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**Presented to the Joint Minerals, Business and Economic Development Interim Committee,
Joint Appropriations Interim Committee, and the
Joint Education Interim Committee**

September 2008

**UNIVERSITY OF WYOMING
SCHOOL OF ENERGY RESOURCES
Third Annual Report, 1 October 2008**
[Pursuant to W.S. 21-17-117(f)]

To the Joint Minerals, Business and Economic Development Interim Committee,
Joint Appropriations Interim Committee, and the
Joint Education Interim Committee

Submitted by: Mark A. Northam, Director, School of Energy Resources

INTRODUCTION

This document is the third annual report of growth and development of the School of Energy Resources (SER) at the University of Wyoming (UW). The Wyoming State Legislature provided authorization and funding for the SER in its 2006 session, through Senate File 37. W.S. 21-17-117(f) requires a report regarding all revenues to and all expenditures by the school during the preceding fiscal year, accomplishments of the school and its benefits to Wyoming's energy economy.

As outlined in the school's academic and fiscal plan, SER's objectives are to provide nationally-competitive undergraduate and graduate instruction in energy-related disciplines, to advance Wyoming's energy-related science, technology and economics research, and to support scientific and engineering outreach through dissemination of information to Wyoming's energy industries, companies, community colleges, and government agencies.

Initiatives developed by the School in FY2008 were under the leadership of SER's Energy Resources Council and guidance of SER Director, Dr. Mark A. Northam, and SER Associate Director, Professor K. J. Reddy.

UW Energy Resources Council

Ron Harper – Chairman	CEO and GM, Basin Electric
Rep. Tom Lockhart – Vice Chairman	Chairman, Minerals, Business, and Economic Development Committee
Harold Bergman (ex-officio)	Director Haub School and Ruckelshous Institute of Environment and Natural Resources
Thomas Buchanan (ex-officio)	President, University of Wyoming
Paul Lang	Sr. Vice President of Operations, Arch Coal Inc.
Keith O. Rattie	President, Chairman, and CEO, Questar Corp.
Bobby Shackouls	Retired President, Chairman, and CEO, Burlington Resources, Inc.
Thomas Stroock	Former US Ambassador to Guatemala; President, Alpha Development Corp.
Sen. Charles Townsend	Appropriations and Select Water Committee, Enhanced Oil Recovery Commission
Rob Wallace	Manager, Government Relations, GE Energy

This report summarizes progress made in the following areas and is consistent with the original plan for SER presented during consideration of the enabling legislation.

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1. DISTINGUISHED FACULTY SEARCHES

In 2006 the Wyoming State Legislature allocated 12 new positions for energy teaching and research to the University of Wyoming. Four searches were conducted in Academic Year 2007, one of which was successful. Dr. Felipe Pereira, formerly of the State University of Rio De Janeiro, accepted our offer and arrived on campus in January 2008 as the first SER Professor of Mathematics.

Based on proposals submitted by college deans and department heads, and on the prospects for building rapidly on existing faculty strengths at UW, Vice President for Academic Affairs Myron Allen authorized international searches for ten additional distinguished faculty members. Searches for these positions took place beginning in fall 2007 with vigorous efforts to recruit outstanding energy-related teachers and researchers from industry, academia and national laboratories. The searches were conducted by seven academic departments in the following areas:

Geology and Geophysics:	Reservoir characterization and rock physics
Geology and Geophysics:	Theoretical/computational seismology
Geology and Geophysics:	High temperature/pressure fluid-rock reactions
Chemistry:	Photoelectrochemistry/renewable resources
Mathematics:	Numerical modeling of reservoir fluid flows
Renewable Resources:	Arid lands reclamation ecology

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Chemical and Petroleum Engineering	Coal conversion technologies
Chemical and Petroleum Engineering:	Petroleum engineering/reservoir simulation
Mechanical Engineering:	Computation fluid dynamics – wind generation
Economics and Finance:	Energy markets and economics

These faculty searches were conducted with a slightly altered philosophy versus the previous year. All four of the searches conducted in the previous year specified that the candidates must be able to fill senior-level positions. This year, the rank was opened to mid- to senior-level positions in most cases, and open-rank in several. The basis of this change was a realization that competition for top-performers in energy-related disciplines is fierce, and that rank is not as important as the ability of candidates to develop innovative course content and to build a strong research effort.

Nine of the ten searches conducted were completed successfully. Each of the successful candidates is jointly appointed in SER and their home department. The following 10 individuals have joined UW as SER faculty members:

***Math:* Felipe Pereira – SER Professor of Mathematics**

Before joining the UW faculty in January 2008, Dr. Felipe Pereira was a professor of Computational and Applied Mathematics at the State University of Rio de Janeiro, where he has served as department chair and chair of the graduate program. In addition, he has served as a member of the Advisory Board of the Brazilian NSF. Since earning his PhD (SUNY-Stony Brook) in 1990, Dr. Pereira has worked on applications of mathematics to enhanced oil recovery, and specifically with collaborators across the world has investigated multiphase flow in multi-scale heterogeneous petroleum reservoirs using both high-resolution numerical simulations and mathematical analysis. Most recently he has worked on the development of models and numerical simulations for flow in fractured reservoirs.

Craig Douglas – SER Professor of Mathematics

Dr. Craig Douglas comes to UW from the University of Kentucky and Yale University. He holds an A.B. in mathematics from the University of Chicago and an M.S., M.Phil., and Ph.D. in computer science from Yale University. He has worked at IBM's Thomas J. Watson Research Center in Yorktown Heights, New York. His research interests include simulating contaminant transport, wild-land fires, combustion, and ocean circulation using dynamic data-driven techniques. He is best known for his work in multi-grid methods. He has run MGNet, a repository for information related to multi-grid, multilevel, multi-scale, aggregation, defect correction, and domain decomposition methods, since its inception in 1991.

***Geophysics:* Subhashis Mallick – SER Professor of Geophysics**

Dr. Subhashis Mallick has more than 20 years of experience in industry, and comes to UW from Chevron Energy Technology in Houston where he is a

Senior Research Scientist. He holds a Ph.D. in Geology and Geophysics from the University of Hawaii. He is a first-rate computational seismologist, with a strong record of developing new approaches to addressing high-profile problems of interest to industry, including reservoir characterization and 4D seismology. His research interests include time-lapse monitoring of petroleum and CO₂ sequestered reservoirs, development of new 3D pre-stack waveform inversion techniques, and seismic anisotropy and rock physics modeling. He will join the faculty as a full professor in August 2008.

Po Chen – SER Assistant Professor of Geophysics

Dr. Po Chen is a theoretical/computational seismologist without peer. He holds a Ph.D. in Seismology from the University of Southern California. His expertise is of impressive breadth, encompassing theoretical seismology and high-performance computing. His principal research interests involve Earth imaging at a variety of scales. He has developed computationally intensive new imaging techniques, including full 3D waveform tomography and 3D pre-stack depth migration. He has worked on earthquake rupture dynamics and seismic hazards and has a strong interest in focusing on energy-related issues, including 4D imaging of sequestered CO₂. He also will make an immediate and long-term impact at the new NCAR facility as an expert in high-performance computing and also will produce first-rate science with that facility. Dr. Chen joined the UW faculty in April 2008 as an assistant professor.

Geochemistry: John Kaszuba – SER Associate Professor of Geochemistry

Dr. John Kaszuba is currently a geochemist and principal investigator at the Los Alamos National Laboratory. He holds a Ph.D. in Geochemistry from the Colorado School of Mines. His research has established a high pressure/high temperature hydrothermal laboratory capable of evaluating multiphase fluid-rock reactions. Dr. Kaszuba's laboratory has produced seminal experimental papers regarding supercritical carbon dioxide reaction processes in brine aquifers, with implications for geologic sequestration of carbon. Current research focuses on integrated laboratory and computational approaches for multiphase fluid-rock interaction and evolution in crustal systems; contact metamorphism; quartz and carbonate veins and textures; redox equilibria in crustal-scale (deep) aquifers; and mass and energy transfer in the crust.

Chemistry: Bruce Parkinson – SER Professor of Chemistry

Dr. Bruce Parkinson is an internationally recognized photoelectrochemist who leads a research group at Colorado State University that investigates novel methods to harness solar energy. A professor at CSU since 1991, Parkinson was a research chemist for DuPont Central Research and Development from 1985-1991. Before that, he was a senior scientist at the Solar Energy Research Institute for four years. He received a B.S. degree (1972) in chemistry at Iowa State University, and earned a Ph.D. in chemistry (1977) at California Institute of Technology. He is the author of more than 140 publications in professional

journals, and holds four U.S. patents. With his expertise, Parkinson elevates UW to the international forefront of solar energy and photovoltaic research. He will leave his current position at CSU to join to become a full professor at UW in August.

***Chemical &
Petroleum
Engineering:***

Maohong Fan – SER Associate Professor of Chemical Engineering

Dr. Maohong Fan comes to UW from Georgia Institute of Technology. His current research interests include applications of nanostructured materials and combined nano-bio technologies in chemical and environmental engineering as well as energy production; identification and removal of contaminants in water and wastewater, and pollutants in air; development of green chemical manufacturing processes and environmental sensors; production and separation of chemicals from biorenewable resources; and characterization and utilization of waste materials. He fulfills editorial responsibilities for several international chemical and environmental engineering journals, has edited and/or authored 10 books, chapters and journals' special issues, and has published more than 70 journal papers.

Dr. Fan received his doctoral degrees from the Chinese Academy of Sciences in 1997, Iowa State University in 2000, and Osaka University in 2003. He has led and worked on many projects in the areas of energy production, its resultant environmental issues, and green chemical synthesis processes. His support has derived from various domestic and international scientific research entities such as the U.S. DOE and EPA, Research Institute of Innovative Technology for Earth/NEDO in Japan, UNDP, and Beijing Science and Technology Commission in China.

Guan Qin – SER Associate Professor of Petroleum Engineering

Dr. Guan Qin comes to UW from Texas A&M University where he has held the position of Assistant VP for Research and Director for Research at Institute for Scientific Computation (ISC) since 2004. At TAMU, his main focus has been on developing global research collaboration and industry outreach. Among other accomplishments, he has raised significant industry funding to support TAMU's China-US Relations Conference Series. Prior to joining TAMU, Dr. Qin had more than 12 years of industry research experience with Exxon Mobil, Mobil, and China National Petroleum Corporation. His research expertise includes the application of advanced scientific computing technology to reservoir modeling, numerical simulation, and basin modeling.

Dr. Qin earned a B.E. degree in Engineering Mechanics at Tsinghua University, and an M.E. degree in petroleum engineering at China Research Institute of Petroleum Exploration & Development (RIPED), both in Beijing, China. He earned his Ph.D. degree in Petroleum Engineering at the University of Wyoming in 1995.

Dr. Qin will join the faculty in January 2009.

Mechanical Engineering: **Name Withheld by request – SER Assistant Professor of Mechanical Engineering**

This position has been filled by a research scientist working in the area of Computational Fluid Dynamics (CFD) and Computational Structural Dynamics (SCD) including algorithm development for CFD, multi-disciplinary design and analysis, and infrastructure development for massively parallel computing. He has applied these computational tools to aircraft and rotorcraft design. He will bring his expertise in these areas to the field of wind energy to perform multi-physics simulations of wind turbines within the Wind Energy Research Center. We are withholding the announcement until next spring since he will not join UW until July 2009.

Economics & Finance: **Timothy Considine – SER Professor of Energy Economics**

Dr. Timothy Considine comes to UW from Penn State University where he is a Professor of Natural Resource Economics. His research on petroleum market analysis has been published in the top economic journals, and The Cato Institute recently published his paper exploring management policy issues facing the U.S Strategic Petroleum Reserve. In fact, the U.S. Department of Energy's Office of the Strategic Petroleum Reserve currently uses his econometric model of world crude oil markets to estimate the market impacts of various management policies.

During Dr. Considine's 26 years of professional experience, he has been awarded major professional honors including a Gilbert White Fellowship at Resources for the Future and a Lucent Technology Industrial Ecology Fellowship. Prior to joining Penn State in 1986, Dr. Considine worked as an Economist at Bank of America, and as the lead analyst for natural gas deregulation at the U.S Congressional Budget Office. He earned a B.A. with Honors in Economics from Loyola University of Chicago, an M.S. in Agricultural Economics from Purdue University and a Ph.D. in Natural Resource Economics from Cornell University.

The search for an Arid Lands Reclamation Ecologist resulted in an offer to a highly qualified international candidate. The candidate rejected our offer after receiving an outstanding counter offer from his current employer. This position will be re-advertised in the fall of 2008.

Finally, in keeping with the plan described in the previous annual report, SER approved two proposals to hire visiting faculty to augment development energy curriculum and research programs.

- Dr. Jim Douglas, Jr., the Compere and Marcella Loveless Distinguished Professor of Computational Mathematics at Purdue University, will join the UW Mathematics faculty for a period of 6 months starting in September 2008. Professor Douglas is recognized as one of the leading experts in applying computational methods to simulation of flows in porous media. He has over 217 published research papers on the numerical solution of partial differential equations, simulation of flows in porous media, attenuated waves, inverse and ill-posed problems.

Dr. Douglas earned a PhD at Rice University. A pioneer in oil reservoir simulation beginning in the early 1950s, he started his professional career with Humble Oil and Refining Company in Houston. He subsequently held academic posts at Rice and the University of Chicago before moving to Purdue.

- Dr. Alforgi Zaid, currently chairman of the Petroleum Engineering Department at the College of Technological Studies, Kuwait, will join the UW Petroleum Engineering faculty as soon as visa arrangements can be completed for a period of one year. Dr. Zaid earned his Ph.D. in petroleum engineering from UW in 1988. With nearly 20 years of international experience, both in industry and academics, Dr. Zaid will make a strong contribution to the rebuilding of UW's petroleum engineering degree program.

2. ACADEMIC INITIATIVES

The School of Energy Resources is committed to energy education that impacts the broadest possible student cross-section. This section describes academic initiatives for students ranging from high school sophomores to graduate students.

Several important academic, research, and outreach programs that were initiated in FY2006-07 were continued in FY2007-08, including:

- the allocation of competitively awarded Graduate Assistantships;
- the Energy Summer Institute for high school students, teachers, and counselors; and
- the Matching Grant Fund program to stimulate energy-related research at UW.

In addition, SER appointed an Associate Director for Academics and developed a proposal for a new Energy Resource Science Undergraduate Degree. Several critical questions concerning the ERS degree proposal remain to be answered, but much progress has been made. During the fall of 2008, discussions will be held with academic deans to seek their concurrence, to refine course selections, and to determine the administrative home for the degree.

a. Associate Director of Academics, SER

Professor Katta Jayaram (KJ) Reddy, Department of Renewable Resources was appointed to the half-time position of Associate Director of Academics in January 2008. In September 2008, Dr. Reddy's appointment was converted to three quarters-time.

Dr. Reddy is a 21-year veteran of the UW faculty, and was a founding member of the SER Academic Council. He has an outstanding academic and research (water quality and resource management, predominantly; 282 publications) reputation on campus. His credibility in both academic and research matters among the 7 colleges is outstanding.

Dr. Reddy has curriculum and degree program development and student advising as his top priorities for SER. He also leads the Academic Council and oversees the faculty searches, the Energy Summer Institute, and the Matching Grants Fund.

b. Academic Council

The *Academic Council* is charged with assisting the Director and Associate Director of Academics in operations of the School. It is intended to represent all facets of the energy teaching and research enterprise at UW. Broad participation across the University ensures the interdisciplinary nature of SER remains strong while faculty engagement across the university is as widespread as possible. In addition to utilizing the *Academic Council* for advice on a variety of important decisions, SER relies on the *Council* to be an advocate for SER programs while serving as an important conduit for delivering SER messages to the broader campus.

The make-up of the *Council* is broad both in the number of colleges represented and in the array of expertise in energy-related technologies:

- i) Geosciences related to the carbon-energy arena such as reservoir modeling and/or reservoir characterization for enhanced oil recovery, coal bed methane, tight gas, coal conversion, coal gasification, etc.
- ii) Renewable and/or alternative energy including basic energy research.
- iii) Environmental aspects of energy development including reclamation issues and CO₂ storage and capture.
- iv) The business of energy including permitting, economic analysis, and law.

The School of Energy Resources is also has substantial ongoing interaction with the Haub School of Environment and Natural Resources (ENR). The Director of ENR is an ex officio member of SER's Energy Resources Council, and is a member of the *Academic Council*, and the Director of SER is co-chairman of the Energy Working Group for the Ruckelshaus Institute. The Haub School has a tradition of active involvement in a variety of energy-related issues. In an effort to encourage policies and directions that advance both the mission of SER and ENR, it is important to have a stable connection to the School of Environment and Natural Resources.

The following membership profile for the *Academic Council*:

- i) Director of the SER – permanent.
- ii) SER Associate Director of Academics – permanent.
- iii) One member from ENR – selected by ENR.
- iv) Five faculty and/or academic professional representatives from colleges across the University. No more than two representatives come from any one college. SER faculty are potential candidates for these appointments.

Appointments are for a two-year period. This approach results in a well-defined rotating membership for the *Council*, thereby increasing exposure of the SER to UW faculty while providing fresh perspectives on the important issues of the day.

Academic Council appointments and their term expiration date are given below.

Mark Northam	Director, SER	Permanent
KJ Reddy	Assoc. Director Of Academics, SER	Permanent

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Harold Bergman	Director, Haub School of Environment and Natural Resources	May 2008
John Jackson	Chair, Department of Management and Marketing	May 2008
Frederico Furtado	Associate Professor, Department of Mathematics	May 2008
Carrick Eggleston	Professor, Department of Geology and Geophysics	May 2009
Morris Argyle	Assistant Professor, Department of Chemical Engineering	May 2009

Those members whose terms expired in May 2008 will have their terms renewed or will be replaced early in the fall of 2008.

c. Energy Summer Institute

A significant component of the academic enterprise of the School of Energy Resources is to develop strong and lasting links with Wyoming's K-12 teachers, counselors, and students. As part of our efforts to connect with Wyoming's youth, SER brought 16 high school sophomores (Class of 2011) and 6 middle school and high school teachers/counselors to UW for our second annual SER Energy Summer Institute. The Institute is designed to provide participants with a superb exposure to the challenging energy problems facing the world—and the exciting solutions on the horizon. In addition to the relevant programmatic content, the Institute also affords the youth of our state a terrific opportunity for exposure to higher education and all that UW has to offer.

The 2008 Energy Summer Institute consisted of three courses:

- *Powering the Future with Renewable Wind Energy.* This class reviewed the broad global energy picture, looked at renewable energy pathways, and focused on wind energy. Participants constructed a Savonius wind turbine and had the opportunity to test its performance in a wind tunnel. Finally, the students visited the wind farm at Arlington, Wyoming. (Taught by Scott Morton, Research Scientist, Department of Mechanical Engineering)
- *Energy-Efficient Architecture.* This class focused on energy use in buildings and how architectural design can produce buildings that use less. It included several field trips to visit examples of innovative energy-efficient design in the Laramie area. (Taught by Anthony Denzer, Assistant Professor, Department of Civil and Architectural Engineering)
- *All Things Geo.* This class was an introduction to global position systems, geographic information systems, and remote sensing technologies. Several field exercises were

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completed. *(Taught by Steven Prager, Assistant Professor, Department of Geography, and Ken Driese, Remote Sensing Scientist, Wyoming Geographic Information Science Center)*

An added feature this year, Dr. Joseph Stepan, Professor Emeritus of Secondary Education, UW College of Education presented a workshop for the teachers on how to incorporate math and science concepts in the classroom.

SER worked hard to promote the Energy Summer Institute across the state early this year. Informational brochures for students, teachers, and counselors were mailed to all K-12 middle schools, junior high schools, and high schools. A first-hand look at this information is viewable at http://www.uwyo.edu/energy_institute.

d. Graduate Assistantship (GA) Allocations

Essential to UW's research enterprise are the talented graduate students that work with the faculty. Graduate students across the University are generally supported through Graduate Assistantships which pay their tuition and fees as well as a modest stipend. GAs may be funded through a limited state pool or through external research support. A GA is one of the most prized resources for any UW faculty member engaged in research activity.

In March 2007, the School of Energy Resources released a call for proposals for 16 GAs to be distributed across the campus. The complete solicitation is provided in Appendix A of this report. The intent of the GA solicitation was to support a broad range of SER activities that enhanced the academic and research mission of the School. Four areas of interest were emphasized in this call for proposals including:

- i) Interdisciplinary research programs,
- ii) Modification of existing courses to increase energy-related content,
- iii) Development of new courses in critical and emerging technology areas, and
- iv) Basic and applied energy research.

The SER received 48 GA proposals (for 16 available GAs) spanning four colleges and the Haub School of Environment and Natural Resources. Proposals were evaluated by SER's Academic Council described earlier in this report. The competition was intense and resource constraints prevented us from funding several proposals of significant merit. A listing of faculty receiving GA awards and their proposal titles is provided in Table 1. Note that one of the GAs is not listed because of failure to recruit a qualified student.

The initial GAs that were awarded run through the spring 2009 semester, and no additional GAs were awarded through this mechanism during FY2007-08. SER plans to offer a new solicitation of proposals in January 2009. During the fall of 2008, the Academic Council will review the appropriate amount of the award based on increased tuition and fees and size of the stipend to remain competitive. Once the amount of the award is adjusted, the number of GAs to be offered will be determined.

Table 1. Fall 2007-Spring 2009 SER/GA Awards

Student	Faculty Advisor	Dept	Title
Amanda Moyer	Carrick Eggleston	Geology & Geophysics	Synthesis of Hematite and Albandite Photocatalytic Films for a Tandem Fuel Cell
Genevieve Mathers	Paul Heller	Geology & Geophysics	A Study of Shapes, Scales, and Spacings of Channel-Belt Sand Bodies in Avulsion-Dominated Fluvial Reservoirs
Michael Stoellinger	Stefan Heinz	Mathematics	A New Concept for the Gasification of Wyoming Coal
Meghan Morrissey	Harold Bergman	Haub School of Environment & Natural Resources	New Course: Applied Environment and Natural Resources Law for Non Lawyers
William Schaffers	David Bell	Chemical & Petroleum Engineering	Wyoming Coal Gasification Economics and Process Technology
Hee Joon Park	Patrick Johnson	Chemical & Petroleum Engineering	Enzyme Nanoparticle Synthesis and Characterization for Biofuel Cells and Cellulose Hydrolysis
Behrooz Raesi	Mohammad Piri	Chemical & Petroleum Engineering	Multiphase Flow in Fractured Reservoirs
Jared Strube	Paul Dellenback	Mechanical Engineering	Modeling Gas Turbine and Thermodynamic Cycle Performance for a Novel IGCC Plant
Min-Hyung Ryu	Mark Gomelsky	Molecular Biology	Sustainable Photosynthetic H ₂ Production: Genetics and Selection of Purple Non-sulfur Bacteria for Optimized H ₂ Production
Jianqiang Huo	B. Patrick Sullivan	Chemistry	Novel Transition Metal Excited States for Solar Energy Conversion
Tomasz Dziejcz	Dan Buttry	Chemistry	Nanoscale Material for Fuel Cells and Advanced Ener4gy Storage
Brian Enchelmeyer	Charles Mason	Economics & Finance	Economic Co-Optimization of Enhanced Oil Recovery and Carbon Sequestration
Zaixing Huang	Michael Urynowicz	Civil & Architectural Engineering	Liquid and Gas Transport in Sub-Bituminous Coals: The Effects of Bubble Nucleation, Growth, and Competitive Adsorption/Desorption
Yiping Liu	David Bagley	Civil & Architectural Engineering	Sustained Biogenic Production of Coal-Bed Methane: Microbial Production of Hydrogen and Acetate
Milton Geiger	Roger Coupal	Agricultural & Applied Economics	Sustainable Energy Futures

One of the requirements of each recipient of an SER GA is to deliver an annual report of work completed in the past year. In addition to the written reports received from each student, twelve of the students also presented their work in either an oral or a poster presentation at the annual Graduate Student Symposium held on April 2, 2008. The flyer for the symposium contained in Appendix A. Written reports are available from SER upon request.

e. Course Modification/Development Providing an Energy Emphasis

The University of Wyoming already offers a significant array of energy-related courses at the undergraduate and graduate levels. One of the purposes of SER is to look for synergistic opportunities that may be available through modification of existing courses and to encourage the development of new courses to address pressing scientific, business, or energy-related policy issues.

This past year, SER has supported the development of two new courses through the GA allocation outlined previously. These courses address the following:

- Applied Environmental Law for Non-Lawyers
- Sustainable Energy Futures

In addition to the above courses to be developed with GA assistance, the SER identified and supported three opportunities for course modification/development designed to increase student awareness of critical energy issues while further elevating SER's academic profile across the campus.

Engineering Science 1060:ES 1060 (Introduction to Engineering Computing) is the first exposure to engineering for students in the College of Engineering. The course introduces students to computing tools for data presentation graphics, equation solving, and manipulation of tabular data. The present course suffers from a lack of focus on specific problems, thereby making it difficult to motivate students to continue their pursuit of an engineering career.

In 2006-07 there was interest in the College of Engineering to reorganize ES 1060 to give it a thematic base that can provide students with a solid motivation to learn the subject content. Establishment of the SER and the strong focus on energy throughout the University makes energy an ideal theme for the course. The SER agreed to provide support to modify ES 1060 to introduce engineering students to the broad spectrum of technical, social, and policy issues associated with energy while maintaining the original objectives of the course. Although the modifications got a slow start, work is now underway to achieve the desired update.

Engineering College Senior Comprehensive Design Experience: Disappearing Roads-Environmentally Friendly Access To Oil And Gas Resources: UW professor and H.T. Person Chair, Charles W. Dolan, teaches an annual engineering college senior design course. The all-college multidisciplinary course for 2007-08 was built on the Texas A&M "Disappearing Roads" competition that explores new and innovative technology to reduce the environmental footprint of energy development in sensitive areas. While the Texas A&M competition is titled "Disappearing Roads," the work can range from simple improvement in road design to total system analysis and redesign of how energy is extracted. Air and water resources, wildlife considerations, and economics are all critical factors to be considered in any proposed design. Because the designs have to be sensitive to the environmental impacts of extraction, students in the Haub School of Environment and Natural Resources are also encouraged to enroll in the course.

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Professor Dolan led a class of approximately 20 students to examine the design of the next generation of oil and gas in desert conditions. The class used the Jonah Field and the new Atlantic Ridge site for case studies.

The myriad of technical, societal, and environmental problems to be resolved provides students with terrific exposure to the energy-related problems at the heart of our great state. The School of Energy Resources is provided support for the course by funding travel of students and faculty to the Jonah Field in the fall of 2007.

The competition culminated in presentations in the spring of 2008. One of the presentation teams from Dr. Dolan's class bested teams from 11 other universities to win the competition. These five individuals developed a layered mat, roll-out road system and a modular frame design for temporary roads and drilling pads. A press release providing details of the presentation can be found in Appendix A.

GEOL3650: Energy: A Geological Perspective: GEOL 3650 provides students with the skills to formulate successfully informed and reasoned responses to questions about energy exploration, exploitation and use they will face as citizens of an industrialized democracy. To accomplish this, the course:

- Introduces students to the techniques necessary for evaluating the geological aspects of energy resources;
- Assesses energy questions economically,
- Assesses the social impacts of energy extraction and use, and
- Builds an awareness of comparative decision-making processes from the local to the international level.

Students are exposed to all of the above through actual case studies that span the globe. As with all real world issues, there are no clear-cut answers to the policy decisions that must be made in each case study. Rather, students must take and defend a position using the geologic, scientific and technical knowledge they have learned and the literacy skills they have mastered.

The case studies for this course were originally developed over a three year period with funding from the Fund for the Improvement of Secondary Education (FIPSE) to the Ellbogen Center for Teaching and Learning. The School of Energy Resources provided support over a two year period to expand the number of available case studies for the course. The goal was to have a library of available case studies ranging from the state level (e.g., coal bed natural gas production) to the international level with local consequences, e.g., expanded coal use in China and the issue of CO₂ emissions; nuclear power (and weapons) in Iran, etc. E

f. Chemistry Research Experiences for Undergraduates (REU) Program

In the fall of 2006, the Department of Chemistry submitted a proposal to the National Science Foundation to make UW a Research Experience for Undergraduates (REU) site for: "*Chemistry Research Related to Energy Science.*" The proposal outlined a program to bring 10 undergraduate students from neighboring colleges to UW for each of the next three summers to work on outstanding problems related to energy science and energy resource development. Educational activities include hands-on research on projects related to the development of clean

and renewable energy sources, energy-related field trips, and scientific seminars and discussions of the chemistry research needed for a sustainable energy plan for the nation.

REU awards are highly competitive nationwide. Although the National Science Foundation declined funding for the Chemistry REU, the School of Energy Resources partnered with the Chemistry Department by committing to fund five undergraduates in the program for the summer of 2007 and again in 2008. The Chemistry Department was able to support a total of 5 students from UW for the REU summer 2008 program. The Chemistry Department used this program as a powerful primer for another proposal to the NSF/REU program in 2008.

g. Curriculum Development

Arguably the most important mission in the academic enterprise of the School of Energy Resources is the development of outstanding curricular programs for students interested in a career in energy. These programs will not only serve our students, they will form a cornerstone for Wyoming's future energy workforce.

Widespread curriculum discussion among faculty, department heads, and senior administrators has occurred during the past year. While undergraduate and graduate programs must be developed, our original efforts are focused on developing a strong interdisciplinary undergraduate program. The result of these efforts is a proposed undergraduate degree program tentatively name Energy Resource Sciences (ERS). It is proposed to place the ERS program under the umbrella of UW's relatively new Earth Systems Science program.

Details of the ERS degree program can be found in Appendix B. This goal of the ERS degree is to offer a diverse curriculum that combines engineering, science, business, law, and natural resources content to build a fundamental understanding of interaction and tradeoffs between energy, environment, policy and the economy. As currently proposed, the curriculum is composed largely of existing courses from Geology and Geophysics, Engineering, Economics, and Environment and Natural Resources in addition to the normal University Studies Program requirements. Over time, newly developed interdisciplinary courses designed specifically for this degree program will be substituted.

The ERS degree will also be marked by a major capstone experience in the senior year. The capstone experience will involve a senior project/thesis that will focus on bringing students together in teams from all different discipline areas to work on an energy problem of importance to the state. SER will attempt to engage state and federal agencies, state government, the state legislature, and private industry to form a meaningful experience that transcends all areas of the SER curriculum.

Next steps for vetting and establishing the ERS degree program include:

- In-depth discussion with the academic deans to seek concurrence
- Conduct a survey of energy stakeholders and potential employers to gauge their interest
- Incorporation of the deans' and survey feedback into a final proposal

3. RESEARCH INITIATIVES

a. Matching Grant Fund

UW faculty and academic professionals are typically engaged in research as part of their job assignments, with the expectation that state-of-the-art research helps maintain professional currency in rapidly changing fields. A successful research program often requires significant external funds – in the form of grants and contracts from federal agencies or corporations – to meet the research objectives. These funds may be used for, among other things, support of undergraduate and graduate students, purchase of critical equipment, and summer salary for the PI.

The national landscape for funding is highly competitive. For instance, proposals to national agencies such as DOE or NSF may have success rates of 20-30 percent – sometimes less. As a result, review panels are forced to choose among many excellent proposals and subtle differences, such as an institution's commitment to help support the research, may dictate any proposal's fate. The SER Matching Grant Fund (MGF) program is intended to provide significant additional leverage to already strong UW proposals, thereby improving the chances of acquiring external funding.

A request for proposals (RFP) to the FY 2007 MGF was issued campus-wide on 31 October 2006. SER committed funds to 17 proposals totaling \$810,200, contingent on the investigators receiving the matching external award. Proposals covered the entire spectrum of energy research and development. A cursory overview of SER funded topics includes:

- Clean coal research
- Geology of fluvial channels for oil field prospects
- Solar energy: Molecular-based photoelectrochemical cells (artificial photosynthesis)
- Enhanced oil recovery—reservoir modeling
- Wyoming oilseed crops for biodiesel production
- Improved nuclear reactor core simulations
- Aerodynamic control of wind turbines
- Coal bed methane co-produced water issues
- Hydrogen production from coal

Funding agencies for the above topics have also been very diverse and include:

- Department of Energy
- American Chemical Society – Petroleum Research Fund
- North Central Sun Grants
- Private Industry
- Idaho National laboratory

All the funding requests for FY2007 MGF have been resolved. Nine of the 17 proposals were funded for a total of \$479 thousand in funds that matched \$1.17 million in outside funding for a

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total of \$1.65 million in research funding. A table of successful projects can be found in Appendix C.

A second RFP was issued campus-wide for the FY2008 MGF on 31 October 2007. The complete RFP is provided in Appendix C. A total of \$1 million was available for the FY2008 MGF. A total of 56 proposals were submitted for consideration. Of those, 32 were approved for a total commitment of \$1.83 million. A cursory overview of research topics approved by SER for FY2008 includes:

- Clean coal research
- Flow through porous media
- CO₂ sequestration in deep aquifers
- Biological degradation of organic waste for fuel cell development
- Impact of foreign policy on energy security in the USA
- Production and sustainability of biofuels in Wyoming
- Ground water monitoring and management
- Arid lands reclamation – soils, microbes, and vegetation
- Solar energy: photoelectrochemical- and organic-based cells
- Chemical reactivity of novel catalysts
- Aerodynamics and control of wind turbines
- Oil and gas production and recovery
- Impact of energy development on habitat and migration of wildlife species.

Once again, funding agencies for the above topics have also been very diverse and include:

- Department of Energy
- American Chemical Society – Petroleum Research Fund
- National Science Foundation
- Institute for Global Environmental Strategies
- Bureau of Land management
- Center for Revolutionary Solar Photo-Conversion

As of July 1, six of the 32 proposals approved by SER have been funded. A total of \$215 thousand in FY2008 MGF funds have matched \$726 thousand in outside funds. Outside funding for ten of the proposals (\$582 thousand in FY2008 funds) has been denied, leaving 16 proposals (\$1.04 million in FY2008 funds) unresolved. A table of approved projects can be found in Appendix C.

With two years of experience in administering the MGF, it appears that the original intent – providing significant additional leverage to already strong UW proposals – is being fulfilled. To date, state funds are being leveraged at a rate of 3-to-1. SER intends to issue a third RFP for the FY2009 MGF in September, and we expect to receive a steady stream of funding requests as faculty interest in the program runs high. The MGF program continues to provide substantial tangible benefits to UW researchers while significantly elevating the overall campus awareness of the School.

b. Development of Research Centers

The School of Energy Resources (SER) includes three units: academic programs, overseen by the Associate Director of Academics; the Institute for Energy Research, composed of externally funded research centers; and the Center for Energy Outreach, providing energy-related information, workshops and technical consulting.

The research centers in Institute for Energy Research are interdisciplinary groups of faculty and graduate student researchers organized to solve particular research problems. Accordingly, these centers are expected to evolve with time. New groups may form to work on emerging energy-related problems, and some existing groups may disband as their project is completed. The centers that have been organized include:

1. Enhanced Oil Recovery Institute (EORI), Prof. J.R. Steidtmann, Director.

The EORI has funding from the Wyoming State Legislature and partners with Wyoming energy producers to perform the following functions:

- Assist Wyoming operators with their EOR projects by applying existing technologies and creating new knowledge when necessary
- Maximize the economic potential and minimize the risk of EOR projects
- Facilitate the testing, evaluation, and documentation of EOR recommendations in the real world settings
- Transfer the information to Wyoming producers by forming partnerships and conducting workshops and conferences
- Develop technologies for capturing CO₂ from flue gases

EORI/UW scientists and engineers from various disciplines work with oil producers to study the issues of maximizing oil production.

2. Coal Bed Natural Gas Center.

Wyoming's coal bed natural gas is an important clean fuel source. This research center has 2 focuses. First, 9 faculty from three different colleges are engaged in a DOE-funded project on how to cost-effectively extract natural gas while minimizing environmental impacts including co-produced water treatment and management. This group presented their first-year results at the American Society of Mining and Reclamation national meeting in June 2007, and plans to present their final results at a conference in fall of 2008 to be held jointly with the Ruckelshaus Institute of Environment and Natural Resources.

Second, a group of faculty from Civil and Architectural Engineering, Chemistry, and the Western Research Institute are working on stimulating additional natural gas production through sustainable biogenic production of coal bed natural gas.

3. Renewable Energy Resources Center.

Faculty from the colleges of Arts and Sciences and from Engineering are conducting fundamental research in energy nanoscience, in particular solar cells, fuel cells and energy

storage. Development of solar fuels may be an important way to supplement fossil fuel energy production, and is a research area where UW and SER could be national leaders. Initial work in this group will:

- Develop and characterize nanocrystalline semiconductor films, and functionalize them with dyes/catalysts for photocatalytic solar fuels generation and possibly for photovoltaic applications.
- Synthesize and characterize nanoparticulate metal oxides as energy storage media.
- Construct a prototype microbial fuel cell based on existing expertise with the metal-reducing species *Shewanella oneidensis* MR-1 and *Geobacter sulfurreducens*.
- Quantify protein adsorption and catalytic activity on semiconductor electrode surfaces as part of a functioning biofuel cell.
- Construct a microfluidic cell capable of utilizing formate (such as from a solar photocatalytic cell) in the production of electrical current.

Groups working on other aspects of renewable energy research may be organized in the future.

4. Arid Lands Restoration Ecology (Wyoming Reclamation and Restoration Center).

Many energy-related activities involve disturbance of the land surface, including mining, oil and gas development, pipelines and power transmission lines. UW has had an active reclamation and restoration program for many years; much of their research has been supported by the Abandoned Mine Lands Research Program. This group is developing a project to demonstrate their abilities in restoration ecology related to surface impacts of natural gas in the upper Green River Basin of Wyoming.

Discussions with the Bureau of Land Management in Wyoming and the Department of Environmental Quality, among others, are ongoing. The proposal is expected to be finalized in late 2008.

5. Clean Coal Technologies Center.

Wyoming coal is one of the major sources of fuel for generation of our nation's electricity; it also may be processed to provide synthetic gases, gasoline, diesel, petrochemicals and other hydrocarbons such as alcohols, and even hydrogen fuels. As global competition for supplies of foreign-produced petroleum intensifies, fuels derived from conversion of coal may become increasingly important to US energy security.

At the same time, concern over the carbon emissions from combustion of fossil fuels is growing. Coal has the highest carbon content among the fossil fuels, so there is pressure from some groups to reduce our reliance on coal. In order to enable reliance on coal to continue and, indeed, grow, new technologies that convert coal to cleaner and more flexible fuels need to be developed.

The Clean Coal Technologies Research Center is intended to conduct research that will lead to development of those technologies. Existing expertise at UW and the Western Research Institute is significant. The hire in 2008 of SER Associate Professor of Chemical Engineering, Maohong Fan (see Distinguished Faculty Search, above), will add new expertise to the pool. SER and the College of Engineering and Applied Sciences are also exploring establishment of international collaborations that will significantly increase the breadth of our expertise.

The partnership between the State of Wyoming (through UW) and GE to build the High Plains Gasification Advanced Technology Center will provide incentive and a platform to continue to build our coal conversion and clean fuels efforts. The School of Energy Resources will continue to develop a strong research center to advance coal conversion technologies, particularly those that are optimized for Wyoming's low sulfur, sub-bituminous coal and for Wyoming's relatively high elevation.

6. Research Center for Fundamentals of Subsurface Flow.

The mission of this center is to fill the knowledge gaps in the current state-of-the-art experimentation and modeling of multiphase flow in porous media to ensure present and future access to subsurface energy resources and carbon storage resources. The Wyoming and national energy matrix is comprised of a significant component of fossil fuels (hydrocarbons and coal). Optimum access to hydrocarbon energy resources from conventional oil and gas reservoirs, coal seams (coal bed methane), low permeability (tight) gas reservoirs and oil shale relies on deep understanding of complex multiphase and multi-component transport phenomena in porous media. Although state-of-the-art Enhanced Oil Recovery (EOR) techniques have many viable applications in Wyoming oil and gas reservoirs, limited success in the application of EOR schemes to subsurface hydrocarbon resources is often due to incomplete understanding of transport phenomena in porous media. Progress in this area would lead to sound design of reservoir exploitation plans and reduction in uncertainties associated with these attempts.

Reduction of carbon dioxide emissions in the US and globally is also an increasingly high priority issue. Developments of carbon capture and storage technologies, and demonstration of their feasibility, are high priorities on the national agenda. The same deep understanding of complex multiphase and multi-component transport phenomena in porous media must be developed to ensure our reactive transport models for carbon dioxide injection provide the best possible predictions of the fate of the carbon.

This research center will be at the forefront of porous media transport phenomena experimentation and modeling, with a unique ability to bridge between fundamentals of multiphase flow in porous media and applications in subsurface hydrocarbon resource production and geological storage of CO₂. Several of the recent SER faculty hires will work with other faculty to progress this work. When the NCAR supercomputer to be built in Cheyenne in partnership with the state is available, this research should be able to take great strides in advancing our knowledge in this important area.

7. Wind Energy Research Center.

Wyoming has a world class wind energy resource base that is largely underdeveloped. Although wind is a clean source of electrical power, much work needs to be done to optimize its conversion and its impact on the grid. Faculty members in Electrical Engineering, Mechanical Engineering, Atmospheric Science and Mathematics have identified key aspects of wind energy research and development that UW researchers are well-poised to pursue. The wind energy research group aims to establish the pre-eminent wind energy laboratory for theoretically, computationally, and experimentally addressing the primary issues that require further understanding to significantly improve wind turbine performance over their current levels. They

have an ongoing effort to model the wind inflow to these turbines, a collaborative effort between researchers with expertise in turbulence, geophysical flows, and large-scale weather forecasting.

A generous grant of \$2 million for BP will provide the financial base for furthering this research. Funding from additional sources may be sought to build a state-of-the-art research facility. SER's offer made to fill the position of SER Assistant Professor of Mechanical Engineering will add critical computational fluid dynamics expertise to advance this research.

8. Carbon Management Research Center

SER established this research center in 2008 in preparation for the increase activity in carbon capture and storage (CCS) in the state and the nation. CCS is poised to become a necessary aspect of fossil-fuel use, especially coal use, and is thus becoming an area of paramount interest to the state of Wyoming. CO₂ injection is also an important part of enhanced oil recovery in the state. It is crucial to have technical expertise at UW to monitor and assess the state of CO₂ at the surface and in the subsurface as well as to predict its movements and chemical behavior over time. Carbon capture on the surface is particularly important to coal-fired plants as they manage the exhaust produced during combustion. Storage of the CO₂ below the Earth's surface essentially in perpetuity will be required to ensure that it stays out of the atmosphere.

UW is the recipient of a \$1.7 million grant from the Department of Energy to begin work on building our understanding of the geology of suitable storage sites, the movement and reactivity of the CO₂ in the subsurface, and methods and techniques that will be required to monitor and verify carbon storage. This project currently is being run out of the Office of Research and Economic Development, but if renewed in future years will be administered by SER. It is composed of 10 tasks that will involve work by a large number of faculty and students in the colleges of Arts and Sciences, and Engineering as well as the Wyoming Geologic Survey. The proposal, as approved by DOE is contained in Appendix C.

UW's and the Wyoming Geologic Survey's involvement in two of the DOE's regional carbon sequestration demonstration partnerships, the Big Sky Partnership and the Southwest Regional Partnership is anticipated to grow substantially. That involvement, as it becomes a reality, will also be overseen by the Carbon Management Center

“Seed” research grants for developing SER research centers

In 2007 and 2008, the School of Energy Resources granted several small ‘seed money’ grants to interdisciplinary groups of researchers who were working to develop SER research centers. The groups receiving this support are:

Sustained Biogenic Production of Coal-Bed Methane SER Coal Bed Natural Gas Center	\$109,800
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Energy Nanoscience: solar cells, fuel cells, and energy storage SER Renewable Energy Resources Center	\$71,000
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Energy Development Mitigation in upper Green River Basin, Wyoming

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SER Arid Lands Restoration Ecology Center	\$50,000
Wind Inflow Modeling and Turbine and Blade Design and Controls SER Wind Energy Research Center	\$104,104
Wyoming Reclamation and Assessment Program SER Wyoming Reclamation and Restoration Center	\$60,000

These grants have been provided to allow research and organizational activities to commence at startup of the research centers. The intent is that the center will use the funds to do the necessary work to prepare for application for outside funding. The centers all seek to provide ongoing support from capture of outside funds.

c. Clean Coal Technologies Fund

Original House Bill No. 301, Enrolled Act No. 121, enacted by the Legislature of the State of Wyoming during the 2007 General Session created a Clean Coal Research Account. The legislature appropriated \$2.5 million dollars to this account to fund the Clean Coal Technologies Research Program. The purpose of this program is to stimulate research to enhance and improve clean coal technologies, with an emphasis on use of sub-bituminous coal at high altitudes. The legislation also created the Clean Coal Task Force (CCTF), composed of the members of the Wyoming Energy Resources Council to the University of Wyoming School Of Energy Resources. The task force was charged with soliciting research proposals for research into clean coal technologies.

The School of Energy Resources issued a request for proposals for the Clean Coal Technologies Research Program on May 15, 2007. Areas of research eligible for consideration include:

- Pre-combustion/pre-gasification technologies
- Combustion and gasification design technologies
- Post-combustion/post-gasification gas clean-up technologies
- Advanced cycle technologies
- Air separation technologies
- Carbon capture and sequestration technologies
- In situ gasification technologies
- Coal to liquids/coal to hydrogen technologies
- Economic analysis

Proposals were solicited from academic institutions and private industry. The program requires a dollar-for-dollar match from non-state funds. Ten proposals were received, including three from universities, four from research institutes and three from industry. After competitive evaluation, four of the proposals were endorsed for funding. Funds for the successful proposals in the amount of \$1.8 million were approved for transfer by the Legislature in March 2008. All four projects are currently underway. Approximately \$670 thousand in funds from the 2007 legislation remain.

The Call for Proposals and the list of successful proposals can be found in Appendix C.

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Section 320 of the Legislature of the State of Wyoming's 2008 budget bill authorizes the DEQ to submit grant application to the federal government for AML funds for specified purposes. One project secured \$3.8 million for clean coal research to be expended pursuant to Section 2(f) of Original House Bill No. 301, Enrolled Act No. 121, to be added to the Clean Coal Research Account. Section 325 of the 2008 budget bill actually creates Section 2(f) by amending the 2007 legislation. Unlike the \$2.5 million appropriation in 2007, the CCTF is authorized to expend the \$3.8 million once the recommended projects are submitted to the Joint Minerals, Business and Economic Development Interim Committee for review.

The 2008 legislation also provides for funding additional research projects from the original \$2.5 million that was not committed in the first round. Those dollars will have to be appropriated by the 2009 or subsequent legislature to fund projects recommended by the CCTF. The \$670 thousand is subject to the same process that occurred for the \$1.8 million.

Finally, the 2008 legislation extended the deadline for expenditure for all of the funds to June 30, 2010.

The School of Energy Resources issued a second request for proposals for the Clean Coal Technologies Research Program on April 25, 2008. This RFP utilized essentially the same language as the original. Areas of research eligible for consideration also remained the same as in the previous RFP. The deadline for submission of proposals was August 1st. Eight proposals were received and have been reviewed. Endorsements are pending review by the CCTF.

4. OUTREACH INITIATIVES

a. Finding the Balance: Climate and Energy

SER, the Enhanced Oil Recovery Institute (EORI), and the School of Environment and Natural Resources (ENR) co-sponsored a summit entitled "Finding the Balance: Energy and Climate" that was held in Teton Village 8-10 October 2007. Speakers included Governor Freudenthal, Lord Ron Oxburgh, UW President Buchanan, Dr. Stephen Schneider, Dr. Geoff Heal, Dr. Michael Economides, Greg Boyce, Ralph Cavanagh, David Siever, Kipp Coddington and others. The agenda and several press releases can be found in Appendix D.

This summit was offered to inform Wyoming stakeholders about how growing concerns over the impact of anthropogenic greenhouse gas emissions will create challenges and opportunities in the future. Text from the presentations and information about how to order a DVD recording of the proceedings can be found on a website at the following link:

<http://www.uwyo.edu/findingthebalance/>.

b. Colloquium Speaker Series

The School of Energy Resources sponsored one public lecture on the future of energy and what it may mean for Wyoming. Professor Michael Celia, the 2008 Henry Darcy Distinguished Lecturer for the National Groundwater Association and chair of the Department of Civil and

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Environmental Engineering at Princeton University, delivered a lecture entitled “Geological Storage as a Carbon Mitigation Option”.

Dr. Celia treated broad questions about the fate of injected CO₂, including possible leakage of CO₂ out of the formation, as well as the fate of displaced fluids like resident brines, that lead to challenging modeling and analysis problems. His lecture was well-attended and timely as many of the questions he addressed are key topics of our own carbon storage research program.

c. SER Sponsorship of the Wyoming Conservation Corps

In 2006 the Wyoming Conservation Corps was organized by UW student Nick Agopian. The program is affiliated with Wyoming and provides students with opportunities to obtain experience and skills in natural resource and environmental career fields through projects focusing on improving Wyoming’s public lands. For FY2008, SER provided \$16,000 to cover student tuition and support for energy related projects in Wyoming. Four teams of 8 (6 students and 2 student supervisors) put in nearly 20,000 service hours on three main energy projects, working with Devon Energy, EnCana, and the BLM on a variety of tasks.

The final report prepared by Nick Agopian for this summer season is presented in Appendix D.

d. SER participation in conferences, exhibitions and trade fairs

As part of its outreach effort, SER participated in a number of conferences, exhibitions and trade fairs in 2007-2008. These include:

- CQ Summit: The Energy Challenges and Your Community; 27 July, Cheyenne. Dr. Mark Northam was an invited panelist.
- Finding the Balance: Climate and Energy; 8-10 October, Teton Village. Co-sponsored with EORI and ENR. Dr. Mark Northam was an invited panelist. UW administration and staff were well represented at this conference.
- 2007 Senior Executive Energy Summit; 3-4 December, 2008, Teton Village. SER was a sponsor of the conference, and Dr. Mark Northam was an invited panelist. Several UW faculty were also invited panelists.
- Clean Coal Technologies: A Conference on Queensland/Wyoming Cooperation; 10-11 April, Brisbane, Queensland, Australia. SER and the College of Engineering and Applied Sciences were sponsors. A team of 5 UW and 1 State of Wyoming personnel spoke at the conference. Dr. Northam presented an invited lecture.
- CBM Fair; 4-5 June, Gillette. SER was a sponsor and had an exhibition booth at this education fair at the Cam-Plex. Associate Director for Academics KJ Reddy and Sarah Schulmeyer manned the booth where information about the new ERS Degree Program was made available.
- 4th Annual Hydrogen Implementation Conference; 22-24 July, Laramie. SER was the major sponsor and Dr. Northam presented the conference open speech.
- Wyoming Mining Association Annual Meeting, 20 June 200, Lake Jackson Lodge. Dr. Northam was an invited speaker.
- 2008 Business Summit of the West; 25 June, Teton Village. Dr. Northam was an invited speaker.

- 1st Annual Sustainable Coal Strategies Symposium; 26-27 June, Sheridan. Dr. Northam was a keynote speaker.

5. DEVELOPMENT ACTIVITIES

The construction of a state-of-the-art UW School of Energy Resources Center is one of the University's highest priorities for private support through the University's academic facilities matching funds program. The Wyoming Legislature appropriated, and the Governor approved \$20 million in state matching funds for construction of the Center. As of the end of June 2008, \$19.4 million has been raised through gifts and state matching funds to build the SER Center.

- EnCana Oil & Gas USA has pledged \$5 million toward the construction of the SER Center facility. EnCana's gift is in addition to a prior gift of \$2 million toward the university's petroleum engineering program.
- Shell Exploration & Production Company gave \$2 million for the SER Center (full payment on commitment was paid in December, 2006).
- In September 2007, BP pledged a total gift of \$5 million to the University. Of that total, \$2 million will support the construction of the SER center building; \$2 million was pledged to the College of Engineering and Applied Sciences establish a Wind Energy Research Center; and \$1 million will support the development of a world-class rock and fluid properties lab.
- ConocoPhillips pledged \$340 thousand to help construct the School of Energy Resources center.
- Marathon Oil Company pledged \$330 thousand to help construct an Interdisciplinary Fossil Fuel Research Lab as part of the SER Center.
- Questar Corporation gifted \$30 thousand to help fund the SER Center.

Gifts are also sought to establish endowments that will supplement annual state support. The University's endowment matching program provides that these gifts can be matched by the State of Wyoming. Other priorities for endowment include support for centers of excellence focused on research areas important to Wyoming's energy industry, supplemental support of professors and graduate and undergraduate students in order to attract the best.

- Jim Nielson, president of the Cody-based energy company Nielson & Associates, has gifted \$5 million toward an endowment for the school's general operations. Nielson's gift supports the Director of the School – annual funding from his endowment will be directed to SER programs at the full discretion of the Director.
- Marathon Oil Company pledged \$670 thousand to UW to fund student internships and scholarships, symposiums, and field trips.
- Anadarko Petroleum Company pledged \$1.5 million to UW to endow the Anadarko Resources Recovery Program. The endowment will be matched by the state. Earnings from the \$3 million endowment will be used to fund a number of faculty, graduate student, and undergraduate student fellowships.

Significant conversations with several other companies are ongoing.

6. Financial Report

As stated at the beginning of this report, the Wyoming State Legislature provided authorization and funding for the SER in its 2006 session, through Senate File 37. The original appropriation was for \$12,071,996 for the 2007-08 Biennium. This level of funding was estimated to be appropriate for the first two years of establishing the School of Energy Resources.

In the spring of 2007, the state legislature approved funding to establish a partnership with the National Center for Atmospheric Research to build the next generation supercomputer in Cheyenne. As a result of that decision and pursuant to legislative appropriation, SER contributed \$2 million from the original budget to fund a portion of the state's contribution to that project. In November 2007, a thorough budget review and spending forecast exercise suggested that an additional \$2.02 million might be returned to the state at the end of the Biennium as a result of slower than expected hiring, among other things. Reductions from these two events left SER with a budget of \$8,051,820 for the 2007-08 Biennium.

As of June 30, 2008, SER's expenditures totaled \$8,050,312. Expenditures have been divided among four accounts to coincide with SER's major activities in the focus areas. High-level details for these expenditures are found in Table 2 below. Major expenditures for the Biennium are summarized as:

- \$1.36 million for various energy-related academic and research activities in the colleges of Arts and Sciences, Agriculture, Business, and Engineering and Applied Sciences.
- \$650 thousand for new SER faculty startup costs
- \$275 thousand for Graduate Assistantships
- \$150 thousand for the Energy Summer Institute
- \$571 thousand spent for Matching Grants
- \$650 thousand for other energy research seed money and startup costs
- \$470 thousand for Outreach, not including travel expenses
- \$1.1 million in administration costs, including personnel searches, salary and benefits for the director and staff, travel expenses, building renovation, and other overhead.

In the 2008 Legislative Budget Session, the state legislature approved funding for the School of Energy Resources for the 2009-10 Biennium. This funding is comprised of two parts. First, the legislature appropriated \$17,420,565 to derive from the Abandon Mine Lands Fund. Second, they approved the carryover of \$2,020,177 of unexpended, unobligated monies appropriated for the support of SER in the 2006 budget session. Combined, these two sources of funds provide \$19,440,742 to operate SER for the 2009-10 Biennium.

Table 2. SER FINANCIAL SUMMARY REPORT, FY2007-08

ADJUSTMENTS TO ORIGINAL SPENDING AUTHORITY		
Original Appropriation	\$12,071,997	
Reduction for NCAR	(\$2,000,000)	
November 2007 Reduced Forecast	(\$2,020,177)	
ADJUSTED SPENDING AUTHORITY FOR 2006-2008 BIENNIUM	\$8,051,820	
 EXPENDITURES BY DIVISION		
	Fiscal Year 2007	Fiscal Year 2008
	Expenditures	Expenditures
ACADEMICS		
Coordinator's Office - Salary, Benefits and Office Support Expenses	\$98,322	\$143,889
<i>Salary & Benefits</i>	<i>N/A</i>	<i>\$83,791</i>
<i>Office Support Expenses</i>	<i>N/A</i>	<i>\$60,098</i>
Undergraduate Research Fellowship Stipends	\$0	\$0
Distinguished Faculty	\$693,575	\$896,519
Visiting Professorships	\$0	\$0
Teaching Internships	\$51,065	\$0
Energy Summer Institute	\$60,579	\$87,605
Other Support (Course Dev, Faculty Searches, Faculty Start-up)	\$0	\$694,764
SUBTOTAL ACADEMICS	\$903,541	\$1,822,777
 RESEARCH		
Institute for Energy Research Technical & Support Staff	\$0	\$0
Half-Time Faculty Appointment and Summer Research Salary	\$0	\$0
Graduate Assistant Stipends	<i>N/A</i>	\$276,856
Research Center Seed Money (aka Start-up Assistance Fund)	\$309,500	\$375,904
Matching Grants Fund (Awarded and Obligated)	\$710,200	\$361,600
Transfer to Sponsored Programs (Matching Grants Reserve Fund) ¹	\$0	\$1,718,936
SUBTOTAL RESEARCH	\$1,019,700	\$2,733,296
 OUTREACH AND SERVICE		
Energy Outreach Center	\$358,662	\$0
Consulting Specialists	\$0	\$0
Other Outreach (Office Support, Workshops)	\$0	\$112,793
SUBTOTAL OUTREACH AND SERVICE	\$358,662	\$112,793
 ADMINISTRATION		
Director's Office - Salary, Benefits and Office Support Expenses	\$567,329	\$532,215
<i>Salary & Benefits</i>	<i>N/A</i>	<i>\$310,864</i>
<i>Office Support Expenses</i>	<i>N/A</i>	<i>\$221,352</i>
SUBTOTAL ADMINISTRATION	\$567,329	\$532,215
 TOTAL EXPENDITURES PER FISCAL YEAR	 \$2,849,232	 \$5,201,080
 TOTAL EXPENDITURES FOR 2006-2008 BIENNIUM	 \$8,050,312	

¹ To meet pending MGF obligations as proposals are receive outside funding.

APPENDIX A

Academic Initiatives

September 2008

UNIVERSITY OF WYOMING

School of Energy Resources

209 Bureau of Mines

Dept. 3012, 1000 E. University Ave.,

Laramie, WY 82071

(307) 766-6254 • Frost@uwyo.edu • <http://uwacadweb.uwyo.edu/ser/>

1 March 2007

Call for Proposals:

SCHOOL OF ENERGY RESOURCES

GRADUATE ASSISTANTSHIPS

The School of Energy Resources (SER) is pleased to announce a call for proposals for Graduate Assistantships (GAs) for AY2007-2009. Funding is available beginning in August of 2007 and will be allocated for a two-year period. Each assistantship includes a \$20,000 annual GA stipend and up to an additional \$4,200 annually for tuition and fees. Although the SER seeks broad participation from across the campus, there is no limit to the number of GAs requested from any department or college. Moreover, GAs are considered to be renewable based on subsequent applications and demonstration of success in previous proposals.

Guidelines for the GA allocation are grounded to the SER Academic and Financial Plan submitted to the Wyoming Legislature in October 2005. The School's mission includes supporting Wyoming's energy industry (present and future) through a collection of academic, research, and outreach programs. The organizing principles underlying the SER are broadly framed by the following core questions:

- How can Wyoming sustain and optimize the long-term production of fossil energy resources?
- To what extent can Wyoming produce energy from renewable and sustainable sources?
- What are the state's roles in the emerging potential markets for CO₂ sequestration, hydrogen production, and transportation fuels derived from coal?
- What measures will smooth Wyoming's transition to a long-range energy economy?
- What curricula are appropriate to prepare students for careers in Wyoming's current and future energy economy?

The above questions touch a broad spectrum of UW's academic enterprise and are interdisciplinary in nature. As such, a fundamental goal of the SER is to develop and maintain a lasting presence that transcends individual colleges and departments, reaching all appropriate corners of the University. In order to achieve this objective the SER seeks:

Strong integration of energy issues in UW's academic mission with additional emphasis on interdisciplinary teaching in energy-related undergraduate and graduate programs.

Using the above statement as an anchor of the SER academic mission, we are releasing this call for 16 GAs to be distributed across the University. Proposals should address one or more of the following topics.

Interdisciplinary Programs: The School of Energy Resources is committed to creating an interdisciplinary culture at UW where students and faculty from different disciplines routinely combine their talents to work on common energy-related problems. Interdisciplinary efforts can not only lead to extraordinary advances in science, they give students the well-rounded experience that is necessary to excel in solving energy problems where disparate disciplines often merge.

Evidence of SER's commitment to an interdisciplinary approach to academics is seen in several current and proposed research centers for the School. For example, UW's Enhanced Oil Recovery Institute combines expertise from geology, engineering, economics, and mathematics to form a powerful scientific effort aimed at improving Wyoming's recovery rates for oil. A proposed Center for Alternative and Renewable Resources may address efficient generation of chemical fuels from solar photocatalytic systems (e.g., artificial photosynthesis), and generation of electrical power using microbial- and bio-fuel cells. Such a program may involve faculty from Chemistry, Zoology and Physiology, Geology and Geophysics, and Chemical and Petroleum Engineering. A more traditional wind energy theme in sustainable power involving Electrical and Mechanical Engineering as well as Atmospheric Science is yet another example of interdisciplinary energy research.

The SER invites GA proposals for students to work specifically on interdisciplinary research programs of interest that cross department and/or college lines. Proposals should clearly document the specific problem of interest and identify all departments where significant contributions are expected. Although, the research program must be truly interdisciplinary in nature, a home department and adviser should be identified.

Course Modification: The University of Wyoming already offers a significant array of courses at the undergraduate and graduate level that are focused directly on energy issues—from Geology and Geophysics to Economics and Finance, from Mechanical Engineering to Renewable Resources, etc. That said, we believe there are substantial opportunities to expand the depth of energy content in courses or modify existing courses to include specific energy applications. For instance, the College of Engineering is in the midst of reorganizing ES 1060, Introduction to Engineering Problem Solving, to have a single overarching theme of energy. Similarly, could a course devoted to mathematical modeling of partial differential equations develop a strong emphasis on the multiphase flow aspects of enhanced oil recovery? Moreover, should aspects of parallel computing be introduced in numerical analysis courses in support of our new NCAR computing efforts in the geosciences?

The possibilities for course modification across several colleges as well as the School of Environment and Natural Resources are substantial. SER invites proposals for GA support that contribute to *substantive and meaningful* changes to courses in support of the SER mission.

Course Development: As noted above, UW already possesses an impressive portfolio of energy-related courses crossing multiple colleges. Proposals to modify existing courses to include an aspect of energy will provide further opportunities to support the SER academic mission. However, clearly some cases can be made for development of new courses to address pressing scientific, business, and energy-related policy issues—or to further complement and encourage interdisciplinary programmatic development. For example, the growing international concern over atmospheric CO₂

abatement may give rise to a course devoted to CO₂ capture and storage. The need to accurately and systematically monitor carbon trading may give rise to demands for a course in carbon accounting.

World energy consumption is soaring to support burgeoning economic expansion in China and India. An international energy security class could explore the political ramifications of the emerging global competition among states to secure their access to scarce natural resources such as oil, natural gas, coal and platinum for fuel cells, and other strategic resources. Particular attention may be paid to the changing global geopolitical context that makes energy exporting states such as Russia and countries in the Middle East and North Africa increasingly important to the continued prosperity of the rest of the world.

Increasingly, compliance with environmental laws and regulations dictates the pace and manner of energy development. Courses may provide students with a basic understanding of how environmental laws and regulations are created and enforced in the context of energy development.

Impressive examples of interdisciplinary success stories related to energy teaching already exist. Civil Engineering and the School of Environment and Natural Resources have teamed up to study the engineering, environmental, and social aspects of piping coal bed methane water discharge from the Powder River Basin to the North Platte River. Geology and Geophysics offers an upper division, non-majors course that addresses a variety of energy issues from scientific, political, social, and cultural viewpoints.

While we are cautious about open-season on new course development due to UW's finite resources of faculty and academic professionals, there may be compelling reasons to develop entirely new courses to support the SER academic mission. We seek *innovative* proposals for GA support to assist in developing these new courses provided a strong case can be made for their introduction.

Basic and Applied Energy Research: The SER recognizes the cornerstone of diversifying and sustaining Wyoming's energy economy lies in solid scientific research exploring new territory. To that end, we seek to provide GA support for research programs addressing basic and applied research related to energy.

UW is home to several laudable research programs aimed directly at assisting every major sector of the Wyoming energy economy. A host of outstanding researchers are at the forefront of modeling fundamental aspects of porous media flow for enhanced oil recovery as well as geologic storage of CO₂. Research programs exist for clean coal technologies to convert coal to hydrogen and other liquid fuels. Plasma processing to remove hydrogen sulfide from natural gas and nitrous oxides from combustion processes are also being investigated. Advances in the technical and environmental issues associated with coal bed methane water quality and discharge are continuous. Finally, UW boasts an impressive collection of colleagues devoted to reclamation, restoration, and rehabilitation of disturbed ecosystems.

There is also strong interest on the campus in advancing energy science beyond the traditional carbon-based fossil fuels. Alternative energy research includes advances in fuel cell technology and hydrogen production using photovoltaics. UW also has a sustained history of interdisciplinary research in wind energy.

The SER seeks outstanding single or multi-investigator proposals for GA support to advance any aspect of energy science or energy-related technology transfer. While a history of demonstrated excellence related to energy research is a positive, the SER also encourages well thought out

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proposals from our colleagues who seek to enter the energy research arena. Exploring new fields of interest is a valued hallmark of the academic environment and UW and the state represent an ideal field laboratory for energy research. The pressing energy issues facing the world today provide additional incentives for studying in this important field.

Some closing general remarks related to this request for proposals are appropriate. First, any proposal for GA support does not have to reside entirely within one of the categories discussed above and may well cross multiple topics. Secondly, we wish to reinforce our commitment to interdisciplinarity as well as course modification and development. In the nascent stages of the School, our emphasis is clearly focused on raising the SER profile within the core of UW's mission—the academic classroom.

For additional information, or clarification, please contact Professor Andy Hansen, Academic Coordinator, School of Energy Resources, hansen@uwyo.edu.

GA Proposal Guidelines

SER/GA proposals are to be limited to three pages (11 point font) with no supplementary information and should address the following topics.

General Information: Begin by supplying the following information at the beginning of the proposal:

- Academic Adviser and Rank
- Department/Division
- Title of Proposal

Current GAs: Provide a brief description of current advising of GAs including the total number of MA, MS, Ph.D. and/or Ed.D.; the project each student is working on; and sources of funding for these students. Please also briefly describe your history of GA advising.

Project Description: Provide a narrative description of your proposal that addresses the purpose, importance, and potential impact to the SER mission outlined previously. Proposed course modifications should be substantial and clearly documented while arguments for new courses must be compelling. Interdisciplinary proposals should provide strong links among participating departments. Proposals addressing basic and applied energy research should document additional activities related to the effort such as external funding or additional graduate or undergraduate involvement.

All proposals should address whether they are seeking students for a masters degree, Ph.D., or Ed.D.

Reporting: The SER will require a written report from all GA awardees on an annual basis to be delivered by April 1 of each year. The report should be limited to three pages and should provide the background of the original proposal, the specific goals of the work, and the results of the effort including the academic status (e.g., progressing to degree, graduated, left the program, etc.) of the students who were supported with the grant. Please list all students supported by the grant and the semesters during which the support was provided. Compliance with the reporting requirements will be viewed as a condition of future renewals of GA support from the School.

Conditions:

- 1) The recipient of an SER/GA grant will return to the School any funds unused due to unfilled GA positions on a prorated basis. However, failure to fill a GA slot immediately (i.e., Fall of 2007) will not result in a loss of the position.
- 2) GA funding under this RFP is valid through Spring semester of 2009.
- 3) Funding from the grant may be used to support students in the summer as well as during the academic year.
- 4) Recipients of an SER/GA agree to enroll in GRAD 5910, ECTL's course in graduate student teaching. See:
http://www.uwyo.edu/ctl/Grad_Student_Resources/CollegeTeach.asp.
- 5) During at least one semester of an SER/GA appointment, GA duties must include a *meaningful* teaching assignment. Such assignments include, but are not limited to, course modification and course development as outlined previously, teaching of a laboratory or lecture course, conducting discussion sessions, etc. Grading papers and holding office hours are examples that are not considered meaningful.
- 6) Publications resulting from SER-sponsored GAs should acknowledge the School of Energy Resources funding.

Submission: All proposals are to be submitted electronically in *Microsoft Word* or *Adobe PDF* formats. Submit proposals to serpros@uwyo.edu with "GA Proposal" listed as the subject line. The deadline for this solicitation is 2 April 2007. Notification of awards will be provided by 16 April 2007.

Evaluation Criteria: The overriding criterion for evaluation of any request to the SER/GA allocation pool is reflected in SER's educational objectives. That is, we seek strong integration of energy issues in UW's academic mission with additional emphasis on interdisciplinary teaching in energy-related undergraduate and graduate programs.

Proposals will be reviewed by Interim Director Carol Frost and Academic Coordinator Andy Hansen with additional guidance from the SER *Academic Council* comprised of faculty colleagues from across the University who have an interest in energy-related research. The SER may accept, decline, or table proposals to a later decision date.

Timing: The SER is keenly aware of the timing of this program as it relates to recruitment of outstanding graduate students. While some positions may be filled in the fall, it is entirely possible that some GAs will not be able to be filled until Spring of 2008, or perhaps later. One can expect future GA solicitations to occur in the fall semester in order to capitalize on the main recruiting season for graduate students.

Announcement for the Spring 2008 Graduate Student Symposium – SER GA Program.



Wednesday, April 2, 2008
School of Energy Resources Presentations
Wyoming Union Room 202

POSTER PRESENTATIONS

10:00 am – noon

Presentation #	Student	Faculty	Department
1	Tomasz Dziedzic	Daniel Buttry	Chemistry
2	Yiping Liu	David Bagley	Civil/Arch Engineering
3	Zaixing Huang	Michael Urynowicz	Civil/Arch Engineering
4	Jared Strube	Paul Dellenback	Mechanical Engineering
5	Meghan Morrissey	Harold Bergman	Environment & Natural Resources
6	Elizabeth Hajek	Paul Heller	Geology & Geophysics

ORAL PRESENTATIONS

Presentation time	Student	Faculty	Department
11:30-11:50 <i>lunch on your own</i>	Min-Hyung Ryu	Mark Gomelsky	Molecular Biology
1:20-1:40	Hee Joon Park	Patrick Johnson	Chemical & Petroleum Engineering
1:40-2:00	Saeed Ovaysi	Mohammad Piri	Chemical & Petroleum Engineering
2:00-2:20	Amanda Moyer	Carrick Eggleston	Geology & Geophysics
2:20-2:40	Michael Stollinger	Stefan Heinz	Mathematics
2:40-3:00	–OPEN–		
3:00-3:20	Brian Enchelmeyer	Charles Mason	Economics & Finance

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Press Release – 2008 Disappearing Roads Competition.

UW Wins First Place in Environmental Competition



June 5, 2008 -- A team of University of Wyoming students won the 2008 Disappearing Roads Competition.

No wonder. They developed a completely recyclable, roll-out road system that, well, disappears nearly without a trace.

The five-person UW presentation team from Professor Charles Dolan's multidisciplinary senior design class bested teams from 11 other universities to win the year-long competition, edging Texas A&M University for the \$20,000 grand prize.

The Disappearing Roads Competition is part of the Houston Advanced Research Center's Environmentally Friendly Drilling Systems Program, which aims to integrate advanced technologies into a drilling rig system that significantly reduces the environmental impact of petroleum drilling and production.

"These types of environmentally-friendly competitions are needed because we're able to take a problem, in our case, environmental drilling, and generate ideas for solving that problem," says Cody's Jacob Olenick, one of 20-plus students in Dolan's class. "I feel like the Disappearing Roads Competition is especially important because we, as a country, are going to be using oil and natural gas for a long time to come and we need to continue to explore ways to make the extraction process as effective and efficient as possible while also minimizing the impact on the environment."

Olenick, who graduated in May with a degree in mechanical engineering, was joined on the UW team by Kristen Beck (Laramie, mechanical engineering) and Nolan Bray (Riverton, mechanical engineering), Tyrel Hulet (Buffalo, civil engineering) and Alyssa Wechsler (Sheridan, environmental and natural resources).

The UW team developed a layered mat, roll-out road system and a modular frame design for temporary roads and drilling pads in environmentally-sensitive areas, such as Jonah Field and the Pinedale Anticline Production Area. The UW project would reduce ground and habitat disruption by up to 88 percent, Olenick says.

The roll-out road and mat drilling pad system were designed with synthetic boards developed by Heartland Biocomposites, a Wyoming start-up company. The boards have superior strength for direct loading as compared to the oak boards that are currently imported from Louisiana and used at Jonah Field. The synthetic boards are also more resistant to extreme weather conditions.

The students fabricated and tested both the mat and roll-out road concepts at the Mountain Cement quarry south of Laramie.

As part of the project, the UW team also met with representatives from the Bureau of Land Management, EnCana USA and Questar Exploration Inc., and briefed U.S. Sen. John Barrasso on the environmental, cost and production aspects of their design.

Barrasso was "very enthusiastic about the direction the project," says Olenick.

"We know that energy is important, but this is our state and we live here, so this project has a direct bearing on the activities and lifestyle of our citizens," Hulet says.

Adds Beck, "A lot of students did individual senior design projects, but this is a project that has the potential to make the state better for my 5-year-old daughter."

Each UW student receives a share of the prize money.

"It was a great experience working on an interdisciplinary team involving mechanical engineers, civil engineers and an environmental and natural resources major. I felt that this group dynamic much more reflects how a project would be conducted outside of the college setting," Olenick says. "The environmental aspect of this design project is what really interested me. I consider myself to be a very environmental person and being able to be a part of this project was a great way to help make an impact."

Photo

A team of University of Wyoming students presents their award-winning disappearing road project to U.S. Sen. John Barrasso. Clockwise from the senator are Jacob Olenick, Cody; Tyrel Hulet, Buffalo; Nolan Bray, Riverton; Kristen Beck, Laramie; and Alyssa Wechsler, Sheridan. (UW Photo)

Posted on Thursday, June 05, 2008

September 2008

APPENDIX B

Energy Resource Science Degree Program

School of Energy Resources (SER) Academic Programs Overview

University of Wyoming

UW's Energy Resource (ERS) Major

Introduction

Energy and environment are integral to global communities and to society. The need for exploiting all forms of energy resources (fossil fuels, renewables, and alternatives) to meet growing energy demands while protecting the environment has become more urgent in recent years.

Society faces many difficult decisions regarding production and consumption of energy, and the consequent impacts on global environment. Pressing questions include: To what extent should we exploit natural resources for energy production? Do we have sufficient energy resources to meet skyrocketing global demands for energy in the future? What must we do to develop sustainable energy programs and policies in light of the increasingly complex interactions of economic needs and environmental imperatives? SER is facilitating development of interdisciplinary academic programs on campus to address these and other critical energy-related issues.

SER is collaborating with the Colleges of Arts and Sciences, Engineering and Applied Science, Agriculture, Business, Education, and Law, as well as the Haub School of Environment and Natural Resources, to offer an interdisciplinary B.S. degree program in Energy Resource Science (ERS). The goal of the ERS degree is to offer a diverse curriculum that combines engineering, science, business, law, and natural resources content to build a fundamental understanding of interaction and tradeoffs between energy, environment, policy and the economy (see Figure 1).

Why An Interdisciplinary ERS Major?

- Energy is a global priority that has strong interactions with climate, water and economy
- We face severe workforce shortages in energy-related fields
- The ERS degree program is a unique opportunity for us to become leaders in energy academics

What is it?

- An interdisciplinary degree program with rigorous education in the fundamentals of energy, climate, water, economics, and policy
- A recruiting tool for UW
- Built from existing courses
- Doesn't compete with other programs

Who is Interested in it?

- High school students and incoming freshmen
- Faculty interested in expanding their horizons
- Local, regional, national, and global stakeholders in energy and related industries
- Future employers

What are we Preparing Students For?

- Critical thinking, innovation, and problem solving skills through multidisciplinary course content
- Team- and network-building concepts
- Cross-cutting exposure to basic energy resources issues
- Future employment in energy and related fields
- Graduate studies in energy disciplines

I. ERS FOCUS (70%)

a. Geology and Geophysics (30%)

The prescribed geology and geophysics content will cover: earth systems and processes; principles governing formation, migration and accumulation of hydrocarbon and mineral resources; and techniques involved in exploring for, evaluating, and producing hydrocarbon reservoirs, traps, and deposits.

b. Engineering (20%)

The prescribed engineering content will cover: analysis of complex engineering systems; thermodynamics of energy and its forms; physical properties of reservoir rocks and fluids; flow through porous media; and drilling fundamentals and methods of production.

c. Economics/Policy (20%)

The prescribed economics and policy content will cover: principles of economics and policy in resource development; fundamentals of global and U.S economies; energy and environmental policy development; risk analysis and management; and sustainability practices.

d. Environment/Natural Resources (15%)

The prescribed environment and natural resources content will cover: principles governing the interaction of energy production, climate and water; economical and practical solutions for water quality management; and restoration of disturbed lands. Students will be challenged to think critically to understand complexities of energy, environment, and natural resources problems.

e. Computational Modeling (15%)

The prescribed computational modeling content will train students in the use of tools for: modeling of earth systems; remote sensing at macro and micro scales; spatial data analysis; and, geographic information systems.

II. UNIVERSITY REQUIREMENT (25%)

The university requires certain general education courses that include chemistry, mathematics, physics, statistics, biology, public speaking, writing, and physical activity.

III. ELECTIVES (5%)

Elective courses encourage students to learn advanced concepts in geology, engineering, and environmental/natural resources areas. They also prepare students for graduate studies in energy resources.

IV. ERS Capstone Project

The concept for an interdisciplinary problem-solving capstone course is to provide students with practical experience in addressing unique industrial problems through team collaboration. It involves extensive collection and interpretation of data, interaction with and integration of diverse disciplines, and decision-making.

Figure 1. Interdisciplinary Components of the Energy Resource Science (ERS) Degree Program at the University of Wyoming.

APPENDIX C

Research Initiatives

September 2008

UNIVERSITY OF WYOMING

School of Energy Resources

209 Bureau of Mines

Dept. 3012, 1000 E. University Ave.,

Laramie, WY 82071

(307) 766-6254 • Frost@uwyo.edu • <http://uwacadweb.uwyo.edu/ser/>

31 October 2006

Call for Proposals:

SCHOOL OF ENERGY RESOURCES MATCHING GRANT FUND

The School of Energy Resources (SER) is pleased to announce a call for proposals for matching grant funds to conduct energy-related research and development. The SER Matching Grant Fund (MGF) pool is funded by a regular appropriation from the Wyoming legislature. Funding is intended to provide significant additional leverage to already strong proposals, thereby improving the chances of acquiring external funding. The SER/MGF pool is available to all UW tenure-track faculty and extended-term academic professionals without preference with respect to tenure status.

For AY 2006-07, proposals will be considered for matching funds from \$10K to \$100K. A total of \$500K is available for distribution this fiscal year. As the program ramps up, proposals will be accepted on a monthly basis with the final deadline of 30 April 2007. Proposals received by the end of a given month will receive notification of their status by the 15th of the following month. Beginning in AY 2007-08, SER envisions a periodic proposal review with deadlines of:

- October 15
- January 15
- May 15

Proposals should target topics supporting the goals and vision of the SER and may include, but are not limited to, subjects in the sciences and engineering, policy formulation and law, business, and education from P-20 to practicing teachers. To maximize the benefit to the University, matching funds granted by SER must leverage new, yet to be acquired, funds from an external source. The matching funds requested cannot exceed the amount requested from the granting agency. For additional information, or clarification, please contact Professor Carol Frost, Interim Director, School of Energy Resources, frost@uwyo.edu.

This program is subject to the affirmative action requirements which are prescribed by the Executive Order 11246 (as amended), Section 202; by the Rehabilitation Act of 1973 (as amended),

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Section 503; by the Vietnam Era Veterans' Readjustment Assistance Act of 1974 (as amended), Section 402 (38 USC 2012).

MGF Proposal Guidelines

SER/MGF proposals are to be limited to three pages (11 point font) with no supplementary information and should address the following topics.

General Information: Begin by supplying the following information at the beginning of the proposal:

- Principal Investigator(s) and Rank
- Department/Division
- Title of Proposal
- Funds requested (Source, amount, and date by which funds will be spent)
 - External
 - UW (exclusive of SER)
 - SER
 - TOTAL

Current Funding: Provide a brief description of current funding of all PIs including the sources of funding and the nature of the research. Also provide information describing support for undergraduate and/or graduate students and post-docs from these projects.

Project Description: Provide a narrative description of your proposal that addresses the purpose, importance, and potential impact to energy research and development. Proposals may range from fundamental basic research that expands the frontiers of energy knowledge to those with direct applications supporting the energy industry of Wyoming and the nation. It is critical to deliver your message with the view that your audience may be composed entirely of persons who are not well-versed in your specific discipline. Clarity and conciseness, written at the appropriate level, should be the fundamental goal as opposed to discipline-specific technical jargon.

Reporting: The SER will require a written report from all grant awardees to be delivered within 90 days of the close of the grant. The report should be limited to three pages and should provide the background of the proposal, the specific goals of the work, and the results of the effort including a list of archival publications, conference presentations, as well as the status of any students (including post-docs) supported with the grant. It is important to write the report so that a nonacademic audience can understand the significance and utility of the work. Compliance with the reporting requirements will be viewed as a condition of future funding from the School.

Conditions:

- 1) The recipient of an SER/MGF grant match will return to the School any SER funds unused after the date specified in the "General Information" section of the proposal.
- 2) An SER/MGF grant match may be revoked in whole or in part should the PI cease to be a University of Wyoming employee during the grant period.

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- 3) Publications resulting from SER sponsored research should acknowledge the School of Energy Resources funding.

Submission: All proposals are to be submitted electronically in *Microsoft Word* or *Adobe PDF* formats. Submit proposals to serpros@uwyo.edu. Deadlines for each month will be midnight of the last day of the month with submission times noted by the email receipt.

Evaluation Criteria: The overriding criterion for evaluation of any request to the SER/MGF program is the direct relevance to fundamental energy issues facing the state and the nation. The SER also believes that education of students is a critical role of the School. Therefore, proposals are strengthened by showing integral components of undergraduate and/or graduate education. Interdisciplinary proposals are encouraged as are proposals which provide for collaboration between established researchers and new members of the faculty.

When established, proposals will be reviewed by a *SER Academic Council* comprised of faculty colleagues from across the University who have an interest in energy-related research. In the interim, funding decisions will be made by Carol Frost, Interim Director of the SER, and Andy Hansen, Academic Coordinator of the SER, in consultation with the Office of Academic Affairs. The SER may accept, decline or table proposals to a later decision date.

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UNIVERSITY OF WYOMING

School of Energy Resources
209 Bureau of Mines
Dept. 3012, 1000 E. University Ave.,
Laramie, WY 82071
(307) 766-6851 • serpros@uwyo.edu • <http://www.uwyo.edu/ser/>

March 7, 2008
Revised

Call for Proposals:

SCHOOL OF ENERGY RESOURCES 2007-08 MATCHING GRANT FUND

The School of Energy Resources (SER) is pleased to announce a call for proposals for matching grant funds to conduct energy-related research and development. The SER Matching Grant Fund (MGF) pool is funded by a regular appropriation from the Wyoming legislature. Funding is intended to provide significant additional leverage to already strong proposals, thereby improving the chances of acquiring external funding. The SER/MGF pool is available to:

- all UW tenure-track faculty and extended-term academic professionals without preference in respect to tenure status;
- all full-time Research Professors and Research Scientists;
- all full-time Post-Doctoral Research Associates, provided that they support their proposal with documentation from their supervising faculty member that space is being provided for the research;
- all full-time Western Research Institute Research Staff.

For AY 2007-08, proposals will be considered for matching funds from \$10,000 to \$100,000. A total of \$1 million is available for distribution this fiscal year. During AY 2007-08, SER will accept proposals for review by the following deadlines:

- October 15
- February 1
- April 15

Proposals received by those due dates will receive notification of their status by the last working day of that month.

Proposals should target topics supporting the goals and vision of the SER and may include, but are not limited to, subjects in the sciences and engineering, policy formulation and law, business, and education from P-20 to practicing teachers. To maximize the benefit to the University, matching funds granted by SER must leverage new, yet to be acquired, funds from an external source. Proposals for new

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equipment purchase will be considered only if they have no other commitments for UW funds, except in rare instances, but will be given lower priority in cases where they compete with research proposals.

Matching funds requested cannot exceed the amount requested from the granting agency. For additional information, or clarification, please contact K.J. Reddy, Associate Director for Academics, School of Energy Resources (Katta@uwyo.edu).

MGF Proposal Guidelines

SER/MGF proposals are to include 3 pages for the proposal (11 point font), 1 page for the budget and 2 pages for the PIs resume. Please address the following topics.

General Information: Supply the following information at the beginning of the proposal:

- Principal Investigator(s) and Rank
- Department/Division
- Title of Proposal
- Funds requested (Source, amount, date by which funds will be spent, and date the award will be announced)
 - External
 - UW (exclusive of SER)
 - SER
 - TOTAL

Current Funding: Provide a brief description of current funding of all PIs including the sources of funding and the nature of the research. Also provide information describing support for undergraduate and/or graduate students and post-docs from these projects.

Project Description: Provide a narrative description of your proposal that addresses the purpose, importance, and potential impact to energy research and development. Proposals may range from fundamental basic research that expands the frontiers of energy knowledge to those with direct applications supporting the energy industry of Wyoming and the nation. It is critical to deliver your message with the view that your audience may be composed entirely of persons who are not well-versed in your specific discipline. Clarity and conciseness, written at the appropriate level, should be the fundamental goal as opposed to discipline-specific technical jargon.

Budget: Provide a detailed one-page budget sheet outlining the general categories where the SER matching grant money will be spent.

Resume: The resume of PIs should be limited to two pages and should provide recent publications/presentations (last 5 years), a list of graduate (including post-docs) and undergraduate students advised, and any other pertinent information.

Reporting: The SER will require a written report from all grant awardees to be delivered within 90 days of the close of the grant. The report should be limited to three pages and should provide the background of the proposal, the specific goals of the work, and the results of the effort including a list of archival publications, conference presentations, as well as the status of any students (including post-docs) supported with the grant. It is important to write the report so that a nonacademic audience can understand the significance and utility of the work. Compliance with the reporting requirements will be viewed as a condition of future funding from the School.

Conditions:

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- 7) The recipient of an SER/MGF grant match will return to the School any SER funds unused after the date specified in the “General Information” section of the proposal.
- 8) An SER/MGF grant match may be revoked in whole or in part should the PI cease to be a University of Wyoming employee during the grant period.
- 9) Publications resulting from SER sponsored research should acknowledge the School of Energy Resources funding.

Submission: All proposals are to be submitted electronically in *Microsoft Word* or *Adobe PDF* formats. Submit proposals to serpros@uwyo.edu. Deadlines for period will be midnight of the 15th day of that month with submission times noted by the email receipt.

Evaluation Criteria: The overriding criterion for evaluation of any request to the SER/MGF program is the direct relevance to fundamental energy issues facing the state and the nation. Because the SER also believes that education of students is a critical role of the School, proposals are strengthened by showing integral components of undergraduate and/or graduate education. Interdisciplinary proposals are encouraged as are proposals which provide for collaboration between established researchers and new members of the faculty. A copy of the evaluation form is included.

Proposals will be reviewed by the SER *Academic Council* comprised of faculty colleagues from across the University who have an interest in energy-related research. The SER may accept, decline or table proposals to a later decision date.

FY 2007
Funding from External Organization Received & MGF Funds Paid

PI	Organization	Proposal	MGF Funds	External Funds	Total Funds
Campbell-Stone, Erin	Wyoming NASA Space Grant	Fault Seal on Low-Angle Normal Faults	\$15,000	\$15,000	\$30,000
Heller, Paul	American Chemical Society	Shapes, Scales, & Spacings of Channel-belt Sand Bodies in Avulsion-dominated Alluvial Basins	\$50,000	\$100,000	\$150,000
Piri, Mohammad	Total E&P UK PLC	Three-Phase Relative Permeabilities for Enhanced Oil Recovery Schemes	\$80,000	\$200,000	\$280,000
Johnson, Patrick	North Central Sun Grant Center	Recoverable Enzyme Nanoparticle Systems for Cellulose Hydrolysis	\$51,600	\$284,600	\$336,200
Tang, Jinke	Sharp Laboratories of America	Investigation of nanospheres for general lighting application	\$50,000	\$120,000	\$170,000
Argyle, Morris	Western Research Institute	Integration of a Structural Water Gas Shift Catalyst with a Vanadium Alloy Hydrogen Transport Device	\$100,000	\$100,000	\$200,000
Bell, David	Idaho National Laboratory	Model Development: Fischer-Tropsch Synthesis & Product Refining	\$50,000	\$50,000	\$100,000
Mavriplis, Dimitri	Department of Energy	Sensitivity Analysis for Uncertainty Quantification & Improved Accuracy in Nuclear Reactor Core Simulations	\$70,000	\$287,426	\$357,426
Argyle, Morris	Idaho National Laboratory	Nonthermal Plasma Reactors for the Decomposition of Hydrogen Sulfide	\$12,492	\$12,492	\$24,984
FY07 Subtotal			\$479,092	\$1,169,518	\$1,648,610
# Proposals				9	

FY 2008
Agreed to Provide Matching Funds-Waiting for Approval from External Organization

PI	External Organization	Proposal	MGF Funds	External Funds	Total Funds
Alvarado, Vladimir	American Chemical Society	Dynamics of solid-stabilized emulsions in porous media	\$50,000	\$50,000	\$100,000
Piri, Mohammad	DOE/EPSCoR	Tight Gas Reservoirs: Experimentation & Modeling of Hysteresis & its Implications for Gas Recovery	\$100,000	\$1,194,000	\$1,294,000
Zhang, Ye	DOE Basic Energy Science	Evaluation of Model uncertainty in CO2 Sequestration in Deep Aquifers	\$82,450	\$82,450	\$164,900
Eggleston, Carrick	Petroleum Research Fund	Optimization of Inexpensive Semiconductors for Solar Carbon Fixation	\$50,000	\$100,000	\$150,000
Johnson, Patrick*	Fossil Fuel Program NETL DOE	Energy from Organic Waste Degradation Using Biological Fuel Cells	\$100,000	\$150,000	\$250,000
Lee, Long	National Science Foundation	Transport Mechanisms for Multi-phase Micro-fluids on Structured Solid Surfaces	\$48,183	\$172,465	\$220,648
Garrison, Jean	Japan Foundation Grant & Institute for Global Environmental Strategies	Energy Security & Climate Security in Asia: Implications for U.S. Foreign Policy	\$38,231	\$300,000	\$338,231
Sullivan, B. Patrick*	Department of Energy	Highly Oxidizing Ligand-to-Metal Charge Transfer Excited States for Solar Energy Conversion	\$88,000	\$345,000	\$433,000
Montague, Derek*	Wyoming DEQ, BLM, US Forest Service, EPA	Upper Green River Basin Ozone Monitoring Study	\$97,952	\$97,952	\$195,904
Tang, Jinke	Department of Energy	Investigating energy transfer in novel Ce3+ & Cr3+ co-doped phosphors & their applications in white light emitting diodes	\$90,000	\$600,000	\$690,000
Moss, Justin	Whitney Benefits	Sustainability of Straight Vegetable Oil & Biodiesel Fuel Production for Wyoming: Development, Production, Use & Education	\$22,850	\$48,750	\$71,600
Chamberlain, Kevin	Department of Energy & Cameco Inc.	Long-term study to assess the utility of Pb isotope analyses for improved monitoring of aquifer interactions in the in-situ U industry	\$60,000	\$60,000	\$120,000
Jun, Sukky	Department of Energy Office of Basic Energy Science	Environment-Dependent Instability of Organic-Based Framework Materials	\$38,587	\$180,000	\$218,587
Johnson, Patrick	Department of Energy Biomass Program	Immobilized enzyme systems for conversion of woody biomass for butanol production	\$100,000	\$500,000	\$600,000
Andersen, Matt	BLM, Wyoming Wildlife & Natural Resource Trust, Anadarko, Questar	Reclamation Costs, Bonding Systems, & the Probability of Reclamation in Wyoming's Oil & Gas Industry	\$44,552	\$32,076	\$76,628
Parkinson, Bruce	Center for Revolutionary Solar Photoconversion	Optimizing Cu2ZnSnS4-based Photovoltaic Devices: An Approach to Inexpensive & Scalable Thin Films & Fundamental Studies of their Semiconducting Properties	\$25,000	\$75,000	\$100,000
FY08 Subtotal			\$1,035,805	\$3,987,693	\$5,023,498
# Proposals			16		

**FY 2008
Funding from External Organization Received & MGF Funds Paid**

PI	External Organization	Proposal	MGF Funds	External Funds	Total Funds
Beck, Jeffrey	Wyoming Wildlife & Natural Resource Trust and USDI Bureau of Land Management	Identifying Disturbance Mechanisms Influencing Habitat Selection by Elk in Natural Gas Development Fields	\$60,000	\$461,500	\$521,500
Chamberlain, Kevin	Cameco, Inc.	Pilot Study to Assess the Utility of Pb Isotope Analyses for Improved Monitoring of Aquifer Interactions in the In-situ U Mining Industry	\$5,000	\$5,000	\$10,000
Norton, Jay	Anadarko, BP, Encana, Questar, Western Sustainable Agriculture Research & Education Program, UW AES Competitive Grants Program, USDA-NRI Soil Processes Program	Effects of Natural Gas Well Development & Reclamation Activities on Topsoil Properties	\$40,000	\$40,000	\$80,000
Beck, Jeffrey	Anadarko Petroleum Corporation	Identifying Habitats for Greater sage-Grouse Population Persistence within the Atlantic Rim, Wyoming Coalbed Methane Field	\$40,000	\$150,000	\$190,000
Argyle, Morris	Jupiter Oxygen	Mercury Removal from Flue Gas Derived from Oxygen Combustion of Coal	\$25,000	\$25,000	\$50,000
Kauffman, Matthew	Wyoming Wildlife & Natural Resource Trust, Wyoming Game & Fish, Wildlife Heritage Foundation of Wyoming	Identifying mule deer migration routes to and from the Pinedale Anticline Project Area	\$45,000	\$45,000	\$90,000
FY08 Paid			\$215,000	\$726,500	\$851,500
# Paid Proposals				6	

CARBON SEQUESTRATION MONITORING ACTIVITIES

Summary of Project Objectives

U.S. Department of Energy (DOE)'s Office of Fossil Energy National Energy Technology Laboratory has awarded the University of Wyoming a \$1.55M contact to prepare for an extended field tests to fully characterize a potential CO₂ storage site in the Moxa Arch of western Wyoming and to demonstrate the long-term storage of sequestered carbon.

The Moxa Arch is a promising site for a large-scale sequestration demonstration for many reasons. 1) It is a geological structure that has stored carbon dioxide for many millions of years, 2) several formations appear to be suitable sequestration reservoirs, 3) carbon dioxide is presently being produced and sold for enhanced oil recovery in this area, and more carbon dioxide is potentially available for this and other uses, including for a future sequestration demonstration. The one-year project will start Sept. 1, 2008, and is composed of 11 tasks:

Task 1.0—Project Management and Planning

PI: Dr. Carol D. Frost, Professor of Geology and Geophysics and Associate Vice President for Research and Economic Development, Other personnel: Dr. Jeffrey D. Hamerlinck, Director of the Wyoming Geographic Information Science Center

Task 2.0—Geological characterization: Assembling and Validating a Well Database

PI: Dr. James D. Myers, Department of Geology and Geophysics

Task 3.0—Geological characterization: Geochemical Characterization of Produced Waters and Gases

*PI: Dr. Shikha Sharma, Associate Director, UW Stable Isotope Facility
Co-PI: Dr. Carol Frost, Professor of Geology and Geophysics*

Task 4.0—Geologic Characterization: Subsurface Structural Evaluation

PI: Dr. Erin Campbell-Stone, Department of Geology and Geophysics

Task 5.0—Geologic Characterization: Surface Structural Analysis

PIs: Dr. Arthur W. Snoke and Dr. Erin Campbell-Stone, Department of Geology and Geophysics

Task 6.0—Laboratory Experimental Activities: Mixed-phase (CO₂+H₂O) Fluid-Rock Reactions

PI: Dr. John Kaszuba, Department of Geology and Geophysics and School of Energy Resources

Task 7.0—Laboratory Experimental Activities: CO₂/Brine Relative Permeabilities

PI: Dr. Mohammad Piri, Department of Chemical and Petroleum Engineering

Task 8.0—Modeling Activities: Feasibility of Geophysical Modeling of CO₂-Reservoirs

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PIs: Dr Subhashis Mallick and Dr. Po Chen, Department of Geology and Geophysics and School of Energy Resources, and Dr. Ken Dueker, Department of Geology and Geophysics

Task 9—Modeling Activities: Multiscale Modeling and Numerical Simulation of CO₂ Injection

PIs: Dr. Felipe Pereira and Dr. Craig Douglas, Department of Mathematics and School of Energy Resources, Dr. Mohammad Piri, Department of Chemical and Petroleum Engineering, and Dr. Fred Furtado and Dr. Victor Ginting, Department of Mathematics

Task 10—Modeling activities: Determination of Optimal Geologic Model Complexity

PI: Dr. Ye Zhang, Department of Geology and Geophysics

Task 11—Performance Assessment

PIs: Wyoming State Geological Survey, Dr. Ronald C. Surdam, State Geologist, Rod DeBruin and John Jiao, Geologists

September 2008

**Legislature of the State of Wyoming
Clean Coal Technologies Research Program**

CALL FOR PROPOSALS

Issued by:

School of Energy Resources
University of Wyoming
209 Bureau of Mines
Department 3012, 1000 E. University Avenue
Laramie Wyoming 82071
307-766-2663
FAX 307-766-6701

Issue date: May 15, 2007

Closing date: August 31, 2007

Additional copies of this solicitation for the Clean Coal Technologies Research Program are available from the School of Energy Resources or at <http://uwacadweb.uwo.edu/SER/>

This program is subject to the affirmative action requirements that are prescribed by Executive Order 11246 (as amended), Section 202; by the Rehabilitation Act of 1973 (as amended), Section 503; by the Vietnam Era Veterans' Readjustment Assistance Act of 1974 (as amended), Section 402 (38 USC 2012).

CALL FOR PROPOSALS
Legislature of the State of Wyoming
Clean Coal Technologies Research Program

1. INTRODUCTION

The Clean Coal Research Task Force, composed of the members of the Wyoming Energy Resources Council to the University of Wyoming School of Energy Resources, requests proposals for research into clean coal technologies. This research is funded in part by the Clean Coal Research Account created by Original House Bill No. 301, Enrolled Act No. 121, enacted by the Legislature of the State of Wyoming during the 2007 General Session.

The Clean Coal Technologies Research Program was created to stimulate research to enhance and improve clean coal technologies, with an emphasis on use of sub-bituminous coal at high altitudes. Proposals are solicited from academic institutions and private industry. They will be evaluated competitively based upon their probable benefits to the State of Wyoming through improved use of Wyoming's coal resource. The results of the research will be available for public dissemination.

The Legislature of the State of Wyoming has appropriated \$2.5 million dollars to the Clean Coal Research Account. Expenditure of these funds requires a dollar for dollar match from non-state funds. These funds will become available upon 1) approval of the research projects recommended by the task force to the Governor and Joint Minerals, Business and Economic Development Interim Committee, and 2) appropriation of the funds from this account by the Legislature in March 2008. Funds are to be expended by June 30, 2009.

2. RESEARCH TOPICS

The Clean Coal Research Task Force (hereafter referred to as the "task force") will accept proposals in areas outlined below.

Pre-combustion/pre-gasification coal technologies – specifically the task force will accept proposals outlining research examining new coal pulverization technologies, coal pretreatment, pre-combustion clean-up of regulated materials such as mercury, metalloids, or new technologies examining coal feed including slurring or others which may support gasification, advanced combustion or existing combustion technologies.

Combustion and gasification design technologies – the task force seeks proposals outlining new methods supporting ultra-supercritical or supercritical combustion using Wyoming coals as the fuel source in Wyoming. These studies may include research that would mitigate the known effects of altitude, water requirement or fuel source that currently cause concern about the placement of ultra-supercritical or supercritical combustion facilities in Wyoming. We also will accept proposals examining the same using other oxy-combustion technologies. In addition, proposals seeking to refine gasifier design and thereby alleviate the current constraints on such facilities caused by altitude, water need or fuel source will be considered. Any other

technologies that improve reactor design and therefore remove barriers to their use in Wyoming are encouraged.

Post-combustion/post-gasification gas clean-up technologies – proposals examining gas clean-up technologies are sought. The committee will entertain research aimed at removing regulated materials, SO_x, NO_x, or carbon dioxide from either coal combustion or gasification facilities. This includes proposals examining cold, warm and hot gas clean-up. It does not include technologies examining fly ash removal.

Advanced cycle technologies – proposals outlining advancement in the use of steam, heat or synthesis gas use are encouraged. This includes technologies describing new polygeneration technologies, new steam, synthesis gas, or heat capture and use technologies.

Air separation technologies – proposals outlining new technologies that reduce the cost of air separation and specifically for the generation of oxygen at higher altitudes to feed the advanced combustion and gasification technologies are sought.

Carbon capture and sequestration technologies – the task force solicits proposals examining the removal of carbon dioxide gas from conventional and advanced combustion and gasification facilities. Any technologies that specifically remove carbon dioxide from the flue gas or other waste streams will be considered. The committee also will entertain proposals dealing with the sequestration of captured carbon dioxide. This may include new compression technologies, modeling studies examining the behavior of carbon dioxide at depth, geologic analysis of mineralization rates of stored carbon dioxide and analyses dealing with the amount of carbon dioxide that may be geologically sequestered in Wyoming.

***In situ* gasification technologies**- proposals outlining *in situ* coal gasification are sought. The task force recognizes that a vast amount of Wyoming coal cannot be mined with current technology. *In situ* gasification research must center on those elements of the technology that makes this process amenable to Wyoming coals and evaluates these technologies relative to environmental issues known to be associated with this type of gasification.

Coal to liquids/coal to hydrogen technologies – proposals examining new technologies whereby Wyoming coal may be converted to liquids including fuels, chemical feedstocks or hydrogen are encouraged. These studies may outline the use of new catalysts, or advancements made in known technologies using Fischer-Tropsch or water gas shift reactions are encouraged. These studies must focus on how these technologies may be developed or modified for their deployment in Wyoming.

Economic analysis – studies examining the cost/benefit of combustion and gasification of Wyoming coals at altitude are sought. It is important to understand how location, altitude, fuel source, water and external factors such as carbon dioxide gas mitigation (such as tax or cap and trade) will affect the ability of industry to install facilities in Wyoming. The result of economic studies should be written in such a way as to provide information from which policymakers can craft legislation and regulation.

3. FUNDING LIMITATIONS AND PROJECT PERIOD

Proposers may request between \$250,000 and \$2,500,000 from the Clean Coal Research Account, to be matched dollar for dollar by non-state funds. Based upon the quality of the proposals submitted, it is possible that during the 2008 Legislature, which adjourns in March 2008, the current appropriation of \$2,500,000 may be increased. Thus, projects requiring a match of more than \$2,500,000 are not excluded but will require legislative action, the likelihood of which is unknown. The Clean Coal Task Force will forward to the Governor and Joint Minerals, Business and Economic Development Committee the projects they recommend by September 30, 2007. Projects will be completed and unexpended funds revert on June 30, 2009.

4. APPLICANT ELIGIBILITY AND QUALIFICATIONS

Participation in this program is open to all university and community college faculty and staff, to private industry, to government agencies, and to individuals. Qualifications of the investigators and appropriateness of the research topics will be major determinants during review of the proposal. The Clean Coal Research Task Force encourages investigators to collaborate with two or more groups (e.g. industry and academia) if they judge this will result in a better project. Where appropriate, the task force also encourages interdisciplinary interactions between researchers.

5. PROPOSAL PREPARATION

A. Minimum requirements

To be eligible for funding, proposals must describe how the research relates to improved use of Wyoming coal at high altitude. All proposals submitted must contain each of the following:

1. Signed application form (Attachment 1)
2. Table of contents
3. Abstract (300 words or less) (Attachment 2)
4. Introduction
5. Detailed explanation of the relationship of the research to improved use of Wyoming coal and increased use of Wyoming coal within the state, and transfer of the results to the State of Wyoming and user groups.
6. Scientific discussion (including experimental design)
7. Statement of work (including schedule and methods)
8. Literature references
9. Appendix, to include:
 - a. Short vitae (maximum 3 pages) for principal investigators
 - b. Description of facilities and equipment to be used
 - c. Other pertinent information bearing on qualifications to conduct project

Budget (see below)

B. Budget format

A detailed budget is requested. The following minimum information must be included.

1. For personnel, please show descriptive job titles, rates of pay, and man-hours/months/days. Fringe benefits should be shown as a separate item, with a brief explanation of the formula used.
2. For supplies, please show a breakdown by major category.
3. For equipment please show a breakdown by item. Non-consumable equipment purchases will not be an allowable cost but will be considered as a match.
4. For travel necessary to conduct the research, including attendance by one or more principal investigators at the annual project review seminar, please show purpose. If a per diem rate is used, please explain the rate fully.
5. For consultants, information similar to that requested above for personnel items should be shown.
6. For the portion of the total project budget that will be supplied or matched from other sources, full information on the sources of the funds should be shown. We recommend a budget format that includes a separate column for each source of funds.
7. A clear statement of the total amount that is requested from the Clean Coal Technologies Research Program.

A budget with the same level of detail must be included for the matching funds from a non-state source. This budget detailing matching funds must include an authorizing signature.

6. SCREENING AND EVALUATION PROCESS

The members of the Clean Coal Research Task Force, composed of members of the Energy Resources Council and/or their designees, will screen all proposals. The members of the task force may choose to submit any proposal to external reviewers and each proposal will be reviewed by at least two individuals with relevant technical expertise.

After consideration of any comments from external reviewers, the members of the Clean Coal Research Task Force will review each proposal and will forward recommendations to the Governor and Joint Minerals, Business and Economic Development Committee.

A. Evaluation criteria

Proposals will be reviewed initially for compliance with the Proposal Preparation guidelines above. Those proposals that are found to be in compliance with those guidelines will be evaluated by use of the evaluation criteria described below. Budget information will be considered during the review.

The Rating Form (Attachment 3) will be used for the review of proposal by the members of the task force and by the external reviewers.

B. Applicant notification

All investigators who submit proposals for consideration will be notified by letter of the recommendation of the Clean Coal Research Task Force to the Governor and Joint Minerals, Business and Economic Development Committee prior to the meeting of the Joint Minerals, Business and Economic Development Committee on September 30, 2007.

7. RESEARCH CONTRACT REQUIREMENTS

The research contract requirements in this section are being recommended by the Clean Coal Task Force to the Joint Minerals, Business, and Economic Development Interim Committee. These reporting requirements are subject to legislative approval as a condition of appropriating funds from the Clean Coal Research Account. Investigators whose proposals are funded are required to:

1. Execute an **agreement** for the research to be performed
2. Submit a **Final Executive Summary Report**
3. Submit a **Final Technical Report** and
4. Present a **Final Seminar** to user groups at a Clean Coal Technologies Workshop organized by the University of Wyoming School of Energy Resources.

1. Execute an agreement for the research to be performed

This agreement shall specify the terms and conditions under which the state funds shall be disbursed, including but not limited to:

- A methodology, including the ability for the State of Wyoming to audit records as necessary, to ensure that matching funds required under the proposal are available and actually expended for the research to be performed.

- A means for the executive summary and final technical report to be submitted to the State of Wyoming to verify that the research described in the proposal for which state funding was provided was accomplished in a manner and of a quality that was represented in the proposal.

2. Final Executive Summary Report

This report should be a concise non-technical summary of project results and recommendations. We intend the audience to include user groups, the general public, and non-specialists in the field. The Final Executive Summary Report should be less than 15 double spaced pages in length.

3. Final Technical Report

The Final Technical Report is intended for use by professionals and other scientists in the general field of clean coal technologies. It should contain a complete and thorough report of project activities conducted. Minimum content of the technical report should be as follows:

- A. Abstract (less than 300 words)
- B. Introduction

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- C. Objectives
- D. Methods
- E. Results
- F. Technical Information (not to exceed 40 double spaced pages)
- G. Conclusions and Recommendations
- H. Appendix with the following:
 - 1. Abstracts of resulting theses/dissertations
 - 2. Full citations for resulting publications and for manuscripts submitted for publication
 - 3. Data on scientific collaborators (persons who worked more than 40 hours in one year), with full identification)
 - 4. Description of inventions
 - 5. Other information that was specifically required by the terms of the award

The Final Executive Summary Report and the Final Technical Report are due September 30, 2009 (90 days after the completion of the projects). **The Final Report should also be submitted in electronic format in order to place it on the web.**

4. Final Seminar

The School of Energy Resources will host a Clean Coal Technologies Workshop in late 2009. All investigators who were awarded funds from the Clean Coal Technologies Research Program will present a seminar at this workshop, which will be open to the public.

All presentations and publications that result from work that is supported wholly or in part with funds from the Clean Coal Research Account should acknowledge this support by use of the following language:

- 1. Funding for this research project was provided by the Wyoming State Legislature.
- 2. The state and federal awarding agencies reserve a royalty-free, nonexclusive, and irrevocable license to reproduce, publish or otherwise use, and to authorize others to use, for state and federal government purposes:
 - a. The copyright in any work developed under a grant, subgrant, or contract under a grant or subgrant, and
 - b. Any right of copyright to which a grantee, subgrantee or a contractor purchases ownership with grant support.

In cases where funds from the Clean Coal Technologies Research Program result in intellectual property that may be copyrightable and/or patentable, an investigator is free to copyright and/or patent the property according to the rules and policies of their employment. However, the condition applies that the Federal government and the State governments reserve a royalty-free, non-exclusive, and irrevocable right to manufacture, produce, publish, copy, or otherwise use and authorize others to use the copyrighted and/or patented property for purposes of Government-sponsored work.

SUBMITTAL INFORMATION

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Please deliver the original proposal, both in electronic and hard-copy form, plus 15 full copies of the proposal to the address below before 5:00 pm Friday, August 31, 2007. No exceptions will be made for late arrival of proposals, for any reason.

School of Energy Resources
University of Wyoming
209 Bureau of Mines
Department 3012, 1000 E. University Avenue
Laramie Wyoming 82071

The electronic copy of the proposal should be emailed to serpros@uwyo.edu with “Clean Coal Technologies Proposal” in the subject line.

If you have questions regarding this funding program or if you need more information, please contact the School of Energy Resources at 307-766-2663 or email serpros@uwyo.edu with “Clean Coal RFP query” in the subject line.

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Attachment 1

**CLEAN COAL TECHNOLOGIES RESEARCH PROGRAM
APPLICATION FORM**

(Please complete this form for each investigator)

Name			
Title			
Organization			
Address			
<i>Street or Box number</i>	<i>City</i>	<i>State</i>	<i>Zip</i>
Contact Info		<i>FAX</i>	<i>E-mail</i>
<i>Phone</i>			
PROPOSAL TITLE			
Total \$ requested from AML program:			

Please complete abstract on attachment 2

Signature of Investigator		Date
Authority (name and title) Organization	<i>Please type or print</i>	
Signature of Authority		Date

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Attachment 2

CLEAN COAL TECHNOLOGIES RESEARCH PROGRAM

PROPOSAL ABSTRACT
(300 Words or less)

Attachment 3

**RANKING FORM FOR PROPOSALS FOR CLEAN COAL TECHNOLOGIES
RESEARCH PROGRAM**

PROPOSAL NUMBER _____ Describe briefly the focus of the project (one or two sentences).

EVALUATION CRITERIA: Please rank the proposal from 1-5 (1 being excellent – 5 being poor) in each of the following categories by circling the desired ranking.

1. ***Relevance and Importance:*** Does this proposal directly address research areas that can be directly related to clean coal technologies as described in the Call for Proposals? If so, does it deal with a subject of particularly high importance to present and future use of Wyoming coal? Does the project have relevance and importance to the economy of the State of Wyoming? Have format requirements been met?

Excellent 1 2 3 4 5 ***Poor***

2. ***Scientific Merit:*** Does this proposal have potential to expand the fundamental knowledge in its specific area(s)? Is it scientifically sound? Is the investigator(s) cognizant of past work? Is the proposal well written, organized, and complete? If appropriate, does it represent an integrated interdisciplinary approach?

Excellent 1 2 3 4 5 ***Poor***

3. ***Feasibility:*** Are the objectives, methodologies, designs, and techniques adequate and completely described? What is your judgment of the likelihood of success given the methods and time frame proposed?

Excellent 1 2 3 4 5 ***Poor***

4. ***Technology Transfer:*** Does the proposal actively address the eventual transfer of results to user groups? Does it actively address the impact the results could have?

Excellent 1 2 3 4 5 ***Poor***

5. ***Qualifications:*** Are the qualification of the investigator(s) commensurate with the proposed research? Are the facilities and equipment adequate? If appropriate, have external funding agencies and cooperators been identified? Has the nature of such cooperation been described?

Excellent 1 2 3 4 5 ***Poor***

6. ***Budget:*** Is the budget reasonable and adequate for the work proposed?

Excellent 1 2 3 4 5 ***Poor***

IMPORTANT! (EVALUATORS, PLEASE COMPLETE THE REVERSE SIDE OF THIS FORM)

September 2008

PROPOSAL NUMBER _____

STRONG POINTS: (Novelty, need for study, exceptional qualifications, etc. Please feel free to use additional pages.)

WEAK POINTS: (Please provide substantive, constructive comments and state the shortcomings. Please feel free to use additional pages.)

NOTES TO REVIEWERS: Comments that do not appear on this form or on an attached sheet will not be considered. We will not search your copy of the proposal for comments. A synthesis of review comments will be provided to investigators if requested. Please return the Rating Form to: School of Energy Resources, University of Wyoming, 209 Bureau of Mines, Department 3012, 1000 E. University Avenue, Laramie, WY 82071.

Clean Coal Technology Fund: Research Projects Funded – 2007 RFP

Title	Submitted by	Principal Investigator	Request	Match	Outside Match Org.	Total Funds	Technology Areas
Pre-Gasification Treatment of PRB Coals for Improved Advanced Clean Coal Gasifier Design	Western Research Institute (WRI)	Dr. Alan Bland, VP	\$399,981	\$399,981	DOE, Nat'l Energy Technology Lab	\$799,962	Pre-combustion/pre-gasification technologies
Capture & Mineralization of Carbon Dioxide from Coal Combustion Flue Gas Emissions: Pilot Scale Studies	Department of Renewable Resources, UW	Dr. KJ Reddy, Professor	\$485,000	\$487,115	Jim Bridger Power Plant	\$972,115	Carbon capture and sequestration technologies
Carbon Capture from Coal Flue Gas on Carbonaceous Sorbents	Supercritical Fluids, Inc., Laramie, WY.	Dr. Maciej Radosz	\$375,000	\$375,000	PacifiCorp Energy EPRI Supercritical Fluids, Inc.	\$750,000	Carbon capture and sequestration technologies
Novel Fixed-Bed Gasifier for Wyoming Coals	Emery Energy Company, Salt Lake City, UT.	Benjamin Phillips, President	\$562,500	\$562,549	Emery Energy Co. WRI	\$1,125,000	Combustion and gasification design technologies

Total CCTF Match \$1,822,481

Total Research Cost \$3,647,078

APPENDIX D

Outreach Initiatives

**2008 Darcy Lecture:
Geological Storage as a Carbon Mitigation Option
Professor Michael Celia, Princeton University
Tuesday March 4, Union Family Room
Reception 2:30 pm / Lecture 3:00 pm**



Anthropogenic emissions have increased atmospheric concentrations of CO₂ by about 35 percent during the past 200 years. The current concentration, about 385 ppm, represents the highest CO₂ concentration in the last 500,000 years. Projected future emissions will double the Pre-industrial CO₂ concentration within the next 50 years. If this relentless increase is to be reduced or reversed technological solutions must be implemented on a massive scale. While many options are being considered, one attractive approach is carbon capture and storage, or CCS.

Geological storage involves capture of CO₂ before it is emitted into the atmosphere and subsequent injection of the CO₂ into deep geological formations. Injection of CO₂ into deep formations leads to a multiphase flow problem that may involve important mass exchange between phases, nonisothermal effects, and complex geochemical reactions. In addition, because enormous quantities of CO₂ must be injected to have any significant impact on the atmospheric carbon problem, the spatial scale of the problem is very large.

Broad questions about the fate of injected CO₂, including possible leakage of CO₂ out of the formation, as well as the fate of displaced fluids like resident brines, lead to challenging modeling and analysis problems. Because important leakage pathways can be localized, and their properties can be highly uncertain, an overall analysis of the system requires resolution of multiple length scales in the context of a probabilistic approach. These requirements render standard numerical simulators ineffective due to excessive computational demands. A series of simplifying assumptions may be proposed to provide more efficient numerical calculations, even to the point of allowing for analytical or semianalytical solutions. Such simplifications, while restrictive in their assumptions, allow for large-scale analysis of leakage in a probabilistic framework while capturing much of the essential physics of the problem. Example calculations illustrate the utility of these methods, and show the current state of leakage estimation. They also lead to a proposal for specific field experiments that can reduce the uncertainty associated with potential leakage pathways.

Professor Celia is the 2008 Henry Darcy Distinguished Lecturer for the National Groundwater Association. He chairs the Department of Civil and Environmental Engineering at Princeton University. He received a B.S. in civil engineering from Lafayette College and an M.S. and Ph.D. in civil engineering from Princeton University. His areas of research include ground water hydrology, ecohydrology, numerical modeling, contaminant transport simulation, and multiphase flow physics. He is a Fellow of the American Geophysical Union and recipient of the 2005 AGU Hydrologic Sciences Award.

WCC ENERGY RESOURCES MANAGEMENT PROJECTS



Introduction

During the 2008 program year the Wyoming Conservation Corps (WCC) received \$16,000 of funding from the School of Energy Resources (SER) at the University of Wyoming. These funds were used to cover education costs of the program for thirty-two WCC students to enroll in the WCC classes and for WCC crew leaders to enroll in the Student Leadership Strategies Class during the spring semester. A total of seventy-two credit hours were funded by this donation.

The WCC seeks to introduce students to the natural resource issues facing Wyoming's energy industry. During the 2008 season the WCC completed three energy related projects throughout the state. Working with three different companies, Devon Energy, EnCana, and RockWell Petroleum, students were introduced to management issues in the Osage Oil Field near Newcastle; the Jonah Field near Pinedale; and Continental Divide Creston area near Baggs.



Ralph Swift (EnCana) and WCC crew leaders. Jonah Field April 19, 2008.

Energy Resources Management Projects

Devon Project – This year the WCC completed a project with the Rawlins Bureau of Land Management Office funded by Devon Energy. Students worked with BLM and Devon staff to remove more than eight miles of woven wire fence from a critical migration corridor in the Continental Divide Creston field north of Baggs and replace it with wildlife friendly fence.

The completion of this project provided students with a hands-on introduction to the wildlife management issues facing energy companies and the BLM in the area south of Rawlins.

EnCana Project – During the spring semester eight WCC crew leaders traveled to Pinedale to work with EnCana in the Jonah Field to collect soil samples at fifty different well sites. Working with Ralph Swift from EnCana and Steve Williams, director of the University of Wyoming's Reclamation and Restoration Ecology Center the students collected over 100 soil samples within a day and a half. In addition to collecting soil samples the students attended a panel in Pinedale that talked about community impacts of energy development in Sublette County. The Panel included Ralf Swift (EnCana), Pete Guernsey (Questar), Betty Fear (UW Trustee), Joel Bousman (Sublette County Commissioner), Steve Brown (Pinedale Mayor), and Steve Williams (Dir. Wyoming Reclamation Restoration Ecology Center). This panel provided additional insight into the impact of energy development on Wyoming's communities and how energy companies actively work with local communities to address social and environmental impacts.

BLM Newcastle Project – This season a single WCC crew completed a project for the BLM Newcastle field office. This project focused on wildlife. The project had students working in the Osage oil field in Weston County. The students spent four days walking power lines in an effort to survey for Raptor kills and look for sage grouse, the students also spent four days repairing wildlife guzzlers throughout the Osage oil field. This project was completed with the cooperation of RockWell Petroleum. The completion of this project introduced students to some of the wildlife management issues facing the BLM and industry in northwest Wyoming.

Current Industry Partnerships / Connections

- Minerals, Business, and Economic Development Committee
 - SF-85, establishing the Wyoming Conservation Corps, was sponsored by the Joint Minerals Committee During the 2007 legislative session.
 - Legislation provides \$312,000 appropriation of matching funds to create incentive for the establishment of the program.
 - Legislation allows for matching funds to be utilized to complete projects with industry.
- Devon Energy
 - Donated a 2005 Ford F-250 Extended Cab truck.
 - Donated \$11,000.
 - WCC completed a Devon sponsored project for the Rawlins BLM office.
- Wyoming Department of Environmental Quality - Supplemental Environmental Project (SEP) Account.
 - The WCC has signed a memorandum of understanding with the DEQ that allows companies found in violation to direct a portion of the penalty to the University of Wyoming. These funds will be used by WCC crews to complete SEPs throughout the state.
- Petroleum Association of Wyoming (PAW)
 - WCC presented to the general assembly at the 2008 annual meeting.
- CBM Education Fair – Gillette, Wyoming
 - Informational booth, 2006 & 2007 fair.
 - Shared a booth with SER at 2008 fair

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Finding the Balance: Energy and Climate

Final Agenda

Monday, October 8, 2007

Summit Kick-Off

7:00 pm Welcome

- **Tom Buchanan**, *University of Wyoming President*
- **Mark Barron**, *Mayor, Town of Jackson, Wyoming*

7:15 pm Wyoming's Place in the Energy-Climate Puzzle

- **Governor Dave Freudenthal**

7:45 pm Global Future for Finding the Energy-Climate Balance

- **Lord Ron Oxburgh**, *Former Chairman, Royal Dutch Shell PLC*

Tuesday, October 9, 2007

8:00 am Welcome, Overview and Challenge to Summit Participants

- **Ambassador Tom Stroock**
-

Morning Session – Climate (8:15 am to 12:00 noon)

Introduction by Harold Bergman, Director of UW Ruckelshaus Institute and Haub School of Environment and Natural Resources

8:15 am Climate Science: The Physical Science of Climate Change-- What we know and what we don't know

- **Martin Manning**, Director, IPCC Working Group I Support Unit, University Corporation for Atmospheric Research

9:00 am Climate Impacts: Understanding Climate Change Impacts in the Context of Uncertainty and Risk

- **Stephen Schneider**, Melvin and Joan Lane Professor for Interdisciplinary Environmental Studies, Professor, Department of Biological Sciences and Senior Fellow, Woods Institute for the Environment, Stanford University

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9:45 am Climate Economics and Policy: Blending Science and Economics in Making Policies

- **Geoff Heal**, Paul Garrett Professor of Public Policy and Business Responsibility, Columbia University

10:30 am BREAK

11:00 am Morning Session Speaker Panel

- Audience Q&A session - Moderated by Bill Blakemore, ABC News

12:00 noon Lunch Break

Afternoon Session – Energy (1:30 pm to 5:00 pm)

Introduction by Jim Steidtmann, Director of UW Enhanced Oil Recovery Institute

1:30 pm Oil and Gas: Technology and Geopolitics

- **Michael Economides**, Professor of Chemical and Biomolecular Engineering, University of Houston

2:15 pm Clean Coal: America's Energy Future -- The Solution for Energy, Economic and Environmental Needs

- **Fred Palmer**, Senior Vice President of Government Relations, Peabody Energy

3:00 pm Energy Mix: What Are the Alternatives?

- **Ralph Cavanagh**, Senior Attorney and Co-Director, Energy Program, Natural Resources Defense Council

3:45 pm BREAK

4:15 pm Afternoon Session Speaker Panel

- Audience Q&A session - Moderated by Bill Blakemore, ABC News

Evening Keynote Address

Introduction by Rob Hurless, Energy and Telecommunications Policy Advisor to Governor Dave Freudenthal

7:30 pm John Lavelle, *President, GE Gasification*

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Wednesday, October 10, 2007

Introduction by Carol Frost, UW Professor of Geology and Geophysics

Morning Session I: Finance and Risk (8:00-9:45)

8:00 am Where is the Money? Capital Markets for Energy Development

- David Siever, Capital Technology, Inc.

8:45 am What are the Risks? Risk, Liabilities and Carbon Trading

- Kipp Coddington, Alston & Bird

9:30 am Session Speaker Panel

- Audience Q&A session - Moderated by Bill Blakemore, ABC News

9:45 am BREAK

Morning Session II: Implications for Wyoming (10:00-1:00)

10:00 am The Energy Picture From a Washington Perspective

- U.S. Senator John Barrasso

10:15 am Distillation

- **Bill Blakemore**, *ABC News*

10:30 am Wyoming Decision-makers and Opinion Leaders Panel

- **Peter Wold**, *President, Wold Oil Properties, Casper, Wyoming*
- **Stephanie Kessler**, *The Wilderness Society and former Board Chair, Greater Yellowstone Coalition*
- **Marion Loomis**, *Executive Director, Wyoming Mining Association*
- **John Corra**, *Administrator, Wyoming Department of Environmental Quality*
- **Mark Northam**, *Director, University of Wyoming School of Energy Resources*
- **Sarah Gorin**, *Board Chair, Equality State Policy Center*
- **Colin Simpson**, *Wyoming House Majority Floor Leader; Attorney, Simpson, Kepler & Edwards, LLC*
- **Rob Hurless**, *Energy and Telecommunications Policy Advisor to Governor Dave Freudenthal*

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- **Tom Stroock**, *Former Ambassador to Guatemala*

11:30 am Panel Discussion and Audience Q&A

- Moderated by Bill Blakemore, ABC News

12:30 pm Summit Wrap-up

- Dick Davis, President, University of Wyoming Board of Trustees

1:00 pm Summit Adjourned

Press Release October 9, 2008

Climate Summit Opens in Wyoming

Oct. 9, 2007 -- Wyoming Gov. Dave Freudenthal on Monday urged the federal government to invest in carbon capture and sequestration as it has in other research areas. He was keynote speaker during a University of Wyoming-sponsored summit "Finding the Balance: Energy and Climate" in Teton Village, Wyo.



Freudenthal said the government should invest in these areas much as it did in the space program in the 1960s and 1970s. Taking carbon from the air is one of the proposals being considered, but there are many unknowns.

"It's not inappropriate to consider," he said. "If we do this right, the costs can be borne. A rational federal policy can supplement state policy. We have the (UW) School of Energy Resources and other things, but they are not going to work as well if there is no rational federal policy," Freudenthal said.

University of Wyoming President Tom Buchanan opened the summit by summing up

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the work of conference experts who are striving to develop recommendations for policy makers dealing with climate change and energy development.

"Our task is straightforward: recognizing our scientific shortcomings and questioning our prognostications while preserving flexibility for future generations," Buchanan said.

The summit, which has brought together prominent experts from a range of disciplines, continues today (Tuesday) and Wednesday with presentations and panel discussions on topics ranging from what scientists know and don't know about climate change to the risks and benefits of carbon trading.

Wyoming plays a large role in all of these discussions because of the breadth and availability of energy sources in the state, including vast reserves of coal, which is the primary fuel in making electricity. Burning coal, however, is also a source of carbon dioxide, which is a greenhouse gas.

Lord Ron Oxburgh, former non-executive chairman of Royal Dutch Shell PLC, and former head of the Department of Earth Sciences who also served as president at Queens' College, among other posts, said he has watched the infighting that has developed among developers of different kinds of energy -- solar versus wind, for example -- as they jockey for primacy, and he dismisses these conflicts.

"Tackling climate change is a major challenge. Every source of energy is going to be needed. None will put the others out of business. And fossil fuels will be needed for at least the next 50 years," Oxburgh said. "Time is not on our side."

Even as those topics are debated, Buchanan highlighted the balance that must be struck: "The greatest costs are unlikely to be felt in our lifetimes."

Photo

Gov. Dave Freudenthal speaks at a University of Wyoming-sponsored summit on

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"Finding the Balance: Energy and Climate" as UW President Tom Buchanan looks on.

Press Release October 10, 2008

Climate Summit Panel Calls for Immediate Action

Oct. 10, 2007 -- Energy production's effects on climate change are huge issues facing the nation and the world, according to a summation at the close of a three-day summit on energy and climate change that concluded today (Wednesday) in Teton Village, Wyo.



Dick Davis, president of the University of Wyoming Board of Trustees, said, "The fact there is dialog taking place about this in Washington, D.C., shows acceptance that these are huge issues that face the nation and the world. And there is optimism that we can get on top of these issues before we're too late."

Davis' comments came after the final panel discussion at "Finding the Balance: Energy and Climate," a three-day summit sponsored by UW.

The panel featured nine speakers from around the state: Peter Wold, president of Wold Oil Properties; Marion Loomis, executive director of the Wyoming Mining Association; Mark Northam, director of the UW School of Energy Resources; John Corra, director of the Wyoming Department of Environmental Quality; Sarah Gorin, chairwoman of the Equality State Policy Center; Wyoming Rep. Colin Simpson from Cody; Stephanie Kessler, soon to be Wyoming program manager for The Wilderness Society; Rob Hurless, energy and telecommunications policy adviser to Wyoming Gov. Dave Freudenthal; and Ambassador Tom Stroock.

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"I can't think of a better time and place to be than where I am," Davis said. "How could I not when ABC's Bill Blakemore is calling this a watershed event?"

UW sponsored the summit to advance the discussion on climate change and the role that Wyoming -- with all its energy resources -- can play in the discussion.

Scientists, energy company officials and policymakers attended the summit. It also drew UW students, residents from Wyoming and several surrounding states, and representatives from both energy companies and environmental groups.

Wednesday's slate of events also included an appearance by U.S. Sen. John Barrasso, who said Wyoming must be at the forefront of discussions of energy and climate change. He agreed with Gov. Freudenthal that serious, focused research is needed, as is immediate action on carbon capture and sequestration and support for turning coal into liquid fuel.

Blakemore, who moderated the panel's summit discussions, has covered climate change as part of his duties for ABC News.

"This was the summit to come to where we could hear all the issues at once," he said.

Photo

University of Wyoming School of Energy Resources Director Mark Northam was among state leaders participating in a panel discussion during Wednesday's closing session of "Finding the Balance: Energy and Climate," a three-summit in Teton Village, Wyo.