



2007-08 ANNUAL REPORT

NOTRE DAME ENERGY CENTER

HELPING TO BUILD A BETTER ENVIRONMENT WITH ENERGY RESEARCH

Energy Center Mission

The Notre Dame Energy Center works to develop new technologies to meet the global energy challenge. Housed in the College of Engineering, the center focuses on five areas of expertise: energy efficiency; safe nuclear waste storage; clean coal utilization; carbon dioxide separation, storage, sequestration, and use; and solar and other renewable resources. The center, which was established in 2005, is also 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.





Letter from the Director

I am pleased to present to you the 2007-08 Annual Report of the Notre Dame Energy Center. It has been an exciting year, and I am grateful to be able to share so many wonderful accomplishments with you. It is through your support and generosity that we have continued to grow the center over the past year and to develop our programs and research initiatives to a level of national recognition. I am proud to be a member of the Energy Center family and look forward to the future as we work together to address today's energy challenges.

When the center began in December 2005, there was but one person at the helm (me, as the director). I am pleased to announce that this year Barbara Villarosa joined the Energy Center as a full-time programs and research specialist, allowing her full engagement in the daily operations and management of the center. In addition, we will be welcoming in April 2009 Patrick Murphy to the newly created position of managing director. In Patrick's new role, his primary responsibility will be to increase our research and scholarly initiatives in the area of energy. As you can see, in spite of the many accomplishments we have already enjoyed over the years, there is still more to come. This growth is due, in large part, to the support provided by senior administrators, Robert Bernhard, vice president for research, and Peter Kilpatrick, the McCloskey Dean of College of Engineering. Both are equally committed to the future of energy and are eager to address our nation's energy challenges through enhanced research efforts at Notre Dame and our increased involvement in policy development. As a result, we are in a much stronger position today than we were when the center first began.

Please know that your support and interest in the Notre Dame Energy Center is truly appreciated by all of us involved in energy at the University of Notre Dame. I hope you will enjoy reading the following pages, highlighting our activities of the past year.

Sincerely,

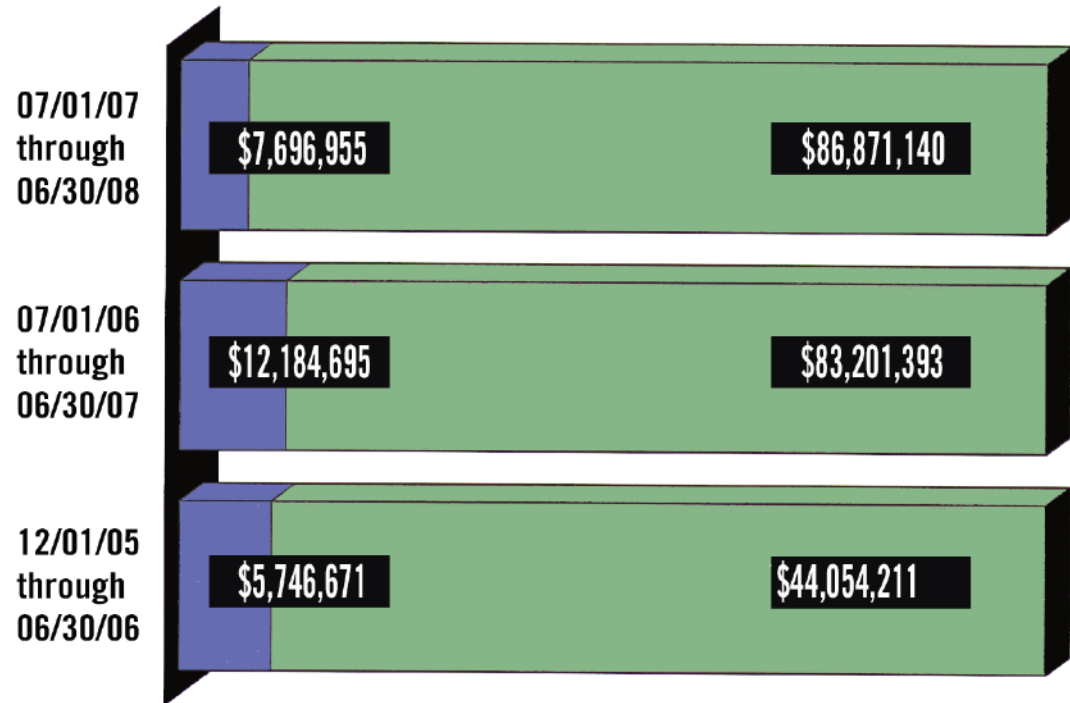
Joan F. Brennecke
Bernard Keating-Crawford Chair in Chemical and Biomolecular Engineering
Director of the Notre Dame Energy Center

Research and Funding Opportunities

Faculty Research

The Notre Dame Energy Center supports energy related research conducted by faculty at the University of Notre Dame in the colleges of engineering, science, arts and letters, and business. Since the inception of the center in December 2005, the University has received more than \$26 million in externally sponsored awards for energy related research. The graph here shows total awards received by fiscal year and the amount designated for energy projects.

ENERGY RELATED RESEARCH AWARDS VS. TOTAL AWARDS RECEIVED SINCE THE INCEPTION OF THE NOTRE DAME ENERGY CENTER



This chart depicts, by fiscal year, the total awards received by the University from external sponsors and the amount awarded for energy related research, since the inception of the Notre Dame Energy Center.

This two-page chart lists the principal investigator(s) and research projects that were awarded during fiscal year 2007-08, totaling \$7.7 million.

ENERGY RELATED AWARDS BETWEEN 07/01/2007 AND 06/30/2008

| PI (CO-PIs) | PROJECT TITLE | SPONSOR | AMOUNT |
|---|--|--|-------------|
| Bartels, David M. | Generation IV supercritical water reactor: water radiation chemistry | Idaho National Laboratory | \$4,855 |
| Bohn, Paul W. | Molecular aspects of transport in thin films of controlled architecture | Department of Energy | \$125,000 |
| Bohn, Paul W. | Three dimensional molecular imaging for lignocellulosic materials | Department of Energy | \$500,000 |
| Brennecke, Joan F. | Ionic liquids for CO ₂ capture from advanced post-combustion or advanced pre-combustion gases | General Electric Foundation | \$122,000 |
| Brennecke, Joan F. | Using ionic liquids in the development of new gas separations methodologies | National Institute of Advanced Industrial Science and Technology — Japan | \$75,010 |
| Brennecke, Joan F. | Energy assistance project for the Indiana Dunes National Lakeshore | National Park Service | \$15,180 |
| Burns, Peter C. | Impact of uranyl alteration phases of spent fuel on mobility of Np in Yucca Mountain | Department of Energy | \$160,000 |
| Burns, Peter C. | Topological structural relationships, properties, and nanostructures | Department of Energy | \$270,000 |
| Carmichael, Ian C. (<i>J. Bentley, J. Laverne, S. Pimblott, G. Hug, G. Ferraudi, D. Guldi, D. Chipman, P. Kamat, D. Miesel, G. Tripathi, D. Bartels, and K. Madden</i>) | Radiation and photochemistry in condensed phase | Department of Energy | \$3,945,000 |
| Dunn, Robert M. | Solar shade | National Collegiate Inventors & Innovators Alliance | \$14,700 |
| Eskildsen, Morten R. | Joint ND/Argonne Graduate Student RA (Ruobing Xie) | Argonne National Laboratory | \$30,744 |
| Fein, Jeremy B. (<i>P. Burns</i>) | Thermodynamic properties of uranyl minerals | Argonne National Laboratory | \$75,000 |
| Fein, Jeremy B. | Phosphate barriers for <i>in situ</i> immobilization of uranium | Department of Energy | \$100,000 |
| Hellmann, Jessica J. (<i>N. Lobo</i>) | Predicting the impact of climate change on animal distributions: The importance of location adaptation and species' traits | Department of Energy | \$194,045 |
| Kilpatrick, Peter K. | Probing the role of heavy metal atoms in asphaltene aggregation | British Petroleum | \$199,751 |

ENERGY RELATED AWARDS BETWEEN 07/01/2007 AND 06/30/2008, cont.

| PI (CO-PIs) | PROJECT TITLE | SPONSOR | AMOUNT |
|--|--|---|--------------------------|
| LoSecco, John M. (<i>C. Jessop and M. Hildreth</i>) | Research in CP violation in the B meson sector | Department of Energy | \$110,000 |
| Maginn, Edward J. | Determination of physical properties of ionic liquids using molecular simulations | Department of the Air Force | \$115,000 |
| Maginn, Edward J. | GOALI — Atomistic simulations of the physical properties and phase behavior of ionic liquid/gas mixtures | National Science Foundation | \$109,321 |
| Matthews, Grant James (<i>F. Weber, A. Afanasjevs, M. Caprio, and S. Frauendorf</i>) | Nuclear properties at extreme density, temperature, and spin | Department of Energy | \$359,000 |
| McCready, Mark J. | Entrainment in two-phase gas-liquid flows | Chevron Research Company | \$2,500 |
| McGinn, Paul J. | Combinatorial screening of proton conductors for intermediate temperature fuel cells | Honda Corporation | \$50,000 |
| Miller, Albert E. (<i>P. McGinn</i>) | Nanofiber paper for fuel cells and catalyst supports | Inorganic Specialists Inc. | \$30,000 |
| Powers, Joseph M. (<i>S. Paolucci</i>) | Advanced multi-scale computational methods for hypersonic propulsion | National Aeronautics and Space Administration | \$120,000 |
| Schneider, William F. | Toward realistic models of heterogeneous catalysis: Simulations of redox catalysis from first principles | Department of Energy | \$134,000 |
| Schneider, William F. | Collaborative research: Predictive modeling of adsorbate and surface ordering effects on catalytic activity | National Science Foundation | \$196,224 |
| Sevov, Slavi C. | Nanorods of silicon and germanium with well-defined shapes and sizes | Department of Energy | \$118,465 |
| Tomar, Vikas (<i>J. Renaud</i>) | Computer aided multiscale design of SiC-Si ₃ N ₄ nanoceramic for high temperature structures | Department of Energy | \$55,000 |
| Wolf, Eduardo E. (<i>A. Mukasyan</i>) | GOALI — Novel impregnated layer combustion synthesis for catalysts preparation: Hydrogen production from methanol | National Science Foundation | \$299,999 |
| Zhu, Yingxi E. | Water-immersed polymer interfaces and the role of their materials properties on distribution | Department of Energy | \$166,161 |
| | | | TOTAL \$7,696,955 |

ENERGY RELATED SEED FUND PROJECTS

| PI | CO-PI | PROJECT TITLE | AWARD |
|---|---|--|------------------------|
| Steven Corcelli Chemistry and Biochemistry | Kathie Newman, Physics, and William Schneider, Chemical and Biomolecular Engineering | Toward Simulating Chemical and Photochemical Reactions for Clean Energy: Methodologies for the Solid-Aqueous Interface | \$40,000 |
| Prashant Kamat, Chemistry and Biochemistry | Paul McGinn, Chemical and Biomolecular Engineering | Catalysts by Design: Semiconductor Nanocomposites for Solar Hydrogen Production | \$40,000 |
| Masaru Kuno, Chemistry and Biochemistry | Prashant Kamat, Chemistry and Biochemistry | Graded Quantum Dot/nanowire Heteroassemblies for Photovoltaics | \$33,298 |
| | | | TOTAL \$113,298 |

The Energy Center also supports faculty who are interested in conducting energy related research through internal funding opportunities. The Seed Fund Program was established this year to provide faculty with start-up funds for projects that would eventually lead to externally funded proposals. A panel of Notre Dame faculty reviewed submissions based on the importance of the scientific problem, novelty of the ideas, potential impact of the work, and how the proposed work complemented ongoing energy research at Notre Dame. The Energy Center awarded \$113,298 in seed grants to faculty for the projects listed here.

Leading the first project is **Steven A. Corcelli**. He and his team are addressing the modern energy infrastructure, which is built around the extraction and refining of fossil fuels through gas-solid chemical reactions. They are working to contribute to a new set of chemical transformations, processes and materials by developing accurate and computationally efficient models that will predict chemical reactions at the solid-aqueous interface. Specifically, they will be studying the structure and reactivity of transition metal oxides in water as it relates to converting light into chemical energy.

Prashant V. Kamat and **Paul J. McGinn** are working to advance the fundamental understanding of solar hydrogen production. Specifically, they are exploring the huge potential offered by the solar production of hydrogen from water-oxide mixed-phase systems to see if more efficient and environmentally safe conversion methods can be developed. During the course of the project, they will be evaluating candidate oxide catalysts and methods, reviewing photocatalytic properties and techniques and identifying the best catalyst compositions in a photo-catalyst membrane assembly for use in a fuel cell.

The third project investigates the use of semiconductor nanostructures for solar energy conversion, with the ultimate goal of growing conductive substrates for a new generation of solar cells. **Masaru K. Kuno** and Kamat are working to develop a new paradigm for the creation of low-cost, high-efficiency, solar energy conversion from photovoltaics made of low-dimensional materials.

Student Research

Undergraduate research in energy systems and processes is also a priority for the Notre Dame Energy Center. Funding for such research is provided annually through The Vincent P. Slatt Fellowship endowment. Now in its third year, the Slatt Fellowship program recognizes and supports energy related research activities of undergraduates, from the use of fossil fuels and nuclear and renewable energy sources to the development of biofuels and more efficient transportation and energy utilization systems. Slatt Fellowships were awarded to the following scholars, totaling \$15,249. Projects are expected to begin in summer 2008 and run through the 2008-09 academic year.



Call



Colón



Esber



Lambert

The Slatt Fellowship was created by Christopher (B.S., EE '80) and Jeanine Slatt in honor of Vincent P. Slatt (B.S., EE '43), the founder of the National Rural Utilities Cooperative Finance Corporation (CFC). CFC provides financing for more than 1,500 electric cooperatives, telecommunications organizations, and state and regional service organizations, which serve more than 39 million people nationwide (12 percent of U.S. consumers), accounting for approximately five percent of the country's electric generation capacity.

The 2008 Vincent P. Slatt Fellows

MICHAEL CALL

Junior, Aerospace and Mechanical Engineering

Advisor: Dr. Robert Nelson

Project: "A Study of Aerodynamic Devices for Load Control" (\$3,609)

Call will be examining aerodynamic control devices such as micro tabs, shape memory materials, and other devices for blade load control — particularly for the blades on a wind turbine — in order to assess the advantages and disadvantages of each in relation to optimum performance and energy capture.

YAMIL COLÓN

Junior, Chemical and Biomolecular Engineering

Advisor: Dr. Joan Brennecke

Project: "Heat Capacities and Densities of Ionic Liquids and Ethanol Mixtures as a Function of Temperature" (\$4,000)

Colón will be evaluating the potential use of specific ionic liquids based on the thermophysical properties of each in different compositions of ethanol.

CHRISTOPHER ESBER

Junior, Biological Sciences

Advisor: Dr. Jason McLachlan

Project: "Evaluating the Role of Evolutionary Change in Wetland Carbon Budgets" (\$3,820)

Esber will be investigating the changing abilities of an ecologically important C₃ coastal sedge to store carbon over a century of rising carbon dioxide levels, sea levels, and temperature fluctuations in order to show that adaptation can develop more efficient plants and more below ground carbon storage.

CAITLIN LAMBERT

Junior, Chemical and Biomolecular Engineering

Advisor: Dr. Joan Brennecke

Project: "Vapor-Liquid Equilibria of Ionic Liquid and Water Mixtures" (\$4,000)

Lambert will be collecting isothermal vapor-liquid equilibria data for a variety of ionic liquid and water mixtures, which will be used to estimate binary model parameters for miscible binaries and predict ternary and higher order system fluid phase equilibria behavior.

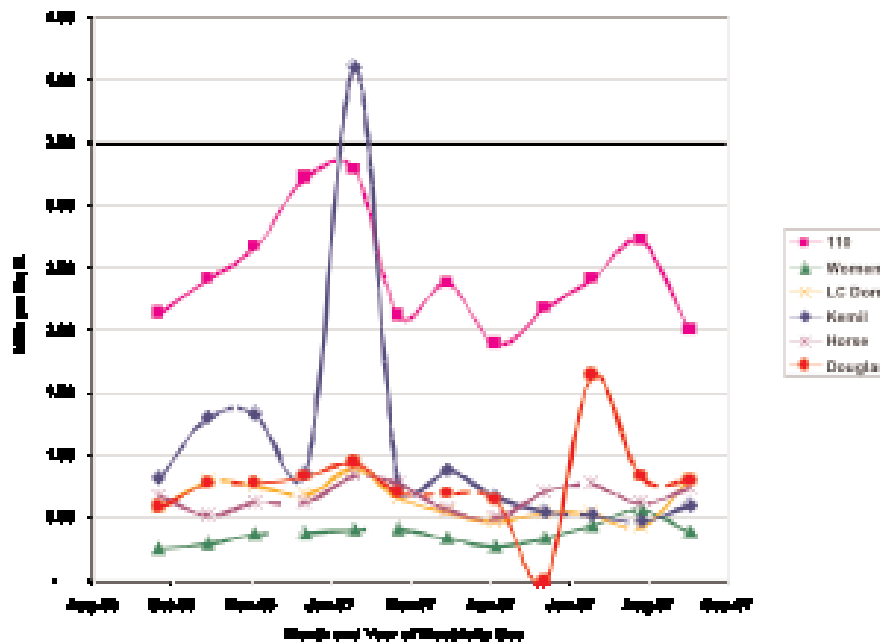
National Park Partnership Program

The Notre Dame Energy Center received external funding from the University-National Park Energy Partnership Program (UNPEPP) for the purpose of improving Indiana Dunes National Lakeshore facilities. During the summer of 2008, three undergraduate students from the University of Notre Dame worked with park officials to conduct onsite research, resulting in specific recommendations for capital improvements at the Indiana Dunes facilities. Students focused largely on energy conservation and savings and projected payback in terms of resources, such as energy use reduction and lower greenhouse gas emissions. The project also resulted in the completion of energy audits of one-third of the Indiana Dunes National Lakeshore buildings, as well as the designs for a geothermal heat pump system for the Paul H. Douglas Center for Environmental Education and a grass roof system for Building 110 at the park headquarters. The students also developed educational materials describing the proposed improvements and energy savings that were posted in the facilities for park guests.

UNPEPP is a nationwide program that links universities with national parks to address energy issues within the parks. Through these partnerships, parks gain assistance with energy related issues, while students obtain problem-solving experience in the energy field. This project was a great opportunity for Notre Dame students to put their training into practice in a real-world setting, which required the use of project management and leadership skills, and promoted the discussion on realistic and responsible uses of resources.

The undergraduate students involved in the UNPEPP project were **Thomas Furlong**, a junior studying aerospace and mechanical engineering; **Brian Klein**, a senior political science major; and **Jackie Mirandola Mullen**, a sophomore pursuing degrees in German and history.

This chart shows the electricity used by each Indiana Dunes facility over a one-year period.



Top photo: Professor Brennecke meets on site with Thomas Furlong and Jackie Mirandola Mullen.

Bottom photo: Undergraduate student researchers Jackie Mirandola Mullen, Thomas Furlong, and Brian Klein discuss the challenges of the UNPEPP project.



Hybrid Motorcycle

Another undergraduate research project sponsored in part by the Notre Dame Energy Center focuses on the development of a hybrid/electric motorcycle. The project team consists of five, undergraduate seniors in Electrical Engineering, known as the Lightning Riders. Team members are **Stephen Govea, Vincent Cano, Brian Bak, John Mrugala,** and **John Sember.**

The creation of the motorcycle began as part of the capstone project course — Electrical Engineering Senior Design — required during senior year. The ultimate goal of the project is to create a fully functional experimental test vehicle, one that can be used to advance hybrid/electric vehicle research while exposing students to the vehicles of the future. The immediate team goal is to solve the engineering challenges involved in the creation of such a vehicle, including the following objectives:

- To redesign the charging and control system to create a more robust system to sustain high-current charging;
- To design a low-voltage power supply system for the electronic components;
- To capture critical variables real-time for future analysis; and
- To design and create a PC based user interface for long-term data storage and analysis.

For more information about the Lightning Riders, visit:

[http://seniordesign.ee.nd.edu/2007/Design Teams/Lightning Riders](http://seniordesign.ee.nd.edu/2007/Design%20Teams/Lightning%20Riders)



Top photo: Senator Richard G. Lugar visited campus and toured the Notre Dame Energy Center on October 8, 2008. Sen. Lugar was especially interested in meeting the Lightning Riders and learning more about their project.

Bottom photos: One of the primary benefits of a plug-in hybrid/electric vehicle is the ability to charge the battery pack from a standard electrical outlet, which is a cheaper and cleaner source of power than burning gasoline directly.

Other Senior Design Projects

Five other senior design projects in the mechanical engineering degree program pursued projects in the energy area in spring 2008. Each group developed a Web site, which provided detailed information on their projects. The senior design course — *AME 470: Mechanical Design* — is required for all seniors and must be passed before mechanical engineers are allowed to design products in the real world. Projects were directed by **Michael Stanisic**, associate professor of aerospace and mechanical engineering, and **Stephen Batill**, professor of aerospace and mechanical engineering.

Each of the four projects submitted under “Portable Wind Energy System” were required to design and construct an energy system that would extract wind energy and convert it to electrical power. The final products are shown here.

The fifth team submitted their project under “Compact Solar Energy System” and designed and developed a market-competitive small-scale solar-power system producing 20W of continuous power without utilizing photovoltaic technology.

Throughout 2007-08, the Energy Center provided more than \$147,000 in financial support to students and faculty at the University of Notre Dame. Students were provided small travel grants to attend energy related conferences and seminars, while faculty and students were granted various amounts of financial support to conduct energy related research. Such initiatives are supported by the Energy Center for the purpose of fulfilling its mission to promote education and encourage energy related research.

**GROUP C1:
REVOLUTIONARY TECHNOLOGIES**
Nicholas Arch, Nicholas Fraser,
Robert Huth, Patrick Noble, and
Michael Toomey

<http://www.nd.edu/~me463c18>

**GROUP C2: WIND-AID: EFFICIENT,
GREEN ENERGY TO THE RESCUE**
David Rupp, James Gates, John
Wloch, Keri Macaulay, and Andy
Crutchfield

<http://www.nd.edu/~me463c28>

PORTABLE WIND ENERGY SYSTEM



**GROUP C3: PINWHEEL
TECHNOLOGIES**
Heather Blaha, Michael McConnell,
Domenic Tassoni, Matt Fuxa, and
Joey King

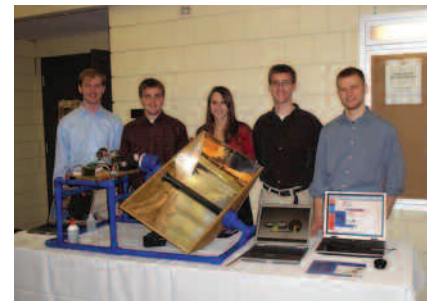
<http://www.nd.edu/~me463c38>



**GROUP C4: TURBINATOR
TECHNOLOGIES, INC.**
Alex Vossler, Bob Herzog, Bryan
Delaney, John Larson, and Mike
O'Brien

<http://www.nd.edu/~me463c48>

COMPACT SOLAR ENERGY SYSTEM



GROUP D1: SOLAR POWER RANGERS
Phillip Hicks, Kevin Kastenholtz, Derek Lipp,
Paul Nistler, and Rachel Paietta

<http://www.nd.edu/~me463d18>

Education and Outreach

Ionic Liquids Workshop

On July 17, the Notre Dame Energy Center hosted the 2007 Ionic Liquids Workshop, sponsored by EMD Chemicals, Inc., and Merck KGaA. Presentations were held at the Eck Visitors Center along with a poster session in the afternoon by Notre Dame graduate students. Topics addressed throughout the day included:

Introduction to Ionic Liquids, Their Structures, Properties, and Applications

William-Robert Pitner
Merck KGaA

Functionalized Ionic Liquids and Their Applications in Catalysis and Synthesis

James H. Davis Jr.
University of South Alabama

Absorption Cycle Utilizing Ionic Liquid as Working Fluid

Mark B. Shiflett
DuPont Experimental Station

Ionic Liquids in the Production of Biofuels and Biobased Products

Seth W. Snyder
Argonne National Laboratory

Use of Ionic Liquids in CO₂ Gas Capture

Edward J. Maginn
University of Notre Dame

Ecotoxicity and Biodegradability of Ionic Liquids for Aquatic Organisms

Konrad J. Kulacki
University of Notre Dame



Dame Student Government. During the week, students, faculty, and staff participated in several energy related activities, including demonstrations and interactive activities on the quad, screenings of energy related films, touring the Notre Dame Power Plant, and taking an energy quiz. The purpose of Energy Week was to create awareness and educate participants on the energy challenges facing our nation today. Below are the results of the week's activities in numbers:

- A \$500,000 in-kind contribution was made to the Notre Dame Energy Center by General Electric for products and services associated with a solar power system array and supporting infrastructure for the new Stinson-Remick Hall of Engineering. The solar panel system is projected to provide power of up to 50 kilowatt-hours and an estimated 55,000 kilowatt-hours annually. The solar panel array will be monitored by a system in the College of Engineering's new learning center, where undergraduate students will be able to track the energy being generated.
- 1,150 energy related items were given away to students, faculty, and staff (250 fluorescent-bulb-shaped post-it notes, 250 multi-message pens, 225 60-watt compact fluorescent light bulbs, 200 water bottles, 150 notebooks, and 75 mini "green frog" radios);
- 319 "Go Fluorescent" t-shirts were sold;
- 112 students took the online Energy Quiz;
- 75 students, faculty, and staff toured the Notre Dame Power Plant; and
- the campus experienced a 2.7 percent reduction in electricity from the voluntary, one-hour "Lights Out."

For more information, visit:

<http://www.nd.edu/~ndenergy/news-and-events/events-archive/EnergyWeek2007.shtml>.

Energy Week

Notre Dame's first ever Energy Week was held October 7-13, 2007. Sponsors of the event were the Notre Dame Energy Center Student Advisory Board, the Energy and Environmental Issues Committee, the Students for Environmental Action, the Joint Engineering Council, and the Notre

NDEER Symposium

During Energy Week on Wednesday, October 10, the Notre Dame Energy Center hosted the sixth annual symposium on Notre Dame Environmental Education and Research (NDEER). The symposium was sponsored by the Notre Dame Energy Center, the Office of Research, the Seng Foundation Endowment for Market Based Programs and Catholic Values, and the Institute for Scholarship in the Liberal Arts. More than 100 students, faculty and staff attended the conference, which focused on energy and the environment. Invited speakers addressed such topics as carbon markets, nuclear energy, and CO₂ capture. Speakers were:

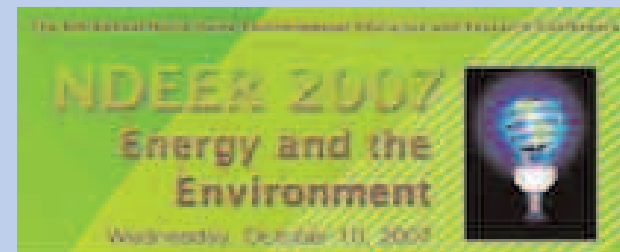
- **John Ledyard**, the Allen and Lenabelle Davis Professor of Economics and Social Sciences at the California Institute of Technology. Ledyard's pioneering work on the theoretical foundations and applications of mechanism design contributed greatly to the understanding of the roles of incentives and information in markets and organizations. Other work by Ledyard includes the development of computer-assisted markets for trading pollution rights, managing resources for spacecraft and instrument design, acquiring logistics contracts, and swapping portfolios of thinly traded securities and decision markets. His talk focused on energy and carbon markets.
- **Rodney Ewing**, the Donald R. Peacor Collegiate Professor of the Department of Geological Sciences at the University of Michigan. Ewing's research involves issues related to nuclear waste disposal. He is an emeritus regents' professor at the University of New Mexico, where he was a member of the faculty from 1974 through 1997. Ewing's lecture addressed nuclear energy issues in the 21st century.
- **Frank Incropera**, the H. Clifford and Evelyn A. Brosey Professor of Mechanical Engineering and Matthew H. McCloskey Dean Emeritus of the College of Engineering at the University of Notre Dame, delivered the talk on behalf of Michael J. Mudd, chief executive officer of FutureGen Alliance, who was unable to attend. Incropera discussed the goals and objectives of the FutureGen Alliance.

Speakers also participated in breakout sessions in the afternoon and in a panel discussion at the conclusion of the conference, moderated by **Joan F. Brennecke**, the Keating-Crawford Professor of Chemical and Biomolecular Engineering and Director of the Notre Dame Energy Center.

NDEER was established in 2001 for the purpose of highlighting the depth and diversity of environmental research at Notre Dame and to develop closer ties among the large, multidisciplinary groups of faculty on campus.

For more information, visit:

http://www.nd.edu/~ndenergy/news-and-events/events-archive/documents/NDEER_07program.pdf.



CRC Seminar

On November 2, 2007, the Center for Research Computing and the Notre Dame Energy Center co-sponsored a seminar, entitled “Discovery of Novel Hydrogen Storage Materials: An Atomic Scale Computational Approach.” Professor **Chris M. Wolverton** from the Department of Materials Science and Engineering at Northwestern University provided an overview of his recent efforts aimed at developing a first-principles computational approach to the discovery of novel hydrogen storage materials. According to Wolverton, such an approach requires several key capabilities to be effective: (1) an accurate prediction of decomposition thermodynamics, (2) the prediction of crystal structures for unknown hydrides, and (3) the prediction of preferred decomposition pathways. Professor Wolverton is a member of the International Commission C20 of IUPAP on Computation Physics and a member of the DOE/FreedomCAR Hydrogen Storage Technical Team. He received his Ph.D. in physics from the University of California at Berkeley in 1993, and his B.S. degree in physics from the University of Texas at Austin in 1987. He has been recognized for his many achievements and most recently received the USCAR Recognition Award and the Noah Greenberg Award from the American Musicological Society.

For more information about Chris Wolverton and his research, visit

<http://www.matsci.northwestern.edu/faculty/cm.w.html>.

Brown Bag Faculty Seminar Series

In February 2008, the Notre Dame Energy Center kicked off its Brown Bag Faculty Seminar Series, providing a unique forum for faculty to learn more about current energy related research projects at Notre Dame and to discuss possible collaborative efforts in the area of energy research.

The first seminar in the series was held February 27, entitled “Smart Wind Turbine Blades.” **Robert Nelson**, professor of aerospace and mechanical engineering, provided an overview of his research dealing with the application of active flow control technology to enhance wind turbine performance and control.

<http://www.nd.edu/~ame/facultystaff/Nelson,Robert.html>.

On March 26, **Eduardo Wolf**, professor of chemical and biomolecular engineering, presented “Catalysis in Fuels Conversion.” Wolf discussed general aspects of the use of catalysts in the conversion of fossil fuels to liquid fuels and then presented examples of recent research and challenges in the area of hydrogen production, as well as current trends in biofuel conversion.

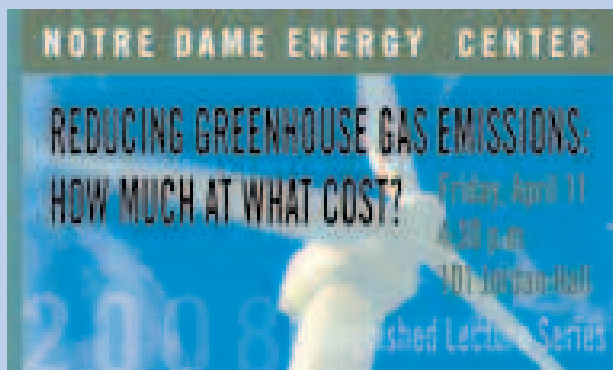
<http://cbe.nd.edu/faculty/show/ewolf>.

“Grid Heating: Utilizing \$7 Billion Dollars in Computational Waste Heat” was the topic presented by **Paul Brenner**, Center for Research Computing, on April 9. Brenner introduced a new grid heating framework to promote the efficient growth and sustainment of commercial, academic, and government computation capabilities resulting in the substantial reduction of cooling expenditures while providing dynamic distributed heating benefits. Brenner also reviewed the current collaboration with the South Bend Botanical Garden and discussed additional grid heating challenges and opportunities in regards to development, implementation, and deployment.

<http://www.crc.nd.edu>.

The series concluded on April 30 with a discussion by **William Schneider**, associate professor of chemical and biomolecular engineering, entitled “Catalysis for Emissions Control.” Schneider explained how the three-way catalytic converter has profoundly reduced the impact of automotive emissions on the environment, yet places limits on the operating range and fuel economy of vehicles. He described the link between emissions and efficiency, the technological approaches to breaking this link, and efforts to apply chemical and atomistic models to aid development of these technologies.

<http://cbe.nd.edu/faculty/show/wschnei1>.



Distinguished Lecture Series

On April 11, 2008, the Notre Dame Energy Center launched the Distinguished Lecture Series and welcomed its inaugural speaker, **Kenneth J. Ostrowski**, Director in McKinsey's Atlanta Office, leader of McKinsey's North America Electric Power and Natural Gas (EPNG) Practice, and co-leader of the Global EPNG Practice. Ostrowski addressed more than 200 students, faculty, and staff in the Jordan Hall of Science regarding the major study that was conducted and released in November 2007 by McKinsey & Company

and The Conference Board. The report detailed how the United States could shave as much as 28 percent off the amount of greenhouse gases it emits at fairly modest cost and with only small technology innovations. The central conclusion of the report indicated that the United States could reduce greenhouse gas emissions in 2030 by 3.0 to 4.5 gigatons of CO₂ using tested approaches and high-potential emerging technologies. These reductions would involve pursuing a wide array of abatement options with marginal costs less than \$50 per ton, with the average net cost to the economy being far lower if the nation can capture sizable gains from energy efficiency. According to Ostrowski, achieving these reductions at the lowest cost to the economy will require strong, coordinated, economy-wide action that would need to begin in the near future.

Before joining McKinsey & Company, Ostrowski was an intern at the Congressional Budget Office, and completed the two-year Financial Management Program at General Electric Company. He received an M.B.A. in General Management with honors from Harvard Business School and a bachelor's degree in finance as magna cum laude from the University of Notre Dame.

For a copy of the report, visit

<http://www.mckinsey.com/client/service/ccsi/greenhousegas.asp>.

Alumni Reunion Weekend and Seminars on Energy and the Environment

The College of Engineering offered four energy and environment focused seminars during the annual Alumni Reunion Weekend on May 30, 2008. Faculty from the Notre Dame Energy Center discussed the following topics:

- "Solar Energy — Beyond the Hype," **Prashant Kamat**, professor of chemistry and biochemistry;
- "The Future of Wind Turbine," **Thomas Corke**, the Clark Equipment Professor of Aerospace and Mechanical Engineering;
- "Propaganda about Climate Change: Is Anyone Really Unbiased?," **Mark McCready**, professor and department chair of chemical and biomolecular engineering; and
- "Is There Really an Energy Crisis?," **Edward Maginn**, professor of chemical and biomolecular engineering.

Other Education and Outreach Activities

“Fighting for the Environment,” an NBC television spot, highlighting research by Notre Dame professors **Joan F. Brennecke**, the Keating-Crawford Professor of Chemical and Biomolecular Engineering and Director of the Notre Dame Energy Center, and **Edward Maginn**, professor of chemical and biomolecular engineering, on containing carbon dioxide emissions that are harmful to the environment.

November 10, 2007 — National Television

Siemens Competition in Math, Science, and Technology, the nation’s premier science research competition for high school students, founded by the New Jersey-based, nonprofit Siemens Foundation to enhance science and mathematics education in America. The keynote speaker for the regional competition awards ceremony was **Joan F. Brennecke**.

November 17, 2007 — Jordan Hall of Science, University of Notre Dame

Green Summit II, sponsored by the University’s Energy and Environmental Issues Committee, Student Activities Office, the Notre Dame Energy Center, and student government, brought together students, faculty, and staff for round-table discussions on topics ranging from conservation efforts to environmentally friendly construction techniques to forging an ND vision for climate change.

January 28, 2008 — McKenna Hall, University of Notre Dame

Lecture and open discussion on “Fossil Fuels: Sustainability, Efficiencies, and Climate Change” by **Joan F. Brennecke** to energy-interested students at Notre Dame.

February 6, 2008 — Fitzpatrick Hall, University of Notre Dame

Saint Mary’s College 18th Annual Hypatia Day, named after the first female mathematician and scientist in history, aims to reinforce seventh-grade girls’ enthusiasm for math and science. Keynote speaker, **Joan F. Brennecke**, presented “Be a Scientist or Engineer, Save the World.”

February 23, 2008 — Carroll Auditorium, Saint Mary’s College

A Hesburgh lecture entitled “Outrageous Energy Prices” was presented to the Notre Dame Alumni Club of Boca Raton by **Thomas Gresik**, professor of economics and econometrics.

February 27, 2008 — Boca Raton, Florida

The final part of the student-faculty debate series focused on global warming and environmental policy. **Mark McCready**, professor and department chair of chemical and biomolecular engineering, presented a background explanation of the issues of global warming, how solar radiation affects climate, and how the temperature changes as a result of this radiation.

March 18, 2008 — University of Notre Dame

The University of Notre Dame Ms. Wizard Day, founded in 1995, provides elementary and young middle-school-age girls the chance to increase their interest and involvement in the sciences. **Joan F. Brennecke** discussed the different ways of generating and saving energy.

March 29, 2008 — Jordan Hall of Science, University of Notre Dame

The University of Notre Dame Committee on Women hosted **Joan F. Brennecke**, who addressed female University staff members and spoke about carbon capture and global climate change.

April 2, 2008 — Jordan Hall of Science, University of Notre Dame

The Notre Dame Energy Center Student Advisory Board participated in **Earth Week's Earth Day Festival**, sponsored by Students for Environmental Action, by handing out energy-related education materials and giveaways to promote Energy Week 2008.

April 22, 2008 — Fieldhouse Mall, University of Notre Dame

The Notre Dame Energy Center provided giveaways to students, faculty and staff to express appreciation for their participation in the annual **Relay for Life** and to promote Energy Week 2008.

April 25, 2008 — Southwest Quad, University of Notre Dame

The Notre Dame Energy Center provided brochures and giveaways to some 500 community members attending the **Downtown South Bend EcoFest**, a community-wide event for all ages, focusing on green technology and healthy living.

June 21, 2008 — St. Joseph River and East Race Walkway, South Bend, Ind.



Looking Ahead

The University of Notre Dame and the Notre Dame Energy Center will host engineers, scientists and state and national leaders responsible for formulating and implementing energy policy on July 7, 2008 at a conference in McKenna Hall. The event will focus on the future of energy research, its effect on society, and the potential it bears for transformative change across Indiana and the nation. “Energy, Citizens, and Economic Transformation for Indiana and America” will explore Indiana’s position in the world of energy, as well as the opportunities offered via developing and new technologies — whether in advanced storage concepts, non-traditional and renewable power generation techniques, or methods to manage the carbon footprint.

Featured presenters will include keynote speaker Rep. **Joe Donnelly**, D-Ind.; **Michelle V. Buchanan**, associate laboratory director for physical sciences at Oak Ridge National Laboratory; **Patricia M. Dehmer**, deputy director of the Office of Science for the U.S. Department of Energy; **Jay P. Gore**, director of the Discovery Park Energy Center at Purdue University; **Paul J. Mitchell**, policy director for economic development, workforce and energy for the state of Indiana; **Hratch G. Semerjian**, president and executive director of the Council for Chemical Research; **Vinod K. Sikka**, director of product development at Ross Technology-Oak Ridge; and **Joan F. Brennecke**, Keating-Crawford professor of chemical and biomolecular engineering and director of the Notre Dame Energy Center.

Topics will cover a range of subjects including the challenges and opportunities in basic energy research, the economic impact of investments in basic research, and the link between energy, the economy, security and the environment. The conference will close with a panel discussion featuring **Paul W. Bohn**, Notre Dame’s Arthur J. Schmitt Professor of Chemical and Biomolecular Engineering and professor of chemistry and biochemistry [moderator]; **David Brenner**, director of Innovation Park at Notre Dame; **Joan Brennecke**; **Patricia Dehmer**; **Hratch Semerjian**; and **Vinod Sikka**.

For more information, visit:

<http://www.nd.edu/~ndenergy/enepolicy2008/index.html>.

Awards and Recognition

Joan F. Brennecke, the Keating-Crawford Professor of Chemical and Biomolecular Engineering and Director of the Notre Dame Energy Center, was named the 2008 Julius Stieglitz Lecturer by the Chicago section of the American Chemical Society (ACS) and the University of Chicago. Presented since 1940 in honor of Stieglitz, it is the highest ACS section award given. Stieglitz was a U.S. chemist who interpreted the behavior and structure of organic compounds in the light of valence theory and applied the methods of physical chemistry to organic chemistry.

The 2008 Julius Stieglitz Lecture is scheduled for November 19, 2008, at the University of Chicago. As the 2008 lecturer, Brennecke joins a list of honorees that includes 13 Nobel Laureates and more than 35 members of the National Academy of Sciences, including **Linus Pauling**, **Robert B. Woodward**, **Herbert C. Brown**, and **George Whitesides**. She is the first chemical engineer to receive the award.

Facilities

The future home of the Notre Dame Energy Center — Stinson-Remick Hall of Engineering — is scheduled for completion January 2010. The building is three stories above grade with a full basement, totaling 163,500 sq. ft. Also contained in the building will be a 9,000 sq. ft. semiconductor processing and device fabrication clean room, a nanotechnology research center, and a learning center for undergraduate students. Stinson-Remick is the first project designed for the University that is seeking LEED certification. A photovoltaic solar array, donated by General Electric, will be incorporated into the new Stinson-Remick building. This system will cover all available space on the roof and is expected to save the University as much as \$6,000 per year in electricity costs. The array will be monitored in the learning center, where the energy produced by the system will be tracked and used by students for experimentation and research. The building will also have a 30kw natural gas microturbine, donated by NiSource Energy Technologies. This microturbine efficiently converts natural gas into electricity, and the waste heat from the exhaust gases will be used to produce hot water for the building. The overall efficiency of the use of energy from this system is expected to approach an impressive 70 percent. The microturbine will be fully monitored and fitted with control of inlet air temperature so it too can be used for student experimentation and research.



Industrial Board

The Notre Dame Energy Center Industrial Board provides guidance and counsel to the Energy Center director in support of the Energy Center mission. Board members are *Thomas Degnan Jr.*, ExxonMobil; *Anthony Earley Jr.*, DTE Energy; and *Michael O'Sullivan*, Florida Power and Light.

Administration

The Notre Dame Energy Center operates under the direction of **Joan F. Brennecke**, the Keating-Crawford Professor of Chemical and Biomolecular Engineering. **Barbara Villarosa**, programs and research specialist, manages the daily operations of the center. The Energy Center Laboratory is located in Fitzpatrick Hall and is home to several energy related research projects, such as the \$2.2 million Department of Energy (DOE) project, “Ionic Liquids: Breakthrough Technology for Post-combustion CO₂ Capture;” the \$300,000 General Electric project, “Ionic Liquids for CO₂ Capture from Advanced Post-combustion or Advanced Pre-combustion Gases;” and the \$1.4 million DOE project, “Ionic Liquids for Utilization of Waste Heat from Distributed Power Generation Systems.”

Energy Center Faculty

Faculty are key to fulfilling the mission of the Notre Dame Energy Center. Faculty provide invaluable resources to the University, while supporting the mission through their energy related research and education programs. Faculty are listed here along with their academic departments and research area(s) of expertise in energy:



J. MATTHEW ASHLEY, Theology
Energy efficiency

STEPHEN BATILL, Aerospace and Mechanical Engineering
Energy efficiency

PAUL BOHN, Chemical and Biomolecular Engineering
Solar and other renewables

JOAN BRENNECKE, Chemical and Biomolecular Engineering
Energy efficiency; CO₂ separation, storage, sequestration, and use

PAUL BRENNER, Center for Research Computing
Energy efficiency

PETER 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 FEIN, Civil Engineering & Geological Sciences
Safe nuclear waste storage

THOMAS GRESIK, Economics
CO₂ separation, storage, sequestration, and use

JESSICA HELLMANN, Biological Sciences
Safe nuclear waste storage; CO₂ separation, storage, sequestration, and use

DAVIDE HILL, Chemical and Biomolecular Engineering
Energy efficiency

FRANK INCROPERA, Aerospace and Mechanical Engineering
Energy efficiency, solar and other renewables

DEBDEEP JENA, Electrical Engineering
Solar and other renewables

RICHARD JENSEN, Economics and Econometrics
Solar and other renewables

PRASHANT KAMAT, Chemistry and Biochemistry
Energy efficiency, solar and other renewables

JEFFREY KANTOR, Chemical and Biomolecular Engineering
CO₂ separation, storage, sequestration, and use; solar and other renewables

MASARU (KEN) KUNO, Chemistry and Biochemistry
Solar and other renewables

EDWARD MAGINN, Chemical and Biomolecular Engineering
Energy efficiency; safe nuclear waste storage; CO₂ separation, storage, sequestration, and use

MARK MCCREADY, Chemical and Biomolecular Engineering
Energy efficiency

PAUL MCGINN, Chemical and Biomolecular Engineering
Energy efficiency

GERALD MCKENNY, Theology
Energy efficiency

JASON MCLACHLAN, Biological Sciences
CO₂ separation, storage, sequestration, and use

DAN MEISEL, Chemistry and Biochemistry
Safe nuclear waste storage; solar and other renewables

ALBERT MILLER, Chemical and Biomolecular Engineering (Emeritus)
Energy efficiency

ALEXADER MUKASYAN, Chemical and Biomolecular Engineering
Energy efficiency

PATRICK MURPHY, Marketing
CO₂ 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 RENAUD, Aerospace and Mechanical Engineering
Clean coal utilization

WILLIAM SCHNEIDER, Chemical and Biomolecular Engineering
Energy efficiency, clean coal utilization

MIHIR SEN, Aerospace and Mechanical Engineering
Energy efficiency

MARK STADTHERR, Chemical and Biomolecular Engineering
Energy efficiency

VIKAS TOMAR, Aerospace and Mechanical Engineering
Clean coal utilization

EDUARDO WOLF, Chemical and Biomolecular Engineering
Energy efficiency

HUILI (GRACE) XING, Electrical Engineering
Solar and other renewables

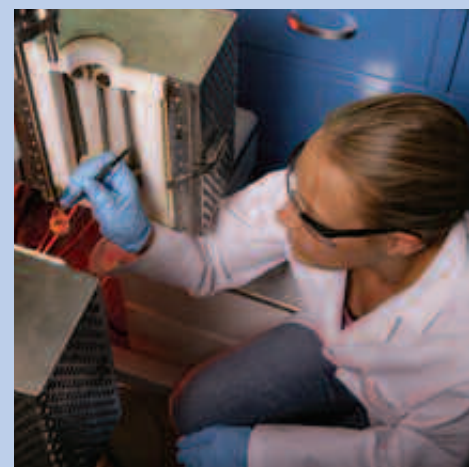


Student Advisory Board

The Notre Dame Energy Center Student Advisory Board provides leadership and advice to the Energy Center director on energy related issues and topics and develops programs and initiatives in support of the Energy Center mission. Members are appointed annually and serve a one-year calendar term. In 2008, membership on the board increased from 13 in 2007 to 23 graduate and undergraduate students, representing a broad range of academic disciplines, ranging from anthropology to electrical engineering to MBA programs.

Throughout the year, board members were actively involved in planning, organizing, and executing several education and outreach events. Most notably, the first-ever Notre Dame Energy Week was held October 7-13, 2008. Energy Week included activities such as the screening of energy themed movies, Notre Dame Power Plant tours, and energy related displays and demonstrations on the quad. In addition to Energy Week, board members hosted a reception for graduate students to solicit their advice and involvement in energy related activities on campus, resulting in a better understanding of graduate student concerns and how Notre Dame can become a more energy-friendly environment for all students. In addition, board members toured the Cook Nuclear Power Plant in Bridgman, Mich., and gained a better understanding of nuclear power generation. In April 2008, many of the board members attended a special presentation by **Raymond L. Orbach**, U.S. Department of Energy's first Under Secretary for Science.

Members of the 2008 Student Advisory Board are listed here:



PATRICK BROWN, Senior
Physics and Chemistry and Biochemistry

KELLY COLLINS, Senior
Environmental Sciences

THOMAS FURLONG, Senior
Aerospace and Mechanical Engineering

COURTNEY HAVEN, Senior
Chemical and Biomolecular Engineering

JOSEPH HERZOG, Graduate Student
Electrical Engineering

NICK HITTLER, Senior
Psychology and Spanish

COLLEEN KELLY, Junior
Economics and Science, Technology and Values

JOSEPH KINDT, Graduate Student
MBA Program

BRIANNA KLCO, Senior,
Environmental Sciences and Anthropology

JENNIFER KOVACS, Sophomore
Chemical and Biomolecular Engineering

LOURDES LONG, Senior
Anthropology, History, and Science, Technology
and Values

TIM MALECEK, Junior
Aerospace and Mechanical Engineering

MEGHAN MANNING, Sophomore
Political Science

REGINA MCCORMACK, Sophomore
Environmental Sciences

LAURA MOORE-SHAY, Junior
Environmental Geosciences and Anthropology

THIEN-AN NGUYEN-VU, Senior
Architecture

SHAWN O'BRIEN, Graduate Student
Nuclear Physics and Nuclear Astrophysics

KATHRYN SABELLA, Senior
Anthropology and Environmental Sciences

STEPHEN SANTRACH, Sophomore
Finance and Portuguese

JEREMY THORNTON, Graduate Student
Law School

MATTHEW WHEBBE, Graduate Student
MBA Program

CHRISTIAN YANG, Sophomore
Business Management and Arabic





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