ENERGY INNOVATION

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PENNSTATE

EARTH AND MINERAL SCIENCES
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Energy Innovation is an annual publication from the EMS Energy Institute in the College of Earth and Mineral Sciences. The EMS Energy Institute is a leading research and development organization focused on energy science and engineering.

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Letter from the Director

Energy continues to be a key word for 2010 in the U.S. as well as throughout the world while the quest for clean, reliable, and affordable power only gains momentum. I am excited to see our labs full of many dedicated students and faculty working on new technologies for the production, generation, and use of our energy resources in an environmentally-friendly manner. Even in the face of ongoing economic challenges, many ground-breaking research projects have been performed and initiatives started at the EMS Energy Institute over the past year. The Institute recognizes and is grateful for the continued support from the University, and the funding from state and federal agencies and industries, which allow us to continue our mission.

One major initiative that involves the Institute is a five-university consortium to provide a range of research and engineering services to the U.S. Department of Energy National Energy Technology Laboratory (NETL). This initiative is being led by Tom Richard, director of the Penn State Institutes of Energy and the Environment; Alan Scaroni, associate dean for Graduate Education and Research, College of Earth and Mineral Sciences; and myself. In addition to Penn Sate, the alliance includes Carnegie Mellon, the University of Pittsburgh, Virginia Tech, and West Virginia University. Another new program is the Electricity Markets Initiative. This initiative, led by Dr. Andrew Kleit, will conduct industry-relevant academic research that examines important questions in electricity restructuring and electricity markets in Pennsylvania. The EMS Energy Institute has also been leading an effort to develop a Joint Energy Research Center with Dalian University of Technology in China (DUT). This mutually beneficial center will establish a formal collaboration between Penn State and DUT and expand on existing cooperative relationships between faculty at the two universities and the exchange of faculty and students. Finally, the Institute continues to have a strong alliance with ConocoPhillips and in March, announced the 2010 ConocoPhillips Energy Prize competition. Begun in 2008, this energy award program is a major outreach initiative for promoting nation-wide energy innovation.

In addition to the many new research projects, the number of faculty and students conducting research at the Institute continues to grow. I am pleased to announce nine faculty members who have recently joined the EMS Energy Institute. Dr. Antonio Nieto has an extensive background in mining engineering; Dr. John Yilin Wang and Dr. Li Li are interested in petroleum and natural gas engineering; Dr. Seth Blumsack, Dr. R.J. Briggs, Dr. Andrew Kleit, and Dr. Zhen Lei all bring research in the area of energy and environmental economics; and Dr. Wayne Curtis and Dr. Donghai Wang bring research collaborations from the College of Engineering.

While growth is desirable, with it come an obvious challenge – space. As I mentioned in the last issue, the EMS Energy Institute with support from the University, Department of Energy and Mineral Engineering, and College of Earth and Mineral Sciences is in the process of renovating a new "energy building" that will primarily hold EMS Energy Institute affiliated faculty and students. Demolition and construction have started and we are planning to occupy the space before the fall semester.

At the EMS Energy Institute, our most valuable resource is our people and their daily enthusiasm for tackling energy challenges. The caliber of our faculty and students and staff is apparent in the many awards garnered each year for research, presentations and publications. With the expansion of our facilities and the growing number of students, faculty and research staff, the EMS Energy Institute is positioned to remain a strong leader in energy research.

Dr. Chunshan Song
Director, EMS Energy Institute
Associate Director, PSIEE
Distinguished Professor of Fuel Science
Professor of Chemical Engineering

EMS Energy Institute Research Programs

Descriptions of these programs and contact information for key researchers can be found at **www.energy.psu.edu.**

Carbon Materials Program

Program Director: Semih Eser

Key Contacts: Angela Lueking, Bruce G. Miller, and Harold Schobert

Coal Science & Technology Program

Program Co-directors: Jonathan Mathews and Sarma Pisupati

Key Contacts: Sharon Falcone Miller and Bruce G. Miller

Clean Fuels & Catalysis Program

Program Director: Chunshan Song

Key Contacts: André Boehman, Caroline Burgess-Clifford, Youngsheng Chen, Xiaoliang Ma, and Harold Schobert

Economics Program

Program Director: Andrew Kleit

Key Contacts: Seth Blumsack, R.J. Briggs, and Zhen Lei

Electrochemical Technologies Program

Program Director: Serguei Lvov

Key Contacts: Mark Fedkin and Chunshan Song

Nanomaterials Program

Program Co-directors: Randy Vander Wal and Angela Lueking

Petroleum & Natural Gas Program

Program Director: Zuleima Karpyn

Key Contacts: Phil Halleck and Tim Ryan

Stationary Power Program

Program Director: Bruce G. Miller

Key Contacts: Jonathan Mathews, Sharon Falcone Miller, and Sarma Pisupati

Sustainable Energy Program

Program Director: Joel Morrison

Key Contacts: André Boehman, Jeffrey Brownson, Caroline Burgess-Clifford, Sharon Falcone Miller, Bruce G. Miller, and Chunshan Song

Transportation Program

Program Director: André Boehman

Key Contacts: Stephen Kirby and Chunshan Song

Partnerships for Innovation

At the EMS Energy Institute our varied research reflects the distinctive backgrounds of our faculty affiliates and supports our belief that the nation needs to diversify its energy production. Our research faculty come from several colleges within the University and look to the Institute, not only for the space and facilities we provide, but also for the opportunity to collaborate with researchers from other departments and colleges. At the EMS Energy Institute, we recognize the innovation that comes from pooling resources, which is why we focus on bringing together researchers and students from around the University.

Part of our mission is to support the research efforts by faculty and students in order to assist in solving today's complex energy issues. We understand that the Institute could not accomplish this mission as an isolated unit. Therefore, we work to foster relationships with the leadership, faculty, and staff in many areas around the University. In addition, these units provide support to the Institute. Below are some of the units that are working with the Institute to move energy research forward.

Department of Chemical Engineering

Department Head: Andrew Zydney

Faculty and students from the Department of Chemical Engineering conduct research and collaborate on projects within the EMS Energy Institute to develop original research.

Department of Mechanical and Nuclear Engineering

Department Head: Karen Thole

Several faculty and students from this department are working with EMS Energy Institute researchers to develop innovative solutions to the world's complex energy issues.

College of Earth and Mineral Sciences

Dean: William E. Easterling

The College of Earth and Mineral Sciences houses the EMS Energy Institute. Faculty and students from almost every department within the College conduct research at the Institute. The College provides strong support to the Institute.

The Department of Energy and Mineral Engineering

Department Head: Yaw D. Yeboah

This department is the home department of many of our faculty affiliates. For this reason, we work very closely with the leadership, staff and faculty from this department. Our unique relationship with EME facilitates the development of collaborative projects and educational programs.

Penn State Institutes for Energy and the Environment (PSIEE)

Director: Tom Richard

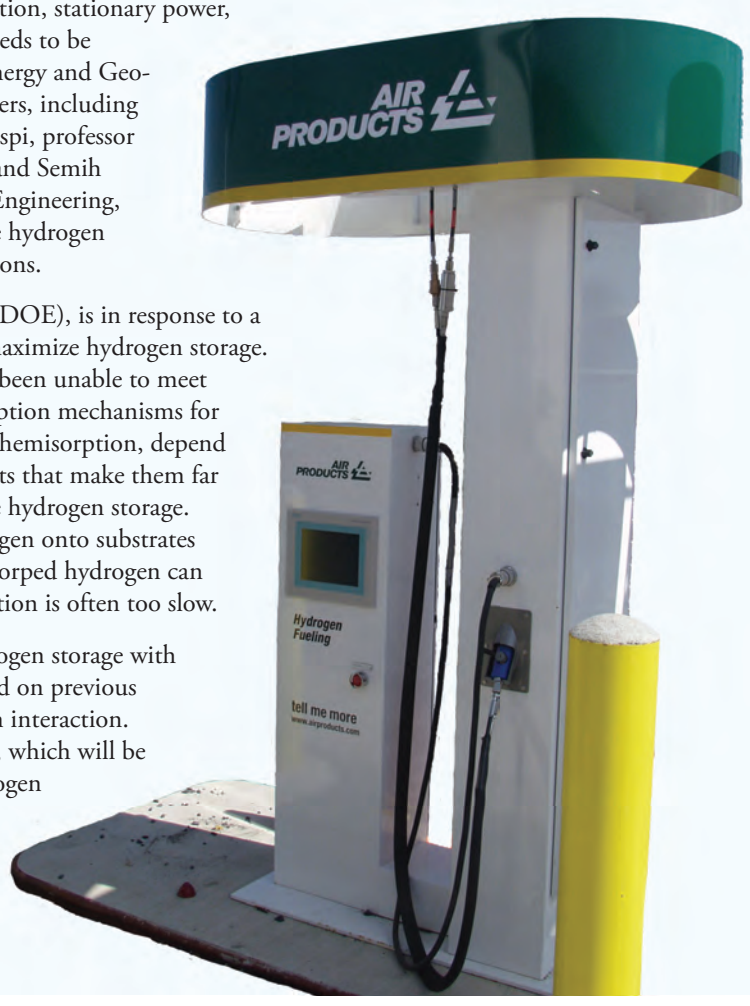
As one of the Institutes for Energy and the Environment, the EMS Energy Institute maintains a strong partnership with PSIEE. In addition, the Institute and PSIEE share many of the same values and the goal to improve energy efficiency, generation and utilization.

Research Briefs from Around the Institute

From exploring alternative energy sources to developing new technologies for the production, generation and utilization of energy, the EMS Energy Institute is involved in almost every aspect of energy research. This section highlights the diversity of some of our ongoing projects. This section is by no means an exhaustive list of projects.

Researchers aim to design new approach to hydrogen storage

Hydrogen is a clean energy carrier and has the potential to significantly reduce dependence on foreign oil and reduce carbon emissions. In order to advance the use of hydrogen and fuel cell technologies in transportation, stationary power, and other applications, storage is a key issue that needs to be addressed. Angela Lueking, assistant professor of Energy and Geo-Environmental Engineering, and a team of researchers, including John Badding, professor of Chemistry; Vincent Crespi, professor of Physics and Materials Science and Engineering; and Semih Eser, professor of Energy and Geo-Environmental Engineering, are in the initial phases of a project that will explore hydrogen trapping in carbon cages through repulsive interactions.



The project, funded by the Department of Energy (DOE), is in response to a need to develop alternative materials and ideas to maximize hydrogen storage. Current approaches face many challenges and have been unable to meet DOE hydrogen storage goals. The traditional adsorption mechanisms for solid-state storage of hydrogen, physisorption and chemisorption, depend intrinsically on attractive interactions and have limits that make them far from ideal for reversible practical room temperature hydrogen storage. The physisorption, or physical adsorption, of hydrogen onto substrates produces a bond that is too weak. However, chemisorped hydrogen can have too strong of a bond and the hydrogen desorption is often too slow.

This project aims to design a new approach to hydrogen storage with carbon hydrogen cage structures, or clathrates, based on previous observations that suggest a unique carbon-hydrogen interaction. Researchers are working to provide novel chemistry, which will be used to create a material consisting entirely of hydrogen trapped in carbon cages. This carbon-hydrogen material could provide a solution for the current hydrogen storage challenges.

Researcher explores process for producing military fuel from domestic resources

As a domestic resource, coal is an appealing fuel source and researchers have been looking at ways to expand its use, especially in areas that would result in the long-term replacement or reduction of the use of imported petroleum. For years, Penn State researchers have been exploring the production of a military logistic fuel JP-8 from coal through several novel processes, which allow the production of JP-8 from coal to be more energy efficient, economical and environmentally friendly.

Dr. Xiaoliang Ma, senior research associate, EMS Energy Institute, is working on one such project, supported by the Defense Advanced Research Projects Agency (DARPA), that explores a novel process for converting coal to JP-8, instead of the conventional direct and indirect coal liquefaction processes. Dr. Ma's work focuses on converting coal-derived light olefins to JP-8, which is one of the key steps in the proposed method for ultimately producing this military logistic fuel from coal and moving the United States toward greater energy independence.

Light olefins can be used to produce liquid hydrocarbon fuels, such as gasoline and diesel; however, no literature has been found about successful conversion of the light olefins to the military logistic fuel JP-8 because the resulting fuels lack needed characteristics. The major challenge to converting light olefins to JP-8 is in increasing the molecular weight of the hydrocarbons and in synthesizing the liquid hydrocarbons with the molecular structures needed for JP-8, such as cycloparaffins (hydrocarbon compounds with rings of carbon atoms). Cycloparaffins with a carbon number from 9 to 16, meaning they have 9 to 16 carbon rings, are the ideal JP-8 components because they have excellent low-temperature fluidity, high volumetric energy content, good combustion quality, and good oxidation and thermal stability, all important characteristics in a fuel that could be exposed to harsh conditions.

The main objective in the conversion of light olefins to produce JP-8 is to explore the feasibility of using a novel process and catalysts for the production of this military logistic fuel from light olefins derived from coal. This joint project is also looking at how to make the conversion process more energy efficient, economical, and environmentally friendly. In order to accomplish these goals, researchers are developing a new two-step process, to synthesize the liquid hydrocarbons with a high concentration of cycloparaffins and a boiling point in the range of 150 to 300 degrees Celsius (302 to 572 degrees Fahrenheit).

The advantages of this process include a resulting fuel that meets all the property requirements for JP-8; a high fuel yield of JP-8 from the light olefins; an energy efficient production process, as it can be conducted at relatively mild conditions; and a production process that doesn't require additional hydrogen.

Xiaoliang Ma

A better understanding of faults may someday help avert earthquake disasters

As the recent disasters in Haiti, Chile and other parts of the World have demonstrated, earthquakes can be devastating to populated regions. Understanding the factors controlling the stress state and nature of slip on major tectonic faults is a fundamental problem in earthquake physics and fault mechanics and important for earthquake hazard assessment. Demian Saffer, associate professor of Geosciences is leading a research project with Eric Kirby, associate professor of Geosciences and Chris Marone, professor of Geosciences that will provide a better understanding of the behavior and stability of mechanically weak faults.

Overall mechanical strength and slip behavior on major tectonic faults depend on the physical properties of the rock and gouge (the crushed material that accumulates from the friction between the two sides of a fault) within these fault zones. This project is a field and laboratory investigation funded by the National Science Foundation in which researchers are investigating the mechanical behavior of natural fault gouges from low angle normal faults (LANFs), which are normal faults with dips of less than forty-five degrees.

The mechanics of slip on LANFs, common throughout the southwestern United States, is one of the most significant unsolved problems in the geosciences. Normal faults with dips of less than thirty degrees should neither form nor be reactivated. Yet, these faults are documented in numerous field studies, and recent studies shows that slip on LANFs can be seismic or aseismic. In addition, LANFs appear to slip under unusually low stress, implying that they are mechanically weak. The potential for earthquakes along these faults is difficult to assess and therefore debated, mainly because of the overall low slip rates and long time span between large earthquakes.

This project is one of the first – if not the first – detailed investigations of frictional strength and stability for natural gouge from LANF systems to address questions about the absolute strength and nature of slip on these faults. Researchers are working to determine whether the gouge composition in LANFs can cause sufficient weakness to be able to explain the slip. In addition, they are looking at the frictional behavior of this fault gouge to find out if the behavior generally results in stable sliding, which would limit the potential for earthquakes along these faults.

Photos courtesy of Sam Haines, post-doctoral fellow, Geosciences.

Graduate student Bryan Kaproth works at the Whipple detachment fault zone in southeastern CA.

Researchers study fuel combustion and emissions characteristics for new biomass fuels

Fluidized Bed Combustor at the EMS Energy Institute.

As concern about carbon dioxide emissions elevates, many industries look for ways to diversify their fuel options. Consequently, the interest in using biomass feedstocks in utility and industrial boilers is increasing as these industries strive to reduce carbon dioxide emissions produced as a result of heat and power generation. Babcock & Wilcox Power Generation Group, Inc. (B&W PGG) is a leading designer, engineer, manufacturer and builder of biomass-fired bubbling fluidized bed (BFB) boilers for the utility and industrial markets, markets in which emissions limits for these boilers continue to be reduced while the variety of biomass fuels continues to expand. B&W PGG has teamed with researchers from Penn State to better understand the combustion and emissions characteristics of biomass fuels and to improve its product offering.

Mr. Bruce G. Miller, senior research associate, EMS Energy Institute, is leading the research team, while several EMS Energy Institute personnel are assisting on the project, including Dr. Sharon Falcone Miller, research associate, and Mr. Ronald T. Wincek, research assistant. As part of this project, Penn State's pilot-scale BFB combustor has undergone extensive modifications that enable it to track emissions profiles from the bed, through the combustion chamber, to the stack. This emission profile information, coupled with fuel particle size, detailed chemical analyses, and operating characteristics, will be used in a combustions/emissions model, which will allow researchers to predict a biomass fuel's performance in a BFB boiler.

In addition, the biomass fuels, which consist of woody materials, herbaceous biomass, animal manure/litter, and other industrial processing wastes, are undergoing detailed analyses to determine the inorganic composition of biomass materials and the behavior of their constituents in a combustion environment. A variety of analytical and computational techniques are being used to assess the depositional and agglomeration behavior of the inorganic components as well as their potential impact on selective catalytic reduction (SCR) units for nitrogen oxides emissions control.

Brad Maben, senior research technician, unloads a delivery of wood chips at the EMS Energy Institute.

Welcome

New Faculty Affiliates

The EMS Energy Institute welcomes the following principal investigators and faculty associates who have joined the EMS Energy Institute for research support and collaborations in the last year. As our research team continues to grow, the EMS Energy Institute anticipates many new projects that will broaden the scope of our research and enhance our ability to provide training and outreach. Detailed profiles can be found at **www.energy.psu.edu**.

Seth Blumsack

Assistant Professor
Energy and Mineral Engineering

Dr. Blumsack's work focuses on policy-relevant engineering, environmental and economic research for the energy, electric power and transportation industries. He also performs research in the area of complex engineered infrastructure networks. Before returning to academia, he served as a journalist and consultant for Economic Insight, Inc. His current research interests include the "Smart Grid" and the transition to more efficient and lower-impact energy, electric power and transportation systems; Marcellus Shale and other unconventional natural gas sources; the structure, vulnerability and performance of energy infrastructure networks; integrated design for the built environment; electricity deregulation; and life-cycle environmental impact assessments.

R.J. Briggs

Assistant Professor
Energy and Mineral Engineering

Dr. Briggs has an interdisciplinary background studying the environmental impact of resource use, design of environmental policy, and the measurement of the health effects of pollution. He holds a Ph.D. in Economics from the University of Texas at Austin, with a focus on Environmental and Natural Resource Economics, and Public Economics. His current research interests include non-renewable resource management and environmental impacts, and policy; design and analysis of permit markets, renewable portfolio standards, and environmental taxes; carbon sequestration and its implications for resource use and climate change; indoor and outdoor air quality and its effect on human health; and normative analysis of environmental policy in dynamic settings.

Wayne Curtis

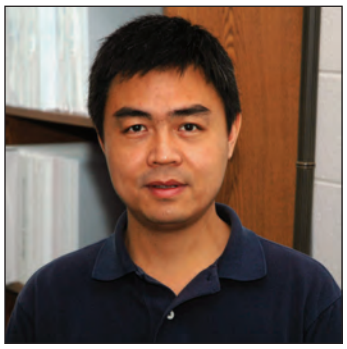
Professor
Chemical Engineering

Dr. Curtis' research interests are in the applications of bioprocess and biomolecular engineering with a particular focus on bioreactor design and optimization. Current research interests are in CO_2 utilization, including photobioreactor systems for algae growth for biofuels production. Through collaborations, the potential for genetic engineering of hydrocarbon synthesis into algae and other CO_2 consuming organisms is also being explored. Other collaborative projects include transient protein expression plant tissue culture, vaccine production in mushrooms and membrane protein expression in photosynthetic bacteria. Several industrial collaborations are focused on plant propagation bioreactors.

Andrew Kleit

Professor
Energy and Mineral Engineering/Meteorology

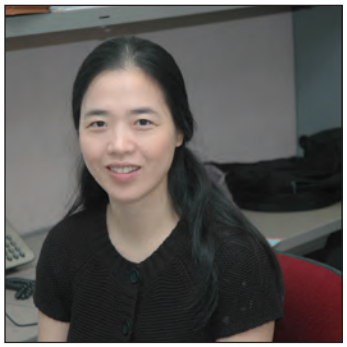
Dr. Kleit is professor of Energy and Environmental Economics and directs the program in Energy Business and Finance. He holds a joint appointment in Energy and Mineral Engineering and Meteorology with interests that lie heavily in both areas. His current research interests include electricity economics, financial risk management, antitrust issues, pharmaceutical economics, weather risk management, and the impact of regulation. Dr. Kleit also directs the Electricity Markets Initiative (EMI), which conducts industry-relevant academic research that examines important questions in electricity restructuring and electricity markets in Pennsylvania.



Zhen Lei

Assistant Professor
Energy and Mineral Engineering

Dr. Lei has expertise in economics and science. He holds a Ph.D. in Agricultural and Resource Economics from the University of California at Berkeley, and Chemistry and Pharmaceutical Sciences from Peking University Health Sciences Center in China. His diverse research interests include economics of innovation, intellectual property, science and technology policy, and energy and environmental economics. His current work includes the roles of technology innovation, diffusion in addressing energy and environmental issues including climate change, economics of electricity markets, and patent evaluation in the context of international patenting and patent litigation.



Li Li

Assistant Professor
Energy and Mineral Engineering

Dr. Li Li has an interdisciplinary background combining areas of petroleum engineering, environmental engineering and geochemistry. Her research interests are in the general area of multicomponent reactive transport processes in natural subsurface systems. In particular, some of her current research topics include microbially enhanced oil recovery (MEOR), geological CO_2 sequestration, and bioremediation of contaminated environments. She focuses on understanding complex interactions between multiple physical and (bio)geochemical processes at multiple spatial scales, and how characteristics of natural environments affect the kinetics of reactions important in MEOR, carbon sequestration, and bioremediation.

Antonio Nieto

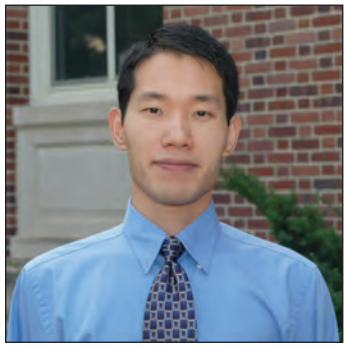
Associate Professor
Energy and Mineral Engineering

Prior to coming to Penn State, Dr. Nieto worked as an assistant professor at Virginia Tech. He also worked in the mining industry in both underground and surface mines. Dr. Nieto's research focuses on Mining Operations and Information Technology, specifically in the areas of geo-spatial characterization and real-time sensorial systems in mining and earth-extractive operations. His research interests include: assisted driving systems, real-time tracking GIS systems, computer based geological modeling, ore reserve estimation, and earth and environmental geostatistical characterization. Dr. Nieto is also working on cyclic solutions for capture and storage of CO_2 (CCS) and the mining and extraction of methane hydrates.

Donghai Wang

Assistant Professor
Mechanical and Nuclear Engineering

Dr. Donghai Wang joined Penn State as an Assistant Professor in 2009 after working at Pacific Northwest National Laboratories as a staff scientist. His expertise is in the design and synthesis of nanostructured functional materials for clean energy technologies including Li batteries, fuel cells, solar cells and green catalysis. His research interests include: electrode material and fabrication of Li batteries, new catalyst developments, nanostructured photo electrode materials for low cost solar cells, and mechanical properties of nanocomposite materials.



John Yilin Wang

Assistant Professor
Energy and Mineral Engineering

Dr. Wang's research focus is on developing new technology to improve productivity and increase recovery of oil, gas, and geothermal resources. He is especially interested in the evaluation, fracturing and development of unconventional resources, including ultra-tight gas, shale gas, coal bed methane, shale oil and geothermal. Before coming to Penn State, Dr. Wang worked as a petroleum and natural gas engineer with a U.S. independent producer. Currently, he is working to build an active lab and effective industry/academia/government consortium, 3S Laboratory, for petroleum research in reservoir simulation, stimulation and strategy.

Seeding Change

Alumna spends a year working on environmental policy for the White House.

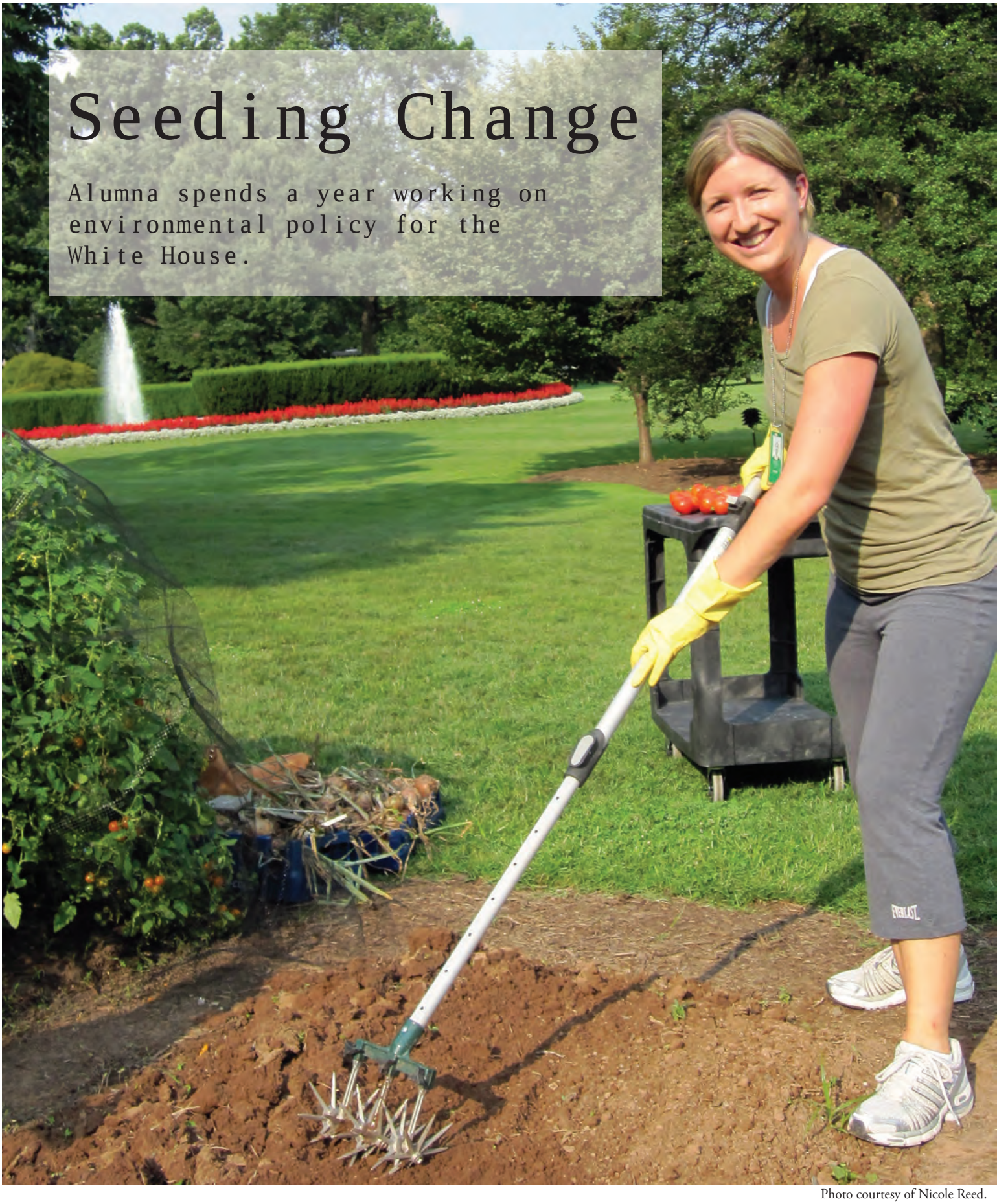


Photo courtesy of Nicole Reed.

When the opportunity arose to take on environmental issues from one of the most influential offices in the country, Nicole Reed jumped at the chance and joined the White House Council on Environmental Quality (CEQ). As part of the Council, she has been able to witness governmental processes in action as she has helped to develop environmental policies and initiatives. Her role has brought many challenges and learning experiences, and even a chance to dig in the White House garden!

Since July 2009, Nicole Reed ('08 Energy and Geo-Environmental Engineering) has been working on the Communities, Environmental Protection, and Green Jobs team in the Council on Environmental Quality as part of a detail assignment expected to last about one year.

Congress established CEQ within the Executive Office of the President in 1970 as part of the National Environmental Policy Act. Today the Council works closely with federal agencies and other White House offices to develop environmental policies and initiatives in support of the President's environmental goals. The Council's Chair serves as the principal environmental policy adviser to the President.

Nicole is completing an 11-month rotation with the Council. In 2008, after graduating from Penn State, Nicole began working as an engineer for the Department of Energy (DOE) in the Geothermal Technologies Program in the Office of Energy Efficiency and Renewable Energy. At DOE she assisted with program management and some workforce development projects for renewable energy and energy efficiency industries. Since she is participating in the Federal Career Intern Program (FCIP), a two-year professional development program, Nicole was required to do a rotation outside of the Geothermal office of Energy Efficiency and Renewable Energy, and CEQ was looking for someone from DOE to help with the green jobs projects. Because of her energy efficiency work for DOE the detail assignment was a great fit.

Most of Nicole's work for CEQ is on an initiative called Recovery Through Retrofit, an action plan to expand green jobs and increase energy savings by retrofitting existing homes to make them more energy efficient. The initiative is a collaboration between eleven departments and agencies, and six White House Offices. One of Nicole's responsibilities is to plan and conduct meetings and manage the activities of this large interagency working group. In addition, she researches and analyzes current and proposed energy efficiency programs and policy options, and works with the Associate Director to coordinate policy implementation.

It was at Penn State that Nicole first became interested in clean energy. When she entered University Park campus, she was unsure about a major until a freshman seminar, taught by Dr. Dennis Thomson, who continues to be a mentor and friend, led her to the College of Earth and Mineral Sciences (EMS) and the Environmental Systems Engineering program.

As an undergraduate and graduate student at Penn State, Nicole spent a great deal of time at the EMS Energy Institute taking advantage of the diverse energy research opportunities. She enjoyed the hands-on research experience as well as the ability to exchange ideas and information with so many other interesting people.

"Being in a lab was new to me," Nicole said, "and it was both frightening and empowering."

If lab work initially seemed overwhelming, she didn't let that keep her away. In fact, she ended up spending about three years working in various areas of the Institute in part because of the outstanding support from fellow students, faculty and staff.

"I was amazed at how helpful everyone was," Nicole said. Even after graduation that support has continued, as she formed many lasting relationships during her time at Penn State. "There have →

"I was amazed at how helpful everyone was."

Opposite: As a White House employee, Nicole Reed was able to volunteer in the White House's organic garden. *This page:* Nicole Reed working at the EMS Energy Institute.

been so many people from the College of EMS and the [EMS] Energy Institute that have supported me along the way, and I am incredibly grateful for their guidance."

As an undergraduate, Nicole conducted research alongside Dr. André Boehman, professor of fuel science, to complete her senior honors thesis on the effects of small amounts of hydrogen addition on the combustion characteristics from a spark-ignition engine. She then spent about six months working for Joel Morrison, research associate at the EMS Energy Institute, as a technical writer and program assistant for the West Penn Power Sustainable Energy Fund (WPPSEF). In this position, she wrote about a variety of sustainable energy technologies being manufactured and deployed throughout Pennsylvania, including solar, wind, and biomass.

While completing her master's degree, she spent two years working with Dr. Chunshan Song, distinguished professor of fuel science, in his clean fuels and catalysis program. Her research, a comparative analysis of various adsorbent materials utilized in desulfurization of liquid fuels for fuel cell applications, was the basis for her master's thesis.

One of the highlights of Nicole's time at the Institute was the 2006 PA Clean Energy Expo. While working for WPPSEF, Nicole helped create a program for high school students attending the Expo, including a scavenger hunt, and coordinate speakers to talk to the students about Penn State and future energy careers.

The fundamental research understanding Nicole gained from her out-of-classroom experience at the EMS Energy Institute continues to give her an edge in her work.

"Although I'm not doing calculations and lab experiments on the job anymore, I still need to keep up to date on the latest research…and my time at the Energy Institute and in Energy and Geo-Environmental Engineering definitely prepared me for that."

She was exposed to energy and environmental issues, including clean energy technologies and energy efficiency while working for the Institute. This background knowledge is constantly useful as she meets daily with people from industry and nonprofit organizations to discuss their organizations' achievements. The science and research background is also important for her "real" job with DOE, which is more technical in nature and which Nicole plans to return to once her position with CEQ ends.

For now, though, she is happy soaking up every new experience, gaining a behind-the-scenes knowledge of policy making, and working with people who really believe in what they do.

"I couldn't be more thankful for the opportunity to be here at this point in my career," she said. "I have always wanted to be at the intersection of energy and environmental issues and this is one of the best places to do that."

In addition, Nicole recently had the opportunity to return to Penn State as a speaker for the 2010 PA Home Energy Conference. (PA Home Energy is a program from WPPSEF to help consumers reduce home energy.) As a representative of CEQ, Nicole provided an update of the Recover Through Retrofit program for one of the conference general sessions.

While CEQ has challenged her to think in a different way, learning about policy and finance has broadened her view of these issues and she's been up to the task.

"I love that my work constantly requires me to develop and improve my general technical understanding of energy efficiency and renewable energy principles and policies," she said. ■

"I have always wanted to be at the intersection of energy and environmental issues and this is one of the best places to do that."

Nicole Reed speaks during the PA Home Energy Conference.

Energy Institute Scholars Explore New Electricity Markets

Amidst Pennsylvania's continued efforts to restructure its retail electricity market, a new initiative has been formed at Penn State to address concerns about affordability, reliability and efficiency. The Electricity Markets Initiative (EMI), under the direction of EMS Energy Institute Scholar Andrew Kleit, professor of Energy and Environmental Economics, has been created to undertake industry-relevant research that examines important policy questions in electricity restructuring and electricity markets throughout Pennsylvania and across the United States.

Electricity restructuring refers to the reorganization of the traditional electric service to allow charges to be separated into generation, transmission, distribution, and other services. This restructuring opens the marketing and purchase of electricity to competition. Distribution and transmission of electricity are considered natural monopolies and continue to be regulated by the government. Restructuring gives electricity generators incentives to invest in generation, which could lead to improvements in efficiency and expanded use of alternative energy. On the retail side, restructuring gives customers the opportunity to shop for power from a variety of firms based on price and product offerings.

According to the Pennsylvania Utility Choice Web site, electric customers in Pennsylvania were among the first given the ability to choose the company that generates their electricity with the passing of the Electricity Generation Customer Choice and Competition Acts in 1996. The first phase of restructuring began in 1998 when consumers in Pennsylvania were allowed to purchase their generation service from competitive suppliers under the protection of price caps on the generation service to allow for an orderly transformation to the open market. The second phase, which is currently in progress, involves the removal of these rate caps to allow the marketplace to set the cost of generation service for retail consumers in the Commonwealth.

While there are many advantages to the restructuring of electricity, challenges still remain in designing policies consistent with other goals for the electricity industry, including reliable infrastructure and minimized environmental impacts. In addition, since many aspects of retail electricity restructuring are relatively new, it is unclear how customers will respond to increased choice in purchasing electricity supplies. EMI will engage industry and regulatory partners in research studies that are designed to influence the ongoing debate about how the U.S. electricity market should address these challenges. EMI's work will inform policymakers to help them implement appropriate policies for the restructured electricity industry.

The EMI is funded by a consortium of electricity market participants, and includes regulators and consumer representatives on its Advisory Board. Research proposals will be submitted to the EMI advisory board by EMS Energy Institute scholars and are subject to the Advisory Board's approval. Potential topics include the market for retail electricity products, the benefits and costs of clean energy sources, such as wind and solar, and the environmental consequences of restructuring. The Initiative began on January 1, 2010, and is moving forward after the kickoff meeting held on February 2. The Initiative will also host an interactive Web site and intends to begin publishing material later this year.

EMI will focus research efforts on issues facing the state of Pennsylvania; however, the intent is that the work will have broader value across the United States and even in other countries considering or active in electricity restructuring. A full EMI conference is planned for April 2011, in which EMI researchers and invited guests will make presentation about the findings of various studies and current issues affecting restructured electricity markets. More information about the Electricity Markets Initiative and current research projects is available at **www.electricitymarkets.psu.edu.**

A hilltop power plant gathering geothermal fluids from the surrounding well field at the Geysers geothermal plant. The Geysers is the single-largest geothermal operation in the world with a capacity of 700MW, located about 100 miles north of San Francisco.

No Rock Left Unturned

Energy Institute researcher looks below the Earth's surface to uncover answers to some of today's most important energy issues.

Twenty-five years may seem like a lifetime, but the time flies by, as they say, when you're doing something you love. For Derek Elsworth, professor, Department of Energy and Mineral Engineering, that includes research and discovering how things work, whether engineered or natural. He enjoys this scientific process and has spent the last 25 years at Penn State conducting research and teaching in the areas of computational mechanics, rock mechanics, and in the mechanical and transport characteristics of fractured rocks.

Rock and fluid physics is an exciting area that has far-reaching applications, from the recovery of hydrocarbon and geothermal resources, and the deep geological storage of CO_2 and radioactive waste, to the dynamics of volcanoes and earthquakes.

"It's an important contemporary area that underpins recovery of renewable energy from the subsurface," Elsworth said. For example, studying the interactions between rocks and fluids can lead to new technologies to access low-carbon fuels such natural gas from unconventional reservoirs and can expand the U.S.'s alternative energy portfolio by solving problems related to geothermal energy and nuclear power.

Understanding Earth's systems

In 1998, one year after the establishment of the EMS Energy Institute, Elsworth began coordinating all his research projects through the Institute. Since that time, he had led a variety of projects that bridge the fields of earth science and engineering.

His primary research interest has focused on the evolution of permeability (a rock's ability to transmit fluids) related to reservoirs within natural systems in order to understand how mechanical and chemical changes will cause these reservoirs to grow and diminish over time. By studying various materials and how permeability is changed, researchers can begin to develop mechanisms such as hydrofracing to gain access to natural gas, geothermal reservoirs, petroleum hydrocarbons, or other liquids trapped in rock. Conversely, low permeability is needed in non-penetrable barriers for the safe storage of energy byproducts such as radioactive waste and CO_2.

"The big stumbling block in nuclear power is what you do with the waste," Elsworth said. "Since the 1950s the preferred mechanism to deal with the spent nuclear fuel has been deep geological disposal – so you burry it." With this solution metal canisters are secured in specialized tunnels backfilled with materials such as low permeability clays and surrounded by the natural geological media. These redundant barriers are needed to entomb the waste for as long as possible, even if a canister ruptures. Therefore, researchers need to understand how permeability evolves over time.

A new geothermal project, hinges on the concept of permeability. This project looks at Enhanced Geothermal Systems (EGS), which, according to Elsworth, is the "holy grail" of geothermal energy.

"The idea is that you can recover thermal energy from the Earth's crust from anywhere in the world, not just on geological plate boundaries where most of the hydrothermal systems exist," he said. Hydrothermal systems, where water is present in porous rock, are the traditional geothermal source. The problem is that these systems only exist naturally in very specific places. In the United States, they can only be found on the West Coast and in Alaska. Currently, Elsworth and his team are using the geysers in California and the Newberry Volcano in Oregon as field sites for the research.

The basic principle of EGS is to drill a deep borehole down to about five kilometers and then stimulate the reservoir through hydrofracing or by injecting fluid under high pressure to fracture the rock enhancing its permeability. This allows the fluid to travel through the hot rock.

"Once it's stimulated, you'd want to intercept that hydrofrac, or stimulated zone, with another borehole and then link it up so you can just circulate fluid in a closed circuit," Elsworth said. Cold water is pumped down into the rock and hot water is forced up the second borehole to be converted into electrical energy. As a follow-up to a previous →

CAUSE students at the Geysers with Calpine's Tom Box.

> "The idea is that you can recover thermal energy from the Earth's crust from anywhere in the world."

project, Elsworth's research team, with funding from the U.S. Department of Energy, is now executing experiments and developing models to understand the short-term evolution and long-term behavior of these geothermal reservoirs.

A second new project explores permeability in relation to coal beds. Currently methane can be extracted from coal seams by drilling a well into the coal and pumping water from the well. This dewatering releases pressure and allows the methane to flow to the surface. However, once the methane is partially depleted, more can be recovered by injecting the coal seam with CO_2. Elsworth and several other researchers are studying and modeling processes related to this enhanced coal bed methane recovery. In particular, the group will look at how permeability changes as the coal swells when injected with CO_2 and shrinks when releasing methane.

Identifying these changes will help in understanding the challenges related to this technique, which in addition to improving methane recovery, could become a key technology for CO_2 capture and storage. CO_2 storage is one possible solution to reduce the effects of greenhouse gas byproducts from fossil fuels and it's another area in which Elsworth is actively conducting research. Just this past year, in September 2009, he ran a roundtable forum on CO_2 sequestration sponsored by the Institute of Advanced Studies at the University of Western Australia. The forum engaged members from industry, academia, and government in discussions about the critical issues with

Going Even Deeper

Derek Elsworth is involved with a new large-scale project, DUSEL, to develop a Deep Underground Science and Engineering Lab in the U.S. While several other countries have deep underground research laboratories, nothing below one kilometer exists in the U.S. A study began in 2002 to determine the feasibility of a *really* deep – 2,200 meters deep – scientific research space within our borders. The Homestake mine in Lead, SD, which is an old gold mine, has been chosen as the site for this facility.

Elsworth has an integral role in planning the facilities design. He serves on the science steering committee charged with interfacing the scientific community with the facility. Basically, he is helping to ensure the site design fits the needs for the proposed experiments.

The project was initially motivated by the desire to have a physics lab where scientists can begin to understand dark matter and dark energy in the universe away from the "noise" of cosmic rays. Researchers plan to build detectors, or large underwater caverns, 1,500 meters underground to observe the interactions of sub-atomic particles.

The DUSEL project will also provide important research opportunities for the fields of Earth science and engineering and Elsworth anticipates being involved with many projects. One experiment will emulate geothermal reservoirs to look at the thermal response of rocks to heating. In another project, researchers will examine water circulation in the Earth's crust and several other projects are aimed at increasing the ability to predict earthquakes and other natural disasters by inducing faulting in rocks to understand the behavior and the strength of rocks.

Currently the preliminary design and rehabilitation of the existing mine into the initial parts of a laboratory is taking place. The National Science Foundation (NSF) is providing the primary support for this project with some additional funding from the U.S. Department of Energy. While DUSEL really got started in 2004, it hasn't been completely ratified by NSF yet. The project is moving through the necessary channels and will go to the National Science Board for approval in May 2011. It will then be presented to Congress and, if approved, construction is slated to begin in 2012 with experimentation starting in 2015.

CO_2 sequestration. Most of the talk focused on the Gorgon project, which is a natural gas recovery project off the northwest coast of Australia – a joint venture between Chevron, Exxon Mobil, and Shell. However, the gas extracted from this offshore gas field is close to 14% CO_2, higher than normal CO_2 levels, so the project is looking into the possibility of reinjecting the CO_2 under the nearby Barrow Island Nature Reserve.

The forum resulted in a detailed summary of the scientific issues with CO_2 storage with the expectation that the interested parties will ultimately fund some of the work to address these concerns. Major issues outlined in the report relate to characterizing reservoirs to predict long-term security of the CO_2, understanding process interactions that will result as a reservoir system is stressed, and monitoring a reservoir system's behavior and verifying that behavior against predicted responses. By addressing these three needs scientists will be able to identify the best CO_2 storage locations and predict any changes that may occur due to changes in temperature, pressure, or other stressors. The overall goal is to have the lowest possible permeability in the rock and to make sure the CO_2 stays put for a long period of time.

Falling into the right place

"You kind of stumble into these things," Elsworth said of how he got into the field of rock and fluid physics. He stumbled into it while working on his Ph.D. in the early 1980s. He began looking at the response of dams on rivers to revised flood sizes, which meant he was studying the interaction between rock and fluids – something he had never worked on before.

At that time, probable maximum flood magnitudes (PMFs) were being revised upwards and many of the dams built in the 1940s were up for relicensing, then 40 years later. Under these lager design floods many of the dams would be overtopped. One of the issues related to a dam's stability is its mechanical response to being overtopped.

"So to pay my way through graduate school, I basically did consulting on that to look at the role of fluids flowing underneath dams, evaluate uplift pressures that would be generated, and how they would affect stability," Elsworth said. "I remember saying at the time that I didn't think this would be a path I would choose to go on." Instead he continued to work in this area for the rest of his professional life.

> "They are the engines that allow us to do the things that we do."

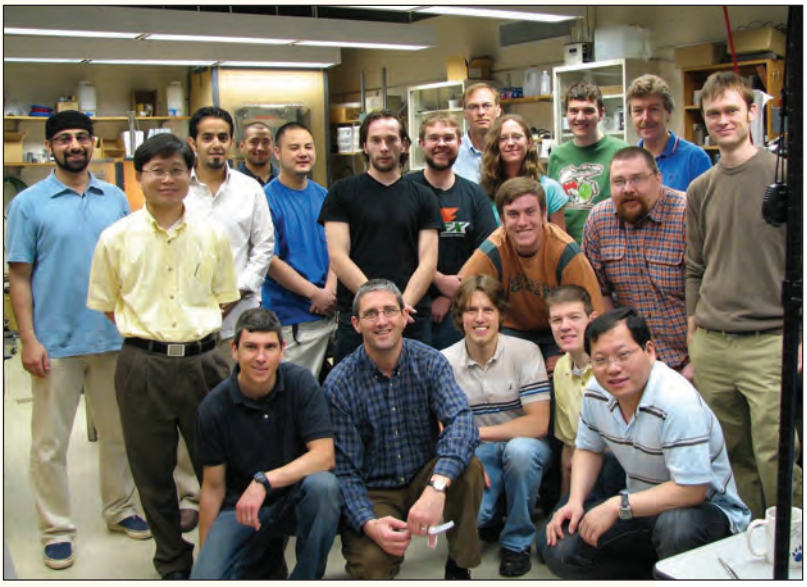
One of the highlights throughout Elsworth's career has been the ability to work with graduate students.

"Working with graduate students is a huge privilege I think," he said. "They are the engines that allows us to do the things that we do."

He enjoys watching their personalities develop over a period of time and seeing their professionalism come out when they are working in non-typical roles, such as when they are traveling or working in the field.

"From the time when you're teaching them stuff to the time when they are teaching you stuff. I think that's a curious and amazing transformation."

Photos courtesy of Derek Elsworth.



Opposite: Bill Boyle, Director of DOE's Regulatory Authority Office, Office of Civilian Radioactive Waste Management talks to students underground at one of the many in situ experiments at the Yucca Mountain Exploratory Studies Facility, NV – the ESF is a tunnel penetrating 5 miles into Yucca Mountain. *This page:* Students and faculty from the G3 Center. Derek Elsworth is first from right in back row.

G3 Center Provides Structure for Rock and Fluid Research

Earthquake nucleation and recurrence, the triggering and timing of volcanic eruptions, the dynamics of ice sheets, the fate and transport of contaminants in groundwater, and the generation of submarine landslides are all influenced by the interaction of rocks and fluids. Understanding rock-fluid relationships is a key component of our ability to predict natural disasters, protect and recover potable water, and to provide safe storage and long-term stewardship of related industrial products and wastes. The Center for Geomechanics, Geofluids, and Geohazards (G3 Center) is working toward understanding these relationships while providing Ph.D. research opportunities to students.

In 2006, the EMS Energy Institute provided seed money to help start the G3 Center with the intention of raising the profile of upstream petroleum research in the Institute and to secure buy in from faculty in the college, especially in the departments of Energy and Mineral Engineering and Geosciences. While a cohesive faculty group existed prior to the G3 Center's establishment, the formation of a concrete organization was needed to increase the awareness of their research. The Center, which is more like a research focus area, has a number of goals. It acts as a hub for the research activities of the participants, it hosts scientific visitors at Penn State to conduct collaborative research, it sponsors impromptu seminars, and it facilitates the interaction of the participants with students and industry. The center's Web site has been a successful recruitment tool for attracting excellent graduate students, and the collaboration allows pooling of resources for technical support.

The G3 Center is currently coordinated by Derek Elsworth, professor of Energy and Geo-Environmental Engineering; Demian Saffer, associate professor of Geosciences; and Chris Marone, professor of Geosciences. The G3 Center has allowed participants to take research they were already doing and package it more coherently to "sell" to industries such as oil companies. Portraying a clear focus is important as they continually work to strengthen connections with these companies. For example, representatives from the G3 Center traveled to Houston in 2007 and 2009 to talk to oil companies about ongoing research and what the Center can do for the companies. One of the main goals of the visits was to bring back some new projects, which they did on each occasion.

In addition, the G3 Center provides a way for Ph.D. students to earn degrees in Energy and Geo-Environmental Engineering, and Geosciences while addressing fundamental problems in fluid flow and rock mechanics. At any one time, there are about 20 students working on projects through the G3 Center and their research has real-world applications in the areas of geo-hazards and geo-environmental issues that can lead to jobs in academia, government, and industry.

G3 Project Examples

- **DUSEL Experiment and Development Coordination**
  Contact: Derek Elsworth
  Coordinating the science plan for a proposed underground research laboratory at the Homestake gold mine in S.D.

- **NanTroSEIZE Drilling Program Projects**
  Contact: Demian Saffer
  An initiative to understand subduction plate boundaries through sampling and monitoring a major fault system implicated in historical great earthquakes and tsunamis.

- **Physical Properties of the San Andreas Fault Zone and the Rock Volume that Surrounds it**
  Contact: Chris Marone
  A project focused on laboratory measurements of frictional, permeability, and elastic properties for both the active San Andreas Fault zone and outcrop samples of lithologies that represent the host rock for the cored San Andreas Fault material.

g3.ems.psu.edu

Students, Faculty Win Conference Awards

Laura Bradley Takes Best Paper at International Conference

Laura C. Bradley, an undergraduate student in Chemical Engineering working at the EMS Energy Institute, received a Best Student Paper Award at the 2009 Clearwater Clean Coal Conference for her paper, "The Effect of Fuel Composition on Pyrolysis Kinetics."

She received the award during the 34th International Technical Conference on Clean Coal and Fuel Systems held from May 31 to June 4, 2009. The Best Student Paper Award Committee evaluated the students on the manuscript they submitted and the presentation of the material during conference technical sessions.

Nine students participated in the award representing Penn State, University of Stuggart, The Ohio State University, Massachusetts Institute of Technology, Illinois Institute of Technology, and University of Utah. Laura, who recently completed her sophomore year, was the sole undergraduate student in the competition. Two students were awarded Best Paper and Laura shared the honor with a Ph.D. student from the University of Utah.

Laura Bradley

Laura presented work she performed as an Independent Study during Fall 2008 that was funded by the Foster Wheeler, NA. Her advisor for the Independent Study and co-author on the manuscript was Dr. Sharon Falcone Miller.

ACS National Meeting Recognition

Ramanathan Sundararaman, a Graduate Student in Energy and Mineral Engineering, received the American Chemical Society (ACS) Petroleum Chemistry Division Student Award for Best Paper during the 238th National Meeting & Exposition of the ACS in August 2009. Only one paper is selected at each national meeting for this award. The award was based on his paper presented at the Fall 2008 ACS National Meeting, "Partial Oxidation Using Air for In Situ Peroxide Generation in Diesel Fuel for Selective Oxidation of Refractory Sulfur Compounds." Co-authors on the paper were Dr. Chunshan Song and Dr. Xiaoliang Ma.

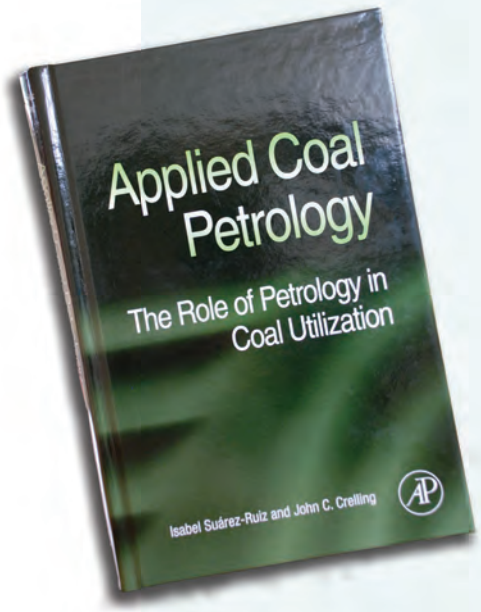

Ramanathan Sudararaman

Currently, Ramanathan is working with Dr. Song in the EMS Energy Institute. His Ph.D. thesis research topic is novel oxidation desulfurization using air for ultra clean fuels.

Dr. Harold Schobert, professor of fuel science, was also recognized during the 2009 meeting. Dr. Schobert received a Distinguished Service Award in "appreciation of his outstanding service to the division of fuel chemistry." This award, limited to members of ten years or more, is presented to an individual who has had "a significant and continued impact on the advancement of fuel chemistry through research, teaching and/or service."

Harold Schobert

Dr. Schobert has held several positions on the executive committee for the ACS Division of Fuel Chemistry. Currently, he is the director of long-range planning.



Applied Coal Petrology, The Role of Petrology in Coal Utilization, Multiple authors, Edited by: Isabel Suarez-Ruiz and John C. Crelling, Academic Press, Elsevier, 388 pp.

Gareth Mitchell, Contributing Author for Award-Winning Book

Gareth Mitchell, research associate in the EMS Energy Institute, was a contributing author for *Applied Coal Petrology: The Role of Petrology in Coal Utilization**, which recently received the 2009 Ralph Gray Award for Outstanding Book in Coal and Organic Petrology. Mitchell, who is also the director of the Coal & Organic Petrology Laboratories at the Institute, wrote the chapter on direct coal liquefaction (chapter 6).

The Ralph Gray Award, given by The Society for Organic Petrology (TSOP), was developed in memory of TSOP founding member, Ralph J. Gray, to recognize excellence in coal and organic petrology publications. While the award was primarily established for refereed papers, outstanding publications in non-refereed venues can be considered and TSOP felt this book warranted recognition.

Applied Coal Petrology, edited by Isabel Suárez-Ruiz and John C. Crelling, is a valuable reference book for coal producers, marketers, industry professionals, researchers, and teachers. It explains the applications of coal petrology, a branch of geology that deals with understanding the origin, occurrence, structure, and history of coal, and petrology's significance in the coal industry and other coal-related areas. According to the book's back cover, "Coal petrology, when employed effectively, is one of the most important tools we have for the management of coal as a producer of energy." This book will provide readers with "information and solutions to the day-to-day issues of coal management and gives the reader insight into long-term planning."

Other contributing authors include: Joan S. Esterle, Robert B. Finkelman, Stephen F. Greb, Jack C. Pashin, Nicola J. Wagner, Colin R. Ward, M. Coertzen, R.H. Matjie, J.C. van Dyk.

Demian Saffer Receives Research Award

Demian Saffer, associate professor, Geosciences, recently received the 2009 Friedrich Wilhelm Bessel Research Award from the Humboldt Foundation. This award is presented annually to about twenty internationally renowned scientists and scholars. These scholars, from across all disciplines, are recognized for their outstanding accomplishments in research to date and their exceptional promise for the future.

In addition to receiving recognition, award recipients are invited to spend a period of up to one year cooperating on a long-term research project with specialist colleagues at a research institution in Germany. Dr. Saffer's collaboration will be with Dr. Achim Kopf at the University of Bremen. Dr. Saffer will be working closely with Dr. Kopf on several projects focused on the hydrologic and mechanical behavior of tectonic plate boundary fault systems. These fault systems give rise to many of the planet's largest earthquakes. The projects will include the development of long-term borehole observatories to monitor processes associated with the earthquake cycle offshore Japan and experimental laboratory studies to measure rock properties within and surrounding the major fault systems.

The Friedrich Wilhelm Bessel Award is given to researchers who have completed their doctorates less than twelve years ago and who are expected to continue producing cutting-edge achievements that will have a significant influence on their discipline beyond their immediate field of work. The Federal Ministry for Education and Research funds the award.

Chunshan Song Named Distinguished Professor of Fuel Science

When Penn State's Office of the President named Dr. Chunshan Song Distinguished Professor of Fuel Science he joined a select group of faculty recognized for exceptional accomplishments in teaching, research, and service. Song's dedication to his field and his students is apparent in his many achievements and contributions over the course of his career.

Song is internationally known for his original and innovative contributions to clean fuels, catalysis, and CO_2 capture and utilization research. He is also a prolific author of many high-impact publications, including 40 plenary or keynote lectures at international conferences, 190 invited lectures worldwide, 170 refereed journal articles, 6 refereed books, 11 special journal issues, 20 patents and patent applications, and over 280 conference papers.

Song has cultivated a great respect for his dedicated and tireless efforts as an active leader in clean fuels and catalysis research and has been elected as Chair of the Fuel Chemistry and the Petroleum Chemistry Divisions of American Chemical Society, as well as Chair of the Advisory Board for the International Pittsburgh Coal Conference. He has also served as chair and/or co-chair of over 35 international symposia, and is currently on eight research journal advisory boards. In addition, Song has held visiting professorships with Imperial College London, University of Paris VI, Tsinghua University, Dalian University of Technology, Chinese Academy of Sciences, Taiyuan University of Technology, and Tianjin University.

In addition to his research accomplishments, Song has made major contributions to teaching, advising and service at Penn State. He has taught many classes and advised over 35 graduate students at the Ph.D. and M.S. level. Song has served the university effectively in various committees at the department, college and university levels. He has played a major role in developing the collaborative partnerships between Penn State and Chevron, ConocoPhillips, and National Energy Technology Laboratory of U.S. DOE, and most recently he has been leading the Penn State efforts in developing an international joint energy research center.

Distinguished professors at Penn State are acknowledged leaders in their fields of research; demonstrate significant leadership in raising the University standards with respect to teaching, research and service; and demonstrate excellent teaching skills and contribute significantly to the education of students who subsequently have achieved recognition of excellence in their fields.

André Boehman Recognized for Paper on Diesel Engine Research

André Boehman, professor of Fuel Science, Energy and Mineral Engineering, was chosen to receive the 2009 SAE John Johnson Award for Outstanding Research in Diesel Engines in recognition of a paper he co-authored, "An Experimental Investigation of the Origin of Increased NOx Emissions when Fueling a Heavy-Duty Compression-Ignition Engine with Soy Biodiesel." The paper was published in the October 2009 issue of SAE International Journal of Fuels and Lubricants. SAE International presented him with the award on April 13.

This award was established in 2008 with a contribution from Dr. John H. Johnson, an expert in the field of diesel engines, to recognize the author(s) of an outstanding technical paper presented at an SAE meeting. The paper must address research advancements in diesel engines in the on- or off-road industries.

The paper's lead author was Charles J. Mueller, Sandia National Laboratories. Co-authors included André Boehman, Penn State, and Glen C. Martin, Sandia National Laboratories.

André Boehman

Chunshan Song Wins the 2010 Henry H. Storch Award in Fuel Chemistry from ACS

Chunshan Song, Distinguished Professor of Fuel Science in the Department of Energy and Mineral Engineering and Director of EMS Energy Institute at Penn State, was selected to receive the Henry H. Storch Award in Fuel Chemistry at the American Chemical Society (ACS) Spring 2010 National Meeting held in March 2010. He received this prestigious award in recognition of his outstanding contributions to fuel science especially in the areas of clean fuels, catalysis, and CO_2 capture and conversion research.

The Henry H. Storch Award, co-sponsored by the Division of Fuel Chemistry of the ACS and Elsevier Ltd., is given annually to recognize an individual in the field of fuel science for an exceptional contribution to research on the chemistry and utilization of hydrocarbon fuels. Special consideration is given to innovation and novelty in the use of fuels, characterization of fuels, and advances in fuel chemistry that benefit the public welfare or the environment. The award is the highest honor for research awarded by the ACS Fuel Chemistry Division.

Song was recently named a Distinguished Professor of Fuel Science by Penn State's Office of the President. He is also professor of Chemical E ngineering and associate director of the Penn State Institutes of Energy and the Environment. He received a bachelor's degree in chemical engineering in 1982 from Dalian University of Technology, China, and a master's degree in 1986 and Ph.D. in 1989 in applied chemistry from Osaka University, Japan. He worked at the Research Center of Osaka Gas Company in Japan prior to joining Penn State in November 1989.

Song is internationally recognized for his original and innovative contributions to his field. His early research at Penn State on catalytic coal liquefaction and the effects of drying on coal conversion at low temperatures led to a new method for preparing highly active dispersed catalysts using a water and sulfide precursor. Based on this discovery, further fundamental studies using probe molecules resulted in two patents licensed to industry for inventions related to nano-sized ultra-high-surface metal sulfide catalysts. From his efforts to make better use of coal-derived aromatics for value-added chemicals, he designed shape-selective alkylation catalysts for synthesis of precursors for advanced polymers and engineering materials from naphthalene, which have also been patented and licensed to industry.

He has made major contributions to the development of coal-based advanced thermally stable jet fuels through his work on fundamental chemistry concerning the effects of intrinsic fuel composition and structure on thermal degradation of jet fuels, and his work on model compounds studies related to stable bicyclic structures and hydroaromatics and their tailored production through catalysis. These developments were part of the large, 20 year, U.S. government-funded jet fuel project led by Harold Schobert at Penn State, which has been scaled up to pilot plant production.

For ultra-clean fuels and fuel cells, Song and his group devised an innovative approach to selective adsorption for removing sulfur from liquid hydrocarbon fuels over solid surface without using hydrogen. This approach has been licensed to industry as well and is already used for making prototype systems.

Song's group recently developed a novel approach to CO_2 capture by "molecular-basket sorbents" consisting of nanoporous matrix and functional polymers with superior capacity and selectivity. In addition, his group developed sulfur-tolerant and carbon-resistant bimetallic and trimetallic catalysts for low-temperature steam reforming of liquid fuels and non-pyrophoric catalysts for oxygen-assisted water gas shift. He recently proposed a new design concept of sulfur-tolerant noble metal catalysts for low-temperature hydrotreating and dearomatization for ultra clean fuels.

A Storch Award Symposium in Honor of Chunshan Song will be held at ACS Fall 2010 National Meeting in Boston during August 22-26, 2010.

2010 Wilson Awards

The College of Earth and Mineral Sciences held its 2010 Wilson Banquet & Awards Presentation April 11 to recognize student achievement, faculty mentoring, faculty commitments to service, and excellence in research and teaching.

Wilson Award for Excellence in Research

College of Earth and Mineral Sciences Dean William E. Easterling (left) with Chris Marone.

Chris Marone received the Wilson Award for Excellence in Research recognizing his "outstanding work in the area of rock mechanics as applied to earthquake and fault physics." Marone is a professor of Geosciences in the Department of Energy and Mineral Engineering.

Wilson Research Initiation Grant

From left: Dean William E. Easterling, dean, College of Earth and Mineral Sciences (EMS); Alan Scaroni, associate dean for graduate education and research, EMS; and Li Li.

Li Li, assistant professor in Energy and Mineral Engineering, received the Wilson Research Initiation Grant.

Wilson Award for Excellence in Teaching

College of Earth and Mineral Sciences Dean William E. Easterling (left) with Zuleima Karpyn.

Zuleima Karpyn received the Wilson Award for Excellence in Teaching for her "passion, commitment and enthusiasm for teaching." Karpyn is an assistant professor of Petroleum and Natural Gas Engineering in the Department of Energy and Mineral Engineering.

Department of Energy and Mineral Engineering Student Awards

Marathon Oil Corporation Scholarship
Michael B. Cronin

Frank and Lucy Rusinko Graduate Fellowship
Meredith A. Hill Bembenic
Gregory K. Lilik
Sarah A. Luchner

Robert and Leslie Griffin Award
Gregory K. Lilik

Charles B. Manula Memorial Scholarship
Douglas E. Middleton
Timothy A. Tomko

EME Graduate Scholarship
Arun Ram Mohan

National Fuels Fund Award
Sachin Rana

Charles B. Darrow Award
Kuen Yehliu

Amerikohl Scholarship
Danielle Petrucci

Marie J. and Joseph N. Hedding Scholarship
Douglass Middleton

Richard L. Naugle Trustee Scholarship in the College of Earth and Mineral Sciences
Timothy Tomko

PNGE Merit Award
Michael B. Cronin

Contracts & Grants

The EMS Energy Institute receives contracts and grants from various government agencies, industries and universities. Below is a sampling of the contracts awarded since April 2009.

Boehman, André
- Research in Thermal Oxidative Stability of Jet Fuel*; Industry*
- Characterization of Fuel Samples*; Industry*
- Fuel Ignition Study in Motored Engine Experiment*; University*

Burgess-Clifford, Caroline
- Coker Runs*, Industry*
- Coker Runs: Catalyst Runs III*; Industry*

Derek Elsworth
- Study on Sedimentary Basins in the U.S.*; Industry*
- Acquisition of a High-Temperature Load and Flow-Through System for Research and Teaching; *National Science Foundation (NSF)*
- Modeling CO_2 Sequestration in CBM Reservoirs; *Industry*
- Mechanical and Transport Characteristics of Coal-Biomass Mixtures; *Industry/U.S. Department of Energy (DOE)*
- Capturing Reservoir Stimulation, Evolution and Induced Seismicity; *DOE*

Eser, Semih
- Analysis of Tubes by Microscopy; *Industry*
- Characterization of Optical Texture and Oxidation Reactivity of Coke Samples, Fouling and Carbonization Tests on Resid Samples Using Microcokers; *Industry*
- Coking of Decant Oil in a PSU Pilot-Scale Delayed Coker and Analysis of Coke Samples to Compare with Results from a Commercial Unit*; Industry*

Fonseca, Dania
- Analysis of Phenolic Resin Binder Samples; *Industry*

Li, Li
- Modeling Processes Relevant to Microbially Enhanced Oil Recovery; *Lawrence Berkeley National Laboratory*

Lueking, Angela
- Hydrogen Caged in Carbon-Exploration of Novel Carbon-Hydrogen Interactions; *DOE*

Lvov, Serguei
- Evaluation of Alternate Thermochemcial Cycles; *Argonne National Laboratory*
- Corrosion Behavior of Carbon Steels in Supercritical CO_2 containing impurities; *Industry/DOE*

Marone, Chris
- Laboratory Study of Fault Healing and Frictional Properties; Role of Fluids; *NSF*

Ma, Xiaoliang
- Development of a Conceptional Process for Converting Light Olefins to JP-8; *Industry*

Mathews, Jonathan
- Modeling of Illinois Coal; *University*

Miller, Bruce G.
- Thermogravimetric Analysis Testing*; University*
- Evaluation of Biomass Feedstocks Through Stoker Combustion Tests*; Industry*
- Combustion and Emission Performance when Firing Coal/Biomass Blends*; Industry*

Morrison, Joel
- *West Penn Power Sustainable Energy Fund, Inc.*

Pisupati, Sarma
- Effect of Catalysts on Coal Combustion and Emission Performance; *Industry*
- Oxy Coal Combustion: Impact on Mineral Transformation, Ash Depositional Behavior and Heat Transfer; *Industry/DOE*

Ryan, Tim
- CT Scans of Coal and Sandstone Samples*; Industry*
- CT Scans of Carbonate Rock Samples*; Industry*
- CT Scans of a Cylindrical Battery Cell*; Industry*

Saffer, Demian
- Mechanics and Seismogenic Potential of Low Angle Normal Faults; *NSF*

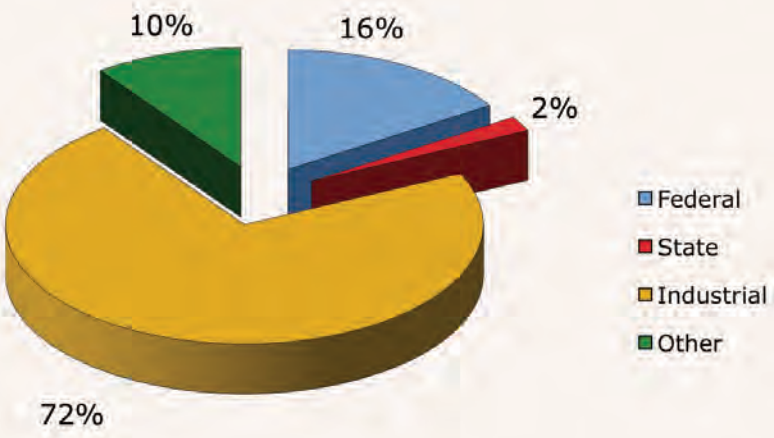
Song, Chunshan
- CO_2 Capture with NO_2/SO_2 Removal from Flue Gas Using Solid Molecular Basket Sorbents; *DOE*
- Naval Aviation Logistic Fuel Desulfurizer, Reformer, and Power System Phase II; *Industry*
- Person-Portable Oxidative Desulfurization System*; Industry*
- Improving Ni Catalyst for Steam Reforming; *Industry*

Vander Wal, Randy
- Soot Formation, Burnout & Evolving Soot Structure; *Oak Ridge National Laboratory*
- An Ultrasensitive, Size Resolved Mass Measurement Device*; Industry*
- Glow Discharge Analyzer for Spacecraft Monitoring; *Industry*

Awards & Funding

EMS Energy Institute Awards by Source

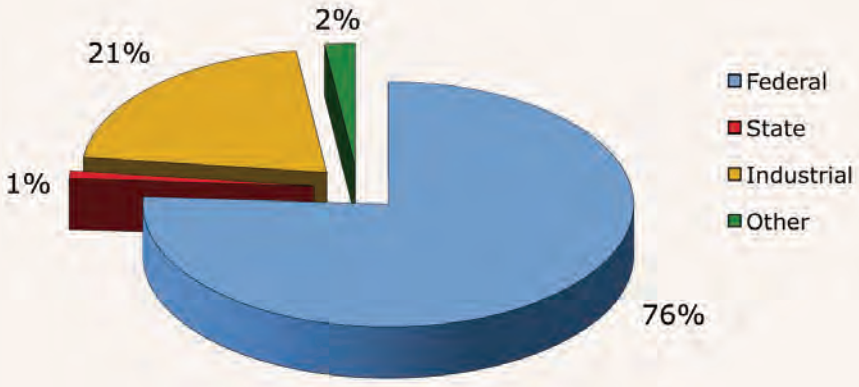
(fiscal year 2006 through 2009)



Total awards: 520

EMS Energy Institute Funding by Source

(fiscal year 2006 through 2009)



Total funding: $28.1 Million

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