that it would be sunny most of the time. *One Interesting Fact:* I have been to 12 countries and 38 states.

Matthew Kudija



Freshman, Aerospace Engineering
Hometown: Paso Robles, CA
Favorite Energy Source: Wind, because of my fascination with aerodynamics. *One Interesting Fact:* I attended the Energy Policy seminar in Washington, D.C. over fall break.

Brianna Kunycky

Freshman, Environmental Science
Hometown: Marlborough, MA
Favorite Energy Source: Solar, because it is clean and virtually inexhaustible. *One Interesting Fact:* I have been dancing for 14 years.

Meehan Lenzen

Junior, Environmental Geosciences
Hometown: Bloomington, IN
Favorite Energy Source: Cellulosic ethanol (not corn ethanol) because if scientists could just find a way to effectively mass-produce it, it could become a great stepping stone away from fossil fuels and towards renewables. *One Interesting Fact:* I hate static electricity (and, therefore, fleece too) more than almost anything in the world.

Jake Lussier

Junior, Computer Science
Hometown: Manchester, NH
Favorite Energy Source: Nuclear energy is not only an effective energy source currently, particularly with ongoing improvements to safety and waste utilization, but research may yield an essentially endless energy supply through nuclear fusion. *One Interesting Fact:* I recently led my dorm in producing over a ton of recyclables during an environmental competition. While the actual recyclability of some of said recyclables is debatable, it definitely helped raise awareness.

Organizational Overview

STUDENT ADVISORY BOARD *(CONTINUED)*

Alex Macomber

Junior, Electrical Engineering
Hometown: Coventry, RI
Favorite Energy Source: Solar of course. With 600 TW of usable solar energy striking the earth, it is all too obvious that solar power is the only clean, renewable energy source capable of supplying the world's 14 TW (and increasing) energy demand. With that said, we need all we can get, so get those breeder reactors on line. *One Interesting Fact:* I grew up on a blueberry farm.

Patrick McCormick

Sophomore, Political Science
Hometown: Alexandria, VA
Favorite Energy Source: Solar--despite what Bob Merrill might have us believe, we know it makes the world go 'round. *One Interesting Fact:* The first school I went to was called Aquinas Montessori, and I've thought learning was cool ever since.

Samantha Miller (Board Vice Chairperson)

Junior, Chemical Engineering
Hometown: Idaho Falls, ID
Favorite Energy Source: Nuclear - I worked at a nuclear engineering facility and I think nuclear energy can be a cleaner, reliable way to provide for our baseload energy demands. *One Interesting Fact:* I'm vegetarian.

Rocio Miramontes

Sophomore, Chemical Engineering
Hometown: Mishawaka, IN
Favorite Energy Source: Cleaner coal, because it is a reliable and abundant source of energy. It will be really great if we continue advancing the cleaner coal technology and improving our methods of sequestering CO_2. *One Interesting Fact:* I once had to get over 200 stitches on my face.

Laura Moore-Shay

Senior, Environmental Geosciences and Anthropology
Hometown: Granger, IN
Favorite Energy Source: Wind because it can be economical in a large area of the United States and has a smaller environmental impact than other forms of energy. *One Interesting Fact:* I spent the last two summers in western Ireland doing archaeology research.

Megan O'Keefe

Junior, Chemical Engineering
Hometown: Pittsburgh, PA
Favorite Energy Source: Wind, because it is renewable and very clean!
One Interesting Fact: I went skydiving in Fiji after studying abroad in Perth, Australia.

Yichao Pan

Sophomore, Mechanical Engineering
Hometown: Suzhou, China
Favorite Energy Source: Wind. Wind turbines are cool, and they will not cause any pollution. It is possible to have a wind turbine on or near our campus. It is able to generate more electricity than the solar panel on Stinson-Remick Hall. *One Interesting Fact:* Seriously, is this required?

Anne Whitty

Sophomore, Program of Liberal Studies
Hometown: Des Moines, IA
Favorite Energy Source: Wind, because its renewable and the wind fields in Iowa are gorgeous to drive through. *One Interesting Fact:* I have never had the chickenpox!

Organizational Overview

NDEC Faculty

Faculty are key to the growth and development of the Notre Dame Energy Center, its research initiatives and education programs. The number of faculty involved in energy related research and education has grown significantly since the Energy Center's inception in 2005. Now totaling 45, a list of the faculty are provided here with their departments and areas of energy expertise.

Thomas Albrecht-Schmitt
Civil Engineering and Geological Sciences
Safe nuclear waste storage

J. Matthew Ashley
Theology
Energy efficiency

Stephen M. Batill
Aerospace and Mechanical Engineering
Energy efficiency

Paul W. Bohn
Chemical and Biomolecular Engineering
Solar and other renewables

Joan F. Brennecke
Chemical and Biomolecular Engineering
Energy efficiency; CO_2 separation, storage, sequestration, and use

Paul R. Brenner
Center for Research Computing
Energy efficiency

Seth N. Brown
Chemistry and Biochemistry
Energy efficiency

Peter C. Burns
Civil Engineering and Geological Sciences
Safe nuclear waste storage

Hsueh-Chia Chang
Chemical and Biomolecular Engineering
Energy efficiency

Patrick Fay
Electrical Engineering
Solar and other renewables

Jeremy B. Fein
Civil Engineering & Geological Sciences
Safe nuclear waste storage

Thomas A. Gresik
Economics
CO_2 separation, storage, sequestration, and use

Gregory Hartland
Chemistry and Biochemistry
Energy Efficiency

Jessica J. Hellmann
Biological Sciences
Safe nuclear waste storage; CO_2 separation, storage sequestration, and use

Kenneth Henderson
Chemistry and Biochemistry
Energy efficiency

Davide A. Hill
Chemical and Biomolecular Engineering
Energy efficiency

Frank P. Incropera
Aerospace and Mechanical Engineering
Energy efficiency; solar and other renewables

Boldizsar Janko
Physics
Energy efficiency

Debdeep Jena
Electrical Engineering
Solar and other renewables

Richard A. Jensen
Economics and Econometrics
Solar and other renewables

Prashant V. Kamat
Chemistry and Biochemistry
Energy efficiency; solar and other renewables

Jeffrey C. Kantor
Chemical and Biomolecular Engineering
CO_2 separation, storage, sequestration, and use; solar and other renewables

Masaru K. Kuno
Chemistry and Biochemistry
Solar and other renewables

A. Graham Lappin
Chemistry and Biochemistry
Energy efficiency

Organizational Overview

NDEC Faculty *(continued)*

Edward J. Maginn
Chemical and Biomolecular Engineering
Energy efficiency; safe nuclear waste storage; CO_2 separation, storage, sequestration, and use

Mark J. McCready
Chemical and Biomolecular Engineering
Energy efficiency

Paul J. McGinn
Chemical and Biomolecular Engineering
Energy efficiency

Gerald P. McKenny
Theology
Energy efficiency

Jason S. McLachlan
Biological Sciences
CO_2 separation, storage, sequestration, and use

Dan Meisel
Chemistry and Biochemistry
Safe nuclear waste storage; solar and other renewables

Albert E. Miller *Emeritus*
Chemical and Biomolecular Engineering
Energy efficiency

Alexander S. Mukasyan
Chemical and Biomolecular Engineering
Energy efficiency

Patrick E. Murphy
Marketing
CO_2 separation, storage, sequestration, and use; solar and other renewables

Robert Nerenberg
Civil Engineering and Geological Sciences
Energy efficiency

Samuel Paolucci
Aerospace and Mechanical Engineering
Energy efficiency

Christian Poellabauer
Computer Science and Engineering
Energy efficiency

Joseph Powers
Aerospace and Mechanical Engineering
Energy efficiency

John E. Renaud
Aerospace and Mechanical Engineering
Clean coal utilization

William F. Schneider
Chemical and Biomolecular Engineering
Energy efficiency; clean coal utilization

Mihir Sen
Aerospace and Mechanical Engineering
Energy efficiency

Anthony Serianni
Chemistry and Biochemistry
Energy efficiency

Slavi Sevov
Chemistry and Biochemistry
Energy efficiency

Mark A. Stadtherr
Chemical and Biomolecular Engineering
Energy efficiency

Eduardo Wolf
Chemical and Biomolecular Engineering
Energy efficiency

Huili (Grace) Xing
Electrical Engineering
Solar and other renewables

Notre Dame Energy Center Office
115 Stinson-Remick Hall
Notre Dame, Indiana 46556

Housed within the College of Engineering in Fitzpatrick Hall since its inception in 2005, the Notre Dame Energy Center's offices and laboratories are now located in 115, 116, 120, and 314 Stinson-Remick Hall. Tours are conducted upon request. Please contact Barbara Villarosa at 574-631-4776 or villarosa.2@nd.edu.

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