



2009 ANNUAL REPORT

1 October 2009

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

UNIVERSITY OF WYOMING
SCHOOL OF ENERGY RESOURCES
Third Annual Report, 1 October 2009
[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

EXECUTIVE SUMMARY

This document is the third annual report of growth and development of the School of Energy Resources (SER) at the University of Wyoming. SER's objectives are to partner with UW colleges 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 stakeholders, community colleges, and government agencies.

Academics

- Recruiting was active during the year. Two faculty searches were conducted in the areas of Reclamation and Restoration Ecology (offer accepted) and Catalysis (offer declined). One visiting faculty in Mathematics was on campus for two semesters.
- The Energy Resource Science BS Degree program was approved by the UW Board of Trustees to be offered starting with the fall semester of 2009.
- Graduate Assistantship program support 15 graduate student. SER approved support for 35 new MS and PhD students.
- The Energy Summer Institute was offered for a third time. Twenty-six high school sophomores and five teachers completed the two week program.

Research

- The Matching Grant Fund continues to meet the objective of providing UW faculty with an advantage in capturing outside grants. \$1.57 million was committed to twenty-one new proposals, although none has yet been approved for funding.
- Ten research centers are in various stages of operation. Four new centers – Carbon Management, Clean Coal Technology, Energy Economics, and Fundamentals of Fluid Flow – were organized during the year.
- The Clean Coal Task Force awarded \$2.5 million in matching funds from the Clean Coal Research Account to five proposals. This adds to the \$1.8 million in matching funds award in the previous year. The state legislature increased the size of the fund by \$10.6 million in its 2009 general session, leaving a total of \$12,418,466 available to fund new research. A third call for proposals attracted 22 submissions. Subsequent review led to

the endorsement for funding of eight additional projects that will utilize \$5,952,766 of the remaining funds.

Outreach

- The position of Associate Director for Energy Outreach was accepted by Mary Byrnes.
- SER sponsored and/or coordinated ten symposia, conferences and workshops during the year.
- Five colloquium speakers were sponsored by SER.

Development Activities

- Work commenced on designing the Energy Resource Center. \$20.5 million has been raised through gifts and state matching funds for construction of the building.
- Significant new gift commitments came from Arch Coal, Inc., Peabody Energy, and Ultra Petroleum.

Financial

- SER's expenditures for FY2009, the third year of a planned four-year buildup, totaled \$4,542,454. Expenditures were lower than expected due factors such as delayed arrival of faculty, failed searches, rejected research grants, and slowed development of programs. Spending for the biennium is still expected to approach the \$19,440,742 appropriated as activity in all areas is accelerating.

INTRODUCTION

Fiscal Year 2009 was the third full year 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 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. The original plan for developing SER called for a four-year ramp up in staffing and activities. That ramp up continues, and we are essentially on schedule.

As outlined in the school's academic and fiscal plan, SER's objectives are partner with the UW colleges 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 stakeholder, community colleges, and government agencies. To pursue those objectives, SER is organized in three units:

- Academic Programs
- Research Programs, including the Institute for Energy Research
- Energy Outreach Programs

Initiatives undertaken in FY2009 were under the guidance of SER's Energy Resources Council and the leadership of Dr. Mark A. Northam-Director, Professor K. J. Reddy-Associate Director for Academics and Mary Byrnes-Associate Director for Energy Outreach.

UW Energy Resources Council

The UW Energy Resources Council, appointed by Wyoming's governor, is responsible for prioritization of research and outreach activities for SER. During FY2009, one member left ERC – Bobby Shackouls, Retired President, Chairman, and CEO, Burlington Resources, Inc. – and two new members joined. Dr. N. Maha Mahasenan and James Kleckner were appointed and confirmed as new members of the council.

At the end of FY2009, the standing members of the University of Wyoming Energy Resources Council are:

Ron Harper – Chairman	<i>CEO and GM, Basin Electric and Basin Cooperative Services</i>
Rep. Tom Lockhart – Vice Chairman	<i>Chairman, Joint Minerals, Business, and Economic Development Interim Committee</i>
Indy Burke (ex-officio)	<i>Director Haub School and Ruckelshaus Institute of Environment and Natural Resources</i>
Thomas Buchanan (ex-officio)	<i>President, University of Wyoming</i>
Paul Lang	<i>Senior Vice President, Operations, Arch Coal Inc.</i>
James Kleckner	<i>VP of Operations, Anadarko Petroleum Corp.</i>
N. Maha Mahasenan	<i>Sr. Policy Advisor - Americas, Hydrogen Energy Int'l</i>
Keith O. Rattie	<i>President, Chairman, and CEO, Questar Corp.</i>
Thomas Stroock	<i>Former US Ambassador to Guatemala; President, Alpha Development Corp.</i>
Sen. Charles Townsend	<i>Appropriations and Select Water Committee, Enhanced Oil Recovery Commission</i>
Rob Wallace	<i>Manager, Government Relations, GE Energy</i>

This annual report summarizes progress made in the following.

- A. Academic Programs
 - 1. School of Energy Faculty
 - 2. Academic Initiatives
 - a) Academic Council
 - b) Energy Resource Science Degree Program
 - c) Faculty Scholarly Activities
 - d) Graduate Assistantship Allocations
 - e) Energy Summer Institute
 - f) Council for Energy Research and Education Leaders
 - g) Publications and Presentations
- B. Research Programs
 - 1. Matching Grant Fund Program
 - 2. The Institute for Energy Research
 - a) Enhanced Oil Recovery Institute
 - b) Coal Bed Natural Gas Center
 - c) Renewable Energy Center
 - d) Wyoming Reclamation and Restoration Center
 - e) Clean Coal Technology Center
 - f) Fundamentals of Fluid Flow Research Center
 - g) Wind Energy Research Center
 - h) Carbon Management Research Center
 - i) Center for Energy Economics and Public Policy
 - j) Uranium Research
 - 3. Clean Coal Technology Fund
- C. Outreach Initiatives
 - 1. Associate Director Search
 - 2. Symposia, Conferences and Workshops
 - 3. Colloquium Speaker Series
 - 4. Participation in Conferences, Exhibitions and Trade Fairs
- D. Development Activities
- E. Financial Report

A. Academic Programs

The mission of SER's Academic Program is to develop interdisciplinary undergraduate and graduate programs to prepare the energy workforce of the future for industry, state and federal agencies, and academics. Professor K. J. Reddy continues to serve as Associate Director of Academics. His duties are to oversee faculty hires, to lead the development of academic programs, to lead the SER faculty in their energy-related activities, to oversee the Academic Council, to administer the prioritization of proposals for the Matching Grant Fund and the Graduate Assistantship Program, and to oversee the Energy Summer Institute. As part of the Academic Program, Dr. Reddy also participates in local, regional, and national programs related to energy education, research, and outreach.

1. School of Energy Resources Faculty

The original plan for development called for creating twelve new distinguished faculty positions for teaching, research, and outreach to fill gaps in energy expertise on campus. During FY2006 and FY2007, UW academic departments partnered with SER to hire ten faculty through national and international searches. Eight of the ten faculty were active for the entire fiscal year, and one (Dr. Qin) for the second half of FY2009. The tenth (Dr. Sitaraman) joined UW in late June 2009. SER faculty members hold joint appointments with their home departments. They are:

- Dr. Felipe Pereira, *SER Professor of Mathematics, Department of Mathematics, College of Arts and Sciences.*
- Dr. Craig Douglas, *SER Professor of Mathematics, Department of Mathematics, College of Arts and Sciences.*
- Dr. Subhashis Mallick, *SER Professor of Geology and Geophysics, Department of Geology and Geophysics, College of Arts and Sciences.*
- Dr. Po Chen, *SER Assistant Professor of Geology and Geophysics, Department of Geology and Geophysics, College of Arts and Sciences.*
- Dr. John Kaszuba, *SER Associate Professor of Geology and Geophysics, Department of Geology and Geophysics, College of Arts and Sciences.*
- Dr. Bruce Parkinson, *SER Professor of Chemistry, Department of Chemistry, College of Arts and Sciences.*
- Dr. Maohong Fan, *SER Associate Professor of Chemical Engineering, Department of Chemical and Petroleum Engineering, College of Engineering and Applied Science.*
- Dr. Timothy Considine, *SER Professor of Economics, Department of Economics and Finance, College of Business.*
- Dr. Guan Qin, *SER Associate Professor of Petroleum Engineering, Department of Chemical and Petroleum Engineering, College of Engineering and Applied Science.*
- Dr. Jay Sitaraman, *SER Assistant Professor of Mechanical Engineering, Department of Mechanical Engineering, College of Engineering and Applied Science.*

In FY2009, the College of Engineering and Applied Science and the College of Agriculture collaborated with SER to conduct searches for remaining faculty positions:

- Reclamation and Restoration Ecology Faculty Position in Department of Renewable Resources, College of Agriculture. A national and international search was conducted and the top 2 candidates were invited to the campus for interviews. An offer was made to Dr. Kristina Hufford, a 2001 doctoral graduate from the University of Georgia in the field of Botany. Dr. Hufford, who is currently completing her work as a post-doctoral research scientist at the University of Western Australia and Kings Park and Botanic Garden, accepted our offer and will join the department in April 2010.
- Catalysis Faculty Position in Department of Chemical and Petroleum Engineering, College of Engineering and Applied Science. A national and international search was conducted and an offer was made to the top candidate after campus interviews. Unfortunately, the offer was rejected. A new search will commence in September 2009.

SER also supported one visiting professor for the academic year. Dr. Jim Douglas, Jr., the Compere and Marcella Loveless Distinguished Professor Emeritus of Computational Mathematics at Purdue University, taught and conducted research in the UW Mathematics Department for two semesters. Dr. Douglas is a pioneer in computational modeling and numerical analysis and was a true asset to the department this past year.

2. Academic Initiatives

This section describes the activities and accomplishments of various academic initiatives undertaken in FY2009.

a. Academic Council (AC)

The Academic Council (AC) represents a broad cross section of faculty with energy teaching and research interests at UW. Members come from five of the seven UW colleges. Broad participation across UW promotes the interdisciplinary mission of SER. The AC is charged with assisting the Director and Associate Director of Academics providing advice on academic directions and grant awards. In addition, the AC advocates for SER programs and serves as an important conduit for SER outreach to the campus.

Appointments to the AC are for a two-year period. This approach results in a well-defined rotating membership for the council, thereby increasing participation of UW faculty in SER initiatives while providing fresh perspectives on the important issues of the day. Since several AC members' terms expired last year, some membership changes resulted. The members of the AC (new members in *italics*) for the past academic year were:

Mark Northam	Director, SER	Permanent
KJ Reddy	Assoc. Director of Academics, SER	Permanent
<i>Indy Burke</i>	Director, Haub School of Environment and Natural Resources	May 2010
John Jackson	Chair, Department of Management and Marketing	May 2010
<i>Peter Stahl</i>	Professor, Department of Renewable Resources; Director Wyoming Reclamation and Restoration Center	May 2009
<i>Vladimir Alvarado</i>	Professor, Department of Chemical Engineering	May 2009
Carrick Eggleston	Professor, Department of Geology & Geophysics	May 2009
<i>Jinke Tang</i>	Professor, Department of Physics and Astronomy	May 2010
<i>Tim Slater</i>	Professor/Wyoming Excellence Chair, Department of Secondary Education	May 2010

b. Energy Resource Science (ERS) Degree program

A major goal of the Academic Program is to prepare the future workforce by developing undergraduate and graduate programs for students interested in careers in the energy sector.

Widespread curriculum discussion among faculty, department chairs, college deans and senior administrators occurred during the past year. Our initial efforts were focused on developing a strong interdisciplinary undergraduate degree program. A proposal for an interdisciplinary Bachelor of Science Energy Resource Science (ERS) degree was presented to the Provost's Office, Academic Deans Council, President's Executive Council, and Board of Trustees in the Fall 2008. The UW Board of Trustees approved the establishment of the ERS degree in January of 2009. The ERS degree will be offered at UW for the first time starting with the Fall 2009 semester.

The ERS curriculum is composed largely of existing courses from Geology and Geophysics, Engineering, Agriculture, Economics, and Environment and Natural Resources in addition to the normal University Studies Program requirements (see Appendix A-1 for curriculum details). Over time, new interdisciplinary courses designed specifically for this degree program will be sponsored and developed to reinforce the curriculum.

After approval of the ERS degree, several promotional and advertising brochures were developed (see Appendix A-2), and the UW Office of the Registrar and individuals involved with academic advising and freshman orientation were informed as a means of establishing a presence on campus for the ERS degree. A wide variety of activities were carried out to recruit students:

- SER was represented at freshmen and transfer student orientation and discovery days.
- ERS degree program information was displayed at UW Union center for two weeks in March 2009.
- An informational letter about the ERS degree program was mailed to undeclared freshmen in Math and Science.
- Several visits were made to "Energy Clubs" at Wyoming public high schools.

As of the close of FY2009, eleven undergraduate students have declared ERS as their major.

SER also developed a proposal for an Energy Resource Graduate Degree certificate in FY2009. A draft copy of the proposal (Appendix A-3) was distributed to faculty, deans of the seven colleges, and the Office of the Provost for their review. Review of the proposal is ongoing.

c. Faculty Scholarly Activities

SER faculty members are fully engaged in teaching, research, and outreach activities. They meet monthly as a group to discuss curriculum development, to review ideas for seminars and invited speaker series, to discuss direction of research programs, etc. Examples of their contributions to scholarly activities that advance the academic mission are listed below.

- Dr. Bruce Parkinson proposed and developed new introductory course titled, *Energy and Society* (CHEM 4920-20, 3.0 Credit Hours) for ERS degree program.
- Dr. John Kaszuba developed a seminar class, entitled *Carbon Capture and Storage* (GEOL 4200-07, 2.0 Credit Hours).
- Dr. Tim Considine proposed and is in the process of developing a course entitled, *Oil: International Evolution*.

The complete list of courses developed with funding from SER is shown in Appendix A-4.

In order to amplify faculty contributions to our mission, the faculty proposed inviting a small number of individuals to serve in an adjunct capacity. Adjunct faculty appointments will help to fill expertise gaps and strengthen contributions to academic, research, and outreach offerings. A set of by-laws has been developed to abide by UW Regulation 5-1 in appointing adjunct faculty to SER (see Appendix A-5 for details).

d. Graduate Assistantship Allocations

Talented graduate students working under the direction of UW's faculty are essential to the university's research enterprise. Graduate students at UW are generally supported through Graduate Assistantships (GA) 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. Assured GAs, a rare commodity on campus, are prized resources for any UW faculty member and provide a significant advantage for recruiting top student prospects.

SER awards GAs through a competitive process and seeks broad distribution across academic units. The awards are made to UW faculty to help them recruit top graduate students in support of the university's energy-related academic, research, and outreach mission.

The first call for proposals for sixteen GAs was released in March 2007, and placed emphasis on four main areas:

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

Forty-eight GA proposals from four colleges and the Haub School of Environment and Natural Resources were evaluated and prioritized by the AC; sixteen were awarded. Full details for these awards – which ran through the Spring 2009 semester – are provided in Table A-1.

One requirement of each recipient of an SER GA is to deliver a report of accomplishments each year. In addition to written reports received from each faculty advisor, students present their work in an oral or a poster presentation at the annual Graduate Student Symposium held in April. The flyer for the symposium and the student abstracts are contained in Appendix A-6. Written reports from the 2009 symposium are available upon request.

A revised call for GA proposals for Academic Years 2010-2011 was issued in October 2008 (see Appendix A-7). Fifty-one proposals were evaluated by the Academic Council, and twenty-two GAs were awarded. Subsequently, ten additional GAs were awarded to support specific program areas not represented in the proposals. Three GAs are currently supported by start-up funds awarded to SER faculty. The total number of new GAs committed to by SER for academic years 2010-2011 is thirty-five (Table A-2).

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

Student	Faculty Advisor	Department	Title
Jianqiang Huo	Dean Roddick	Chemistry	Novel Transition Metal Excited States for Solar Energy Conversion
Amanda Moyer	Carrick Eggleston	Geology & Geophysics	Synthesis of Hematite and Albandite Photocatalytic Films for a Tandem Fuel Cell
Elizabeth Hajek	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
Milton Geiger	Roger Coupal	Agricultural & Applied Economics	Sustainable Energy Futures
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
Jasmin James	Charles Mason	Economics & Finance	Economic Co-Optimization of Enhanced Oil Recovery and Carbon Sequestration
Saeed Ovaysi	Mohammad Piri	Chemical & Petroleum Engineering	Multiphase Flow in Fractured Hydrocarbon Reservoirs
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
Arash Aghaei	Mohammad Piri	Chemical & Petroleum Engineering	CO ₂ Sequestration in Deep Saline Aquifers
Yiping Liu	David Bagley	Civil & Architectural Engineering	Sustained Biogenic Production of Coal-Bed Methane: Microbial Production of Hydrogen and Acetate
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
Jared Strube	Paul Dellenback	Mechanical Engineering	Modeling Gas Turbine and Thermodynamic Cycle Performance for a Novel IGCC Plant
Courtney Kitchen	Ingrid Burke	Haub School of Environment & Natural Resources	New Course: Applied Environment and Natural Resources Law for Non Lawyers

Table A-2. Fall 2009-Spring 2011 SER/GA Awards

College	Department	Faculty Advisor	Title
Arts & Sciences	Chemistry	Milan Balaz	Influence of supramolecular organization on energy transfer properties of chromophore-DNA arrays

College	Department	Faculty Advisor	Title
Arts & Sciences	Chemistry	Bruce Parkinson	Quantum Dot Sensitization: Strategies for Increases in Photovoltaic Solar Cell Efficiencies
Arts & Sciences	Chemistry	Dean Roddick	New Catalyst Strategies for Selective Coal Modification & Liquefaction
Arts & Sciences	Geography	Steven Prager	Enhancing the School of Energy Resources Goespatial Capacity
Arts & Sciences	Geology & Geophysics	Po Chen	Addressing the Computational Challenges of Time-Lapse, Full-Wave seismic Imaging Using Hybrid Cluster of GPUs & CPUs
Arts & Sciences	Geology & Geophysics	Ken Dueker	Monitoring of Hydrocarbon & Carbon-sequestered Formations Using Time-lapse Seismic & Electromagnetic Data
Arts & Sciences	Geology & Geophysics	John Kaszuba	Co-Sequestration of CO ₂ -SO ₂ Mixtures Emitted from Coal-Fired Power Plants
Arts & Sciences	Geology & Geophysics	Subhashis Mallick	Monitoring of Hydrocarbon & Carbon-sequestered Formations Using Time-lapse Seismic & Electromagnetic Data
Arts & Sciences	Mathematics	Stefan Heinz	New Concept for the Gasification of Wyoming Coal
Arts & Sciences	Physics & Astronomy	Jinke Tang	Research & course development in thermal & electrical transport in energy materials
Arts & Sciences	Physics & Astronomy	Wenyong Wang	Ternary Metal Oxide Nanowires for Power Applications
Agriculture	Renewable Resources	Jay Norton	Understanding disruption & recovery of ecological structure & functioning for restoration of disturbed Wyoming ecosystems
Business	Economics & Finance	Timothy Considine	Economic, Technological & Environmental Challenges Facing the Electricity Sector
Education	Secondary Education	Timothy Slater	Interdisciplinary Ph.D. Program for SER GAs in Science Education
Engineering & Applied Science	Atmospheric Science	Robert Field	Understanding of Ozone Precursors
Engineering & Applied Science	Chemistry & Petroleum Engineering	Vladimir Alvarado	Water Chemistry Modification for Improved-Oil Recovery: Chemical, Interfacial & Rheological Mechanisms in Porous Media
Engineering & Applied Science	Chemical & Petroleum Engineering	David Bell	Wyoming Coal Gasification Economics and Process Technology
Engineering & Applied Science	Chemical & Petroleum Engineering	Lamia Goual	Characterization & Bio-Remediation of Dissolved Organic Matter in Wyoming Oilfield Waters
Engineering & Applied Science	Chemical & Petroleum Engineering	Patrick Johnson	Carbon Dioxide Capture via Enzyme Nanoparticle Biocatalysis
Engineering & Applied Science	Chemical & Petroleum Engineering	Patrick Johnson	Enzyme Nanoparticle Synthesis and Characterization for Biofuel Cells and Cellulose Hydrolysis
Engineering & Applied Science	Chemical & Petroleum Engineering	Mohammad Piri	Multiphase Flow in Fractured Hydrocarbon Reservoirs
Engineering & Applied Science	Chemical & Petroleum Engineering	Mohammad Piri	CO ₂ Sequestration in Deep Saline Aquifers
Engineering & Applied Science	Civil & Architectural Engineering	David Bagley	Microbial BioEngineering & Applied Science for Renewable Energy
Engineering & Applied Science	Civil & Architectural Engineering	Jay Puckett	Building Green & Building Performance-Demonstration, monitoring & validation of predictive energy conservation models

College	Department	Faculty Advisor	Title
Engineering & Applied Science	Computer Science	Liqiang Wang	Addressing the Computational Challenges of Time-Lapse, Full-Wave seismic Imaging Using Hybrid Cluster of GPUs & CPUs
Haub School of Environment & Natural Resources		Ingrid Burke	New course development: Environmental & Natural Resource Science
College of Law		Jerry Parkinson	Course Development: Introduction to Energy Regulation

e. Energy Summer Institute

A significant component of the academic enterprise of SER 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, 26 high school sophomores (Class of 2012) and 5 elementary, middle, and high school teachers came to UW for our third annual Energy Summer Institute (ESI). The Institute exposes participants to two weeks of challenging energy problems facing the world, and exciting solutions on the horizon. In addition to the relevant programmatic content, the ESI also affords a terrific opportunity for exposure to higher education and all that UW has to offer.

This year, participants in the ESI came from Afton, Basin, Big Horn, Casper, Cheyenne, Cody, Cowley, Douglas, Dubois, Evansville, Gillette, Glendo, Glenrock, Greybull, Laramie, Newcastle, Pinedale, Riverton, Sheridan, Shoshoni, Story, Wheatland, and Worland. The 2009 Energy Summer Institute consisted of the following courses:

- *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 completed including a geo-caching activity at the Vedauwoo Campground. (Taught by Ken Driese, Remote Sensing Scientist, Wyoming Geographic Information Science Center).
- *Energy on Earth and Cultures of Energy.* These integrated classes covered the basic energy physics and provided an overview of energy history. The ways energy has been harnessed by human populations around the world and choices made depending on many cultural, social, political, and ethical factors were reviewed. Participants built solar cookers and solar cells. (Taught by Carrick Eggleston, Professor, Department of Geology and Geophysics and Sarah Strauss, Associate Professor, Department of Anthropology).

Once again this year there were added features.

- 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.
- Dr. K.J. Reddy gave a presentation on “Higher Education and Research: Example Energy and Water”.
- Field trips included a visit to the Duke Energy Happy Jack Wind Farm, the UW Central Energy Plant, the UW Indoor Practice Facility, the CSU Engines & Energy Conversions Lab, Habitat for Humanity, and Curt Gowdy State Park to use the solar cookers and solar cells.

The Energy Summer Institute was aggressively promoted across the state. Informational brochures for students and teachers were mailed or e-mailed to all middle schools, junior high schools, and high schools. SER was also a sponsor for the Math and Science Teachers Conference in January at Casper College where the ESI was pitched. A first-hand look at this information is viewable at http://www.uwyo.edu/energy_institute.

f. Council for Energy Research and Education Leaders

SER is a founding member of the Council for Energy Research and Education Leaders (CEREL), a collaboration of leaders from university-based energy centers and programs working together to advance the role of higher education in energy fields. The functions of CEREL include: 1) promotion and support of efforts to advance knowledge and learning in energy fields (engineering, agriculture, the humanities, and physical, biological, and social sciences), and 2) sharing information about people, programs, organizations, and curricula in energy research and education to prepare future workforce. More information about CEREL is available at <http://ncseonline.org/CEREL>

Dr. Reddy was elected to the Executive Committee of CEREL as Secretary-Treasurer. His leadership role in CEREL will advance our interactions not only with other universities but with federal agencies such as the Department of Energy, the National Science Foundation, the US Geologic Survey, and the US Department of Agriculture, nonprofit organizations such as the Electric Power Research Institute, and private companies in the energy industry. Furthermore, our participation in CEREL provides an opportunity to showcase UW’s emerging leadership role in interdisciplinary energy-related education and research.

g. Publications and Presentations

SER personnel presented and published the following papers during FY2009. These activities advance the academic and outreach mission of the school.

- KJ Reddy presented a paper at *The Eighth Annual Carbon Capture and Sequestration Conference* in Pittsburgh from May 4-7th, 2009 entitled "Capture and Storage of Flue Gas Carbon Dioxide". Co-authors are Morris Argyle (Dept. Chemical and Petroleum Engineering), Attili Viswatej (Dept. Renewable Resources), Paul Fahlsing (Jim Bridger Power Plant), and Mark Northam.

- K.J. Reddy and SER graduate student Ashley Whitman (M.S. candidate, Department of Renewable Resources) both presented papers at the 26th annual conference of American Society of Mining and Reclamation in Billings, MT in June, 2009. Whitman’s paper was entitled, “Coalbed Natural Gas Produced Water Quality Trends in the Powder River Basin, Wyoming”. Reddy’s invited paper was entitled “Coalbed Methane Natural Gas Produced Water Research in Wyoming”.
- K.J. Reddy and Mark Northam attended the Council for Energy Research and Educational Leaders (CEREL) Spring conference in Washington, DC from April 20-21st, 2009. Dr. Reddy presented a plenary paper on UW’s Energy Resource Science Interdisciplinary Degree Program and University and Energy Partnerships.
- Dr. Reddy and Dr. Northam prepared an invited Feature Article for publication in the *Journal of Exploration and Production: Oil and Gas Review*. The article, entitled “Geochemistry and effective management of produced water from natural gas extraction: Recommendations for Industry”, will appear in Volume 7, Issue 2, which is currently in press.
- Dr. Reddy also prepare an invited article entitled “Give clean coal a chance and you might fry bigger fish. Lesser of Two Evils: Nuclear or Coal?” for the Freakonomics Blog, *New York Times*, which appeared on July 15, 2009.
(<http://freakonomics.blogs.nytimes.com/2009/07/14/lesser-of-two-evils>)

B. Research Programs

1. Matching Grant Fund

UW is a research university, so faculty and academic professionals engage in research as part of their job assignments. Successful research programs require significant external funds (grants and contracts) to meet their objectives. This is especially true in the energy arena. The funds are required for, among other things, support of undergraduate and graduate students, post-doctoral research staff, purchase of critical equipment, and summer salary for principal investigators.

The national landscape for funding is highly competitive. For instance, proposals to national agencies such as the Department of Energy and the National Science Foundation often have success rates of 20-30 percent or less. As a result, review panels are forced to choose among many excellent proposals. Subtle differences, such as an institution’s commitment to help support the research, may dictate any proposal’s fate. The Matching Grant Fund (MGF) provides significant additional leverage to already strong UW proposals, thereby improving the chances of capturing external funding.

There is significant lag-time between the submission of a research proposal and announcement of awards. Funds are committed at the time of submission in order to improve UW’s success rate. This circumstance builds uncertainty into the distribution of funds. Often, there are several vintages of MGF funds working in any fiscal year, and commitments almost always carry over. In FY2009, commitments from FY2008 were honored, and new commitments that will carry over into FY2010 were made.

FY2008 MGF Commitments

A call for proposals for the FY2008 MGF was issued on October 1, 2007. The target for funding was \$1 million. Fifty-seven proposals were competitively evaluated by the AC; thirty-two were approved for a total commitment of \$1.83 million. As always, there is an expectation that some will be rejected by the funding agency. Research topics approved by FY2008 include:

- 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
- Groundwater 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.

Outside agencies for the above topics are 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

Ten of the thirty-two supported proposals were funded. A total of \$715,122 in FY2008 MGF funds are matched to \$1,444,144 in outside funds. The remaining obligations from the FY2008 offering are \$173,900. A table of approved projects can be found in Appendix B-1.

FY2009 MGF Commitments

A call for proposals (the third in the series) for the FY2009 MGF was issued on September 30, 2008. A total of forty proposals were evaluated by the AC; twenty-one were approved for a total commitment of \$1.57 million. Research topics include:

- Clean coal research
- Flow through porous media
- CO₂ sequestration in deep aquifers
- Soil and plant reclamation
- Solar energy: photoelectrochemical- and organic-based cells
- Chemical reactivity of novel catalysts

- Aerodynamics and control of wind turbines
- Oil and gas production and recovery
- Economic impact of enhanced oil recovery and carbon capture storage
- Drivers of electrical energy demand

None of the twenty-one FY2009 approved proposals have been funded yet. A table of approved projects can be found in Appendix B-2.

With three 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 for successful projects. Although it is too early to be certain, it appears that funds-capture by proposals submitted in FY2009 has been less successful than in previous years. A number of factors may be influencing this result – including economic downturn and redirection of federal funding to large projects as a result of the *Economic Stimulus Programs*. SER will continue to monitor the success of the program and implement revisions to procedure as warranted to ensure that the funds are used to create an advantage for UW research.

A fourth call for proposals for the FY2010 MGF will be issued in September, and we expect to receive a steady stream of funding requests as faculty interest in the program runs high. The call will be modified to explain changes in the way MGF proposal approval will be administered to provide more flexibility in timing to meet the needs of principle investigators who submit proposals under a wider range of deadlines. The funding limit will also be raised for proposals seeking large grants.

2. The Institute for Energy Research

The Institute for Energy Research is composed of research centers that are established with seed funding from the SER budget. Each research center strives to achieve support through outside funding, an accomplishment that may take several years. Research centers bring together faculty and graduate student from multiple disciplines to develop important energy research programs. Accordingly, these centers are expected to evolve with time. New groups may form to work on emerging problems, and some existing centers may disband as their programs are completed. Ten research centers were either active or being organized in FY2009:

a) Enhanced Oil Recovery Institute – Prof. J.R. Steidtmann, Director

The Enhanced Oil Recovery Institute (EORI) is funded primarily by an appropriation from the Wyoming State Legislature. For the FY2009-2010 Biennium, EORI is working with an appropriation of \$6.11 million. EORI is overseen by the Enhance Oil Recovery Commission (EORC) which was created in 2004. The EORC consists of eight commissioners appointed by the Governor. In FY2009, the commission included the following members:

- Governor Dave Freudenthal, *ex-officio*
- Senator Charles Townsend, *ex-officio*
- Ron Surdam, State geologist, *ex-officio*
- Lynne Boomgaarden, director, Office of State Lands and Investments

- Gail Chenoweth, Marathon Oil Company
- Bern Hinckley, geologist, Hinckley Consulting
- Jim Neiman, UW trustee
- Peter Wold, president, Wold Oil Properties (Chairman)

EORI and UW scientists and engineers from various disciplines work with oil producers to study issues of maximizing oil production, 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 economic potential and minimize risk of EOR projects.
- Facilitate testing, evaluation, and documentation of EOR recommendations in real-world settings.
- Transfer information to Wyoming producers by forming partnerships and conducting workshops and conferences.
- Develop technologies for capturing CO₂ from flue gases.

The EORC submits a separate annual report to the Joint Minerals, Business and Economic Development Interim Committee that covers the activities of EORI. That report can be found on their website (<http://www.uwyo.edu/eorcommission/reports/default.asp>) when it has been completed.

b) Coal Bed Natural Gas Center – Professor David Bagley, Director

The Coal Bed Natural Gas Center (CBNGC) was established in May 2007 with a seed grant of \$77,000 from SER, which was supplemented by an additional \$21,600 awarded in February 2008. It operates as a consortium of UW researchers: D. M. Bagley (Professor and Head, Civil and Architectural Engineering), F. Basile (Associate Professor, Chemistry), S. Jin (Adjunct Professor, Civil and Architectural Engineering), S. Sharma (Associate Director, UW Stable Isotope Facility) and M. Urynowicz (Associate Professor, Civil and Architectural Engineering). The principal goal of the center is to develop technologies to sustain biogenic production of coal bed natural gas and therefore extend the economic life of coal bed natural gas wells.

The CBNGC has made progress toward its technical, educational and economic goals. On the technical side, seed funding was used to purchase two instruments: a total organic carbon analyzer and a gas chromatograph-mass spectrometer (with funding from NSF). Both are used extensively by researchers in the CBNGC. Finally, seed funding is used to purchase supplies used by the CBNGC researchers.

Research has begun to:

- identify pretreatment processes to enhance *in situ* solubilization of coal
- identify specific constituents being released during pretreatment

- evaluate the interaction of coal concentration and pH on microbial degradation of the coal, and
- examine the isotopic fractionation of carbon and relate it to microbial processes.

On the educational side, the CBNGC has supported two doctoral students in Civil and Architectural Engineering (Yiping Liu and Zaixing Huang, both of whom received SER Graduate Assistantships and started with the CBNGC in Fall 2007). A doctoral student in Chemistry (Wesley Rodgers) joined the CBNGC in Fall 2008 and several undergraduate students in Chemistry have also worked with the Center. All three doctoral students are now supported on funding external to the SER.

A key goal of the CBNGC is to develop sustainable funding outside of the SER. Progress toward this goal has been steady. In January 2009, key UW investigators in CBNGC were awarded \$321,409 (UW amount) from RPSEA as collaborators with investigators from the Colorado School of Mines (lead organization) and the United States Geological Survey for the project "Comprehensive Investigation of the Biogeochemical Factors Enhancing Microbially Generated Methane in Coal Beds" (total award was \$864,333.) This funding continues through August 2010 and represents the start of sustainable external funding for the CBNGC.

SER seed funding has been critical for the CBNGC to pursue research to enhance biogenic production of coal-bed natural gas. The initial seed funding has, to date, been leveraged almost three-fold with RPSEA funding.

c) Renewable Energy Center – Professor Patrick Sullivan (deceased), Director

UW faculty (Geology and Geophysics, Chemistry and Physics) have been working toward proposing a new direction for the Renewable Energy Center (REC). Renewable energy technologies are an inevitable part of our nation's energy future, and Wyoming is well situated not only for wind power (the subject of a separate center) but also for other renewable energy technologies. A central member of the original group was the late Professor Pat Sullivan. It has taken some time after his passing to regroup and reform the REC.

Participating faculty have made several advances in research:

- Wenyong Wang and Jinke Tang in the Physics and Astronomy Department are developing materials for quantum dot-sensitized nanowire array photovoltaic cells. They are spearheading a group writing a proposal for the DOE EPSCoR program to further develop these novel materials. Tang is also working on new thermoelectric and LED lighting materials. Bruce Parkinson, Jon Pikal, Debashis Dutta, and Carrick Eggleston are also participating in this proposal.
- Yuri Dahnovsky is working on the fundamental physics of electron transfer across interfaces, and has proposed a course in solar cells with Eggleston.
- Eggleston has synthesized nanocrystalline iron oxide photocatalysts for water oxidation, to be used in tandem with a dye sensitized SrTiO₃ solar cell to make a photocatalytic cell capable of producing formate from sunlight, oxidized carbon species, and water.
- Dutta has succeeded in making microfluidic fuel cells that generate electrical power from formate.

- Patricia Colberg has made successful measurements with a microbial fuel cell design that utilizes oxide electrodes.

Most of the participants contributed to a recent proposal to the National Science Foundation to purchase a field emission scanning electron microscope, an essential material characterization tool. Also, Dr. Parkinson has quickly developed a very well-funded research group at UW, and is a great asset to the group as a whole. He brings tremendous experience and expertise to solar energy research at UW, as well as new materials synthesis capabilities in his new laboratory. Eggleston and Parkinson, in recent work with newly obtained NASA grant funding, have shown that heterogeneous photochemistry on Mars is a possible explanation for chemical conditions there. Patrick Johnson has worked in collaboration with Eggleston on the properties of enzymes immobilized on oxide substrates; these enzymes have a potential role in biofuel cells. Dr. Johnson is also working on cellulosic ethanol research.

In summary, the group has been very active despite the setback of Pat Sullivan's passing. Several proposals have been written, and more are underway.

d) Wyoming Reclamation and Restoration Center – Professor Peter Stahl, Director

Most energy-related activities involve disturbance of the land surface. 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. The Wyoming Reclamation and Restoration Center (WRRC) was established to integrate the work of these separate individuals to form a comprehensive research and outreach program.

Principal Investigators currently associated with WRRC are Peter D. Stahl, Stephen E. Williams, K.J. Reddy, George F. Vance, Ann Hild, Roger Coupal, Jay B. Norton, Jeffrey Beck, and Matthew Anderson – all professors in the College of Agriculture. Research accomplishments of the WRRC in 2008-9 have been quite extensive.

- Final Report to the DEQ for the completed research project entitled “Mechanisms for stabilization and accumulation of organic carbon in reclaimed mine land soils”, funded by the AML Research Program, \$222,220, 2005-2008.
- Collection of data at the Belle Ayr Coal Mine for an international study examining “Recovery of soil biota on post Mining Sites in USA and Europe”, funded by KONTAKT, Czech Ministry of Education, 2008-2012.
- Completed a study on soil aggregate and organic carbon dynamics in short-term topsoil stockpiles at the Belle Ayr Coal Mine in Campbell County. Paper accepted for publication in the international journal *Soil Use and Management*.
- Selection, sampling and analysis of natural gas well pad topsoil stockpiles and adjacent undisturbed areas in the Wamsutter, Jonah, and Pinedale Anticline production areas in collaboration with BP, EnCana, and Questar. This work was repeated four times over the summer and will continue after reclamation for three years. Vegetation monitoring will begin next spring. In addition, preparation began for evaluating controlled livestock impact after reclamation seeding at each of the above sites. Livestock treatments will entail 25 cattle on 0.25 acres for 24 hours and will occur this September and October

after seeding (in collaboration with local livestock owners/grazing permittees from each area).

- Completed the project “Development and identification of *rhizobiaceae* and *fabaceae* symbioses for enhancing biological inputs of nitrogen in reclamation of disturbed lands”.
- Presented paper and published proceedings entitled “Impacts of oil and natural gas on prairie grouse: current knowledge and research needs.” Pages 66--87 in R. I. Barnhisel, editor. 2009 Joint Conference: 26th Annual Meeting of the American Society for Mining and Reclamation and 11th Billings Land Reclamation Symposium. Billings, Montana, USA.
- Published paper entitled “Recovery of greater sage-grouse habitat features in Wyoming big sagebrush following prescribed fire.” In *Restoration Ecology* 17:393–403.
- Submitted annual reports for 3 field restoration projects being conducted in Wyoming by graduate students.
- Paper accepted for presentation at the ASMR/Billings Conference and published in the Proceedings: “Economic Issues and Policies that Affect Reclamation Decision Making”.
- Paper accepted by the Western Agricultural Economics Association for the publication *Western Economic Forum*: “Economic Issues and Policies of Reclaiming Orphan Gas Wells and Implications for Currently Active Wells”.

Outreach activities by the WRRC over the past year included:

- Best Management Practices Bulletins – a series of BMP Bulletins is being developed to address some of the fundamental needs of the reclamation industry in Wyoming. Topics include topsoil storage and handling, land recontouring, erosion control, seeding methods, etc.
- Participated in the Reclamation Schools presented by Brenda Schladweiler of BKS Environmental at Rock Springs and Buffalo in 2009. These Reclamation Schools presented basic information on proper reclamation techniques for professionals in the Oil and Gas Industry.
- Presented a full-day workshop at the Billings Land Reclamation Symposium entitled “Soil Management for Site Reclamation” for environmental professionals.
- Served on the General Program and Organizational Committee of the 2009 Billings Land Reclamation Symposium.
- Presented a departmental seminar entitled “Investigating wildlife population response to disturbance in sagebrush habitats” to the Department of Natural Resources Ecology and Management, Iowa State University, Ames, Iowa, USA.
- Developed Oil and Gas Surface Compliance Internships. These positions will be multifaceted and the individuals selected will have mentored exposure all aspects of energy development including permitting, construction considerations, planning, reclamation and monitoring.

Finally, the WRRC has made great progress in capturing funding to sustain continuing research. 2009 Wyoming General Session Laws, Chapter 159, Section 339 (C) (v) and (vi) appropriated AML funds, to be administered by the DEG, in the amounts of \$500 thousand to the College of Agriculture for operating support for the WRRC, and \$1.5 million to the College of Agriculture to provide initial funding for a proposed \$20 million endowment, respectively. Income from the

endowment will be available to fund the WRRC. Various other smaller grants have also been received.

e) Clean Coal Technologies Center – Professor O. A. Plumb, Director

Wyoming coal is a major source of fuel for generation of our nation's electricity. It also holds considerable promise for improving our nation's energy security as technologies are developed to gasify and convert coal to synthetic fuels and petrochemicals. Continued use of coal faces significant challenges in light of growing concerns over the role of carbon dioxide (CO₂) in forcing climate change. 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 preserve and grow reliance on coal, new technologies that convert coal to cleaner and more flexible fuels must be developed.

The Clean Coal Technologies Center (CCTC) conducts research to develop those technologies. During FY2009, Professor O. A. (Gus) Plumb agreed to serve as director of the CCTC. Existing expertise at UW and the Western Research Institute is significant. Maohong Fan, SER Associate Professor of Chemical Engineering, joined the Department of Chemical and Petroleum Engineering in 2009 and adds new expertise to the pool. The College of Engineering and Applied Science and SER are moving to establish 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 provides incentive and a platform to continue to build our coal conversion and clean fuels efforts. The College of Engineering and Applied Science is seeking an SER faculty candidate in the area of catalysis to contribute to this program.

UW is developing a broad research program 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. In FY2009, Arch Coal, Inc. became a corporate partner in that regard. Arch committed a gift of \$1.5 million to UW that will be matched by the state. Half of that gift and the match will go toward endowing the CCTC. Peabody Energy made a commitment of \$2 million to UW that will also be matched by the state. The allocation of those funds is still undetermined, but it is likely that a portion of that gift will also go toward endowing this center.

f) Fundamentals of Fluid Flow Research Center – Professor L. F. Pereira, Director

The mission of the Fundamentals of Fluid Flow Research Center (FFFRC) is to conduct and integrate advanced experimentation and modeling of multiphase flow in porous media to ensure future access to subsurface energy resources and carbon storage resources.

The Wyoming and national energy matrix is dominated fossil. Optimum recovery of fossil energy resources from conventional reservoirs, coal seams (including 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. State-of-the-art enhanced oil recovery (EOR) techniques have many viable applications in Wyoming oil and gas reservoirs, and even greater success in the application of EOR schemes to subsurface hydrocarbon resources can result from more complete understanding of transport phenomena in porous media. Progress in this area will lead to sound design of reservoir exploitation plans and reduction in uncertainties associated with these attempts.

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.

The FFFRC will be at the forefront of porous media transport research. By integrating experimentation and modeling, the center will develop 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. When the NCAR supercomputer – to be built in Cheyenne in partnership with the state – is available, this research will take great strides in advancing our knowledge in this important area.

In FY2009, Dr. Luis Felipe Pereira, SER Professor of Mathematics, was appointed director, and Dr. Mohammad Piri, Assistant Professor of Petroleum Engineering, was appointed associate director of the FFFRC. Twelve UW faculty from three academic departments have committed to work as principle investigators (PI) working under the FFFRC umbrella. Draft proposals are under consideration and seed money has been committed to support their research. The PIs are actively submitting proposals for grants to provide sustainable support for the center.

g) Wind Energy Research Center – Associate Professor Jonathan Naughton, Director

Wyoming has a world-class wind energy resource base that is significantly 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 is 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.

Since the formation of the Wind Energy Research Center (WERC) by the College of Engineering and Applied Science, SER has invested \$260 thousand directly in the center's operation, has provided a faculty position in Wind Energy (Dr. Sitaraman), has committed three MGF awards (\$100 thousand awarded, \$200k pending), and has contributed \$50 thousand for the recently purchased wind tunnel.

Thirteen UW faculty currently have active projects with WERC. The establishment of WERC has significantly impacted graduate student recruiting and support. Seven MS and two PhD students, and four post-graduate researchers are currently working in this program.

WERC has had a significant impact on relationship-building with key industry groups. Industry has been interested in both our research capabilities as well as our workforce production capability. Industry leaders such as BP (\$2 million grant in 2008), GE, and Siemens, as well as other less-known players are working with WERC, or have expressed interest in doing so. Relationship-building with other academic institutions is also progressing. Montana State, Boise State, Penn State, the University of Florida, and Danish Technical University are all current collaborators.

Several competitive grants – totaling almost \$1 million – have recently been awarded to UW to support research in WERC:

- Professors Jonathan Naughton and Mark Balas received \$450 thousand from DOE to work on characterizing and controlling wind turbine blade flows. Commitments of \$100 thousand through MGF and another \$80 thousand from UW funds bring the total to \$630 thousand.
- WERC received \$195 thousand from DOE to support MS students pursuing degrees in wind energy (PI- Naughton).
- David Walrath received a Phase II SBIR with Z4 energy in Laramie.
- GE awarded several min-grants to WERC for \$65 thousand: Bob Kelly, William Lindberg, Manjinder Singh and Jonathan Naughton received an award for Lidar Development and Use, Mark Balas and John O'Brien received an award for Lidar for Control, John Turner received an award for wind turbine foundations, and Jennifer Tanner received an award for evaluating joints in advanced wind turbine towers.

Several grants are currently pending review:

- \$1.855 million (UW's share) proposal to DOE as part of a Wind Energy Consortium between academia and industry. GE is the principal wind energy company, and Ohio State University is the lead.
- \$2 million (UW's share) pre-proposal to NSF for an Engineering Research Center. Notre Dame is the lead University.
- Pre-proposal for DOE-EPSCoR University/Lab Partnership with Sandia National Labs on advanced computing for wind energy.

h) Carbon Management Research Center – Directorship Open

UW established the Carbon Management Research Center in 2008 in preparation for an increase of activity in carbon capture and storage (CCS) in the state and the nation. SER partners with the Office of Research and Economic Development, the Wyoming State Geologic Survey, and UW colleges in the conduct of research under this center.

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. 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. CO₂ injection is also an important part of enhanced oil recovery in the state. It is crucial for UW to have technical expertise to evaluate CO₂ storage resources, and to predict, assess, and monitor movements and chemical behavior CO₂ into the subsurface over time.

In FY2009, UW commenced an open search for a Director of Carbon Management. The Director of Carbon Management will coordinate all of the various research endeavors carried out by the Carbon Management Research Center, will provide direction and support in seeking outside funding, and will be instrumental in forging relationships with research and commercialization partners. Three candidates interviewed for the position. An offer was tendered to the top candidate but was recently rejected. The search is ongoing.

UW was the recipient of a \$1.7 million grant from the Department of Energy in 2008. Research was conducted under the leadership of Dr. Carol Frost, Associate VP for Research and Economic Development during FY2009 to build 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 program is composed of 10 tasks that incorporate research by a large number of faculty and students in the Colleges of Arts and Sciences, and Engineering and Applied Science as well as the Wyoming Geologic Survey. The proposal, as approved by DOE is contained in Appendix B-3. The Department of Energy awarded UW an additional \$823 thousand to continue this work in FY2010.

2009 Wyoming General Session Laws, Chapter 159, Section 339 appropriated \$8 million in AML funds to SER to support the CO₂ Sequestration Research. In June 2009, UW President Tom Buchanan and Governor Dave Freudenthal appointed a five-person Wyoming Carbon Sequestration Steering Committee to, prioritize the allocation of funds. Members of that steering committee are:

- Rob Hurless, Energy and Telecommunications Advisor, Wyoming Executive Office
- Ron Surdam, Wyoming State Geologist
- Carol Frost, Associate VP for Research and Economic Development
- Mark Northam, Director, UW School of Energy Resources
- William Gern, VP for Research and Economic Development (ex officio)

The steering committee agreed to commit matching funds for recent grants submissions under the 2009 DOE Recovery Act Solicitations. Funds were committed for "Site Characterization of Promising Geologic Formations for CO₂ Storage" (\$6.5 million), "Commercial-scale geological CO₂ Sequestration with displaced fluid management" (\$4 million), and "Regional Sequestration Technology Training" (\$856 thousand). The total exceeds \$8 million, but it is unlikely that all of the grants will all be funded. The steering will reallocate funds that are released from commitment if grant submissions are rejected by the DOE.

i) Center for Energy Economics and Public Policy – Professor Tim Considine, Director

SER is in the process of establishing the Center for Energy Economics and Public Policy (CEEPP). Dr. Timothy Considine, SER Professor of Economics is the author of the proposal, and will serve as director for the center.

The vision of the CEEPP is to create a nationally recognized center of excellence through the development of empirically-based energy economy models to estimate the economic impacts of energy policies. CEEPP investigators will perform integrated engineering-economic cost analysis using observable data to model the cost and rate of adoption of new energy technologies. Integration of detailed energy technology models with an econometric model of energy markets and the general economy will serve to explain how energy markets and business cycles are affected by energy and environmental policy initiatives.

Collaboration will be a key component of CEEPP in its mission to achieve national recognition. As the center is being established, the UW-based core of investigators will seek to partner with other respected contributors from the public and private sectors with interests in modeling the impact of energy choices and constraints on economies. The directorate will encourage such interactions through development of local, regional and national research program elements.

An important goal of the CEEPP will be to publish frequently and widely. In addition to publishing in scholarly journals, we will develop an outreach program to transfer knowledge and information to energy stakeholders, business leaders, and consumers. Educating the public about the economic impact of choices to be made in the energy sector is an important element of the center's mission.

Finally, the CEEPP will strive to secure external contracts and grants to sustain the center's vision. Seed money will establish the base from which future efforts will grow, and will be used as leverage to capture additional funding.

j) Uranium Research Fund

Pursuant to 2008 Wyoming Session Laws, Chapter 48, Section 336, a plan was developed to establish a Uranium Research Center. The plan (Appendix B-4) was presented to the Joint Minerals, Business, and Economic Development Interim Committee at their October 2009 meeting in Jackson, WY. That plan was later revised, and 2009 General Session Laws, Chapter 159, Section 339 appropriated \$1.6 million of AML funds to SER to conduct Uranium Research with the following guidance:

The School of Energy Resources under the direction of the University of Wyoming Energy Resources Council and in consultation with the Wyoming mining industry may develop:

(A) A research program for uranium under the school of energy resources at the University of Wyoming. This program shall focus on optimizing the economic recovery of the resource through groundwater restoration, research on waste water management and the development of a seminar to educate the public and the industry about uranium and uranium extraction;

(B) A program at the school focusing on technology transfer that would help industry with access to and application of existing in situ recovery processes. The program shall be designed to promote research and technology transfer efforts;

(C) A database which would include information concerning uranium exploration, development and production;

(D) A research program which would focus on future production of uranium resources in Wyoming; and

(E) Other programs as identified by the energy resources council.

SER personnel met with representatives of the Wyoming Mining Association and the Uranium industry to create a roadmap for satisfying this directive. As a result, a workshop for industry, regulatory, and academic experts is planned for September 22-23, 2009 to identify knowledge, technology, and regulatory barriers and gaps that will be instrumental in directing future activities in this area. Furthermore, a public forum is being planned for Spring 2010 to address public concerns about existing and future Uranium In Situ Recovery operations.

3. Clean Coal Research Account

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.

Section 320 of the Legislature of the State of Wyoming's 2008 Budget Bill authorizes the Wyoming Department of Environmental Quality (DEQ) to submit a grant application to the federal government for Abandoned Mine Lands (AML) funds for specified purposes. One project secured and additional \$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 remainder of the original \$2.5 million that was not committed in the first round. The \$677,519 is now subject to the same process as the \$3.8 million, i.e., the CCTF has the authority to expend the funds. The 2008 legislation extended the deadline for expenditure for all of the funds to June 30, 2010.

In September 2008, the CCTF approved funding for five of the eight submitted proposals. Funding for the successful proposals totaled \$2,672,120, leaving \$1,127,880 for allocation to future projects.

Chapter 57 of the Legislature of the State of Wyoming’s 2009 General Session Law extends the sunset date for the Clean Coal Task Force (CCTF) from June 30, 2010, to June 30, 2013 (section 2). Section 5 (a) provides that the 2007 general fund appropriation to the clean coal research account will not revert on June 30, 2010, but can continue to be used for clean coal research until the reversion date of June 30, 2012, which now applies to all of the funds.

Finally, Chapter 159, Section 339 of the Legislature of the State of Wyoming’s 2009 General Session Law authorizes the DEQ to submit grant application for an additional \$10,613,047 to be added to the Clean Coal Research Account.

To summarize, three separate appropriations of funds have been made to the Clean Coal Research Account:

Appropriation	Amount
2007 Appropriation	\$2,500,000
2008 Appropriation	\$3,800,000
2009 Appropriation	\$10,613,047
Subtotal	\$16,913,047
2007 Commitments	(\$1,822,481)
2008 Commitments	(\$2,672,120)
Remaining Balance	\$12,418,466

In total, nine projects have been funded and the Clean Coal Research Account currently holds \$12,418,446 to fund new research.

The CCTF authorized the distribution of a third request for proposals on April 7, 2009 (http://www.uwyo.edu/sersupport/Clean_Coal/Clean_Coal_RFP/Wyoming_Clean_Coal_RFP_2009.pdf) with a submission deadline of August 3, 2009. Areas of research eligible for consideration remained the same as in the previous RFP, but language in the request emphasized that the CCTF seeks to fund technology demonstration projects as well as technology development research. 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

In all, 22 proposals were submitted and a total of \$15,663,827 was requested. The program requires at least a dollar-for-dollar match from non-state funds.

The Task Force met on August 28, 2008 to review and evaluate 21 proposals (one failed to comply and was withdrawn). In accordance with the 2008 legislation referenced above, the Task Force submitted their recommendation to fund eight proposals. Funding these projects will utilize \$5,952,766 from the Clean Coal Account.

The 2009 Annual Report of the Clean Coal Task Force to the Joint Minerals, Business, and Economic Development Interim Committee (Appendix B-5) lists the results of all three rounds of review or proposals for the Clean Coal Technologies Research Program.

C. OUTREACH INITIATIVES

1. Associate Director Search

A search to fill the position of Associate Director of Energy Outreach commenced in September 2009. Mary Byrnes, formerly a Commissioner with the Wyoming Public Services Commission was the successful candidate and assumed her current duties in November 2009. The Associate Director of Energy Outreach leads the activities of the Outreach Program.

2. Symposia, Conferences, and Workshops

SER's energy outreach mission is to serve as a source of knowledge to energy stakeholders in Wyoming. One of the most effective ways to reach appropriate interest groups is through sponsorships of symposia, conferences, and workshops where experts are invited to deliver lectures on important topics, and then hold discussions with participants in the audience. In FY2009, we were very active in carrying out that mission.

The following are significant offerings that benefitted from SER support and coordination:

- SER sponsored and played a major role in coordinating the 4th annual **Hydrogen Energy Implementation Conference** on behalf of the Governor's Office. Governor Freudenthal was a keynote speaker. The conference addressed technology, economics, policy, government activities, and international team-building necessary to build a hydrogen economy. The conference included a full professional program, exhibits, and networking events and was held at the Hilton Garden Inn, Laramie, Wyoming, July 22-24, 2008.
- The College of Business and the College Engineering and Applied Science asked SER to help sponsor an **Energy Economics Summit** on September 4, 2008. Topics were discussed by panels of experts that had local, regional, national and global perspectives. Topics included: the economics of oil, gas, coal, uranium and renewable resources; sustainable business practices and ethics.

- The Enhanced Oil Recovery Institute convened the **Wyoming EOR/IOR Conference** in Jackson on September 15-16, 2008. SER sponsored and participated in the conference.
- SER developed, coordinated and hosted the **Wyoming Pipelines: The Territory Ahead** Conference held in Cheyenne in October 2008. The agenda included panels on Certification, Construction and Operation of Pipelines, Regulation, Pricing, and Taxation. Harold Heinze, CEO of Alaska Natural Gas Development Authority, was the Keynote Speaker. Dennis Stickley, SER Visiting Professor of Law was the convener and a major contributor to the conference.
- SER sponsored and contributed to the UW Stroock Forum with the title “**Wyoming Lands and People: Water Management on the Upper Green River**” in Pinedale on November 15-16, 2008.
- The UW International Studies Program and History Department asked SER to co-sponsor a series of symposia entitled **Global Competition for Energy: Implications for Wyoming and the World** that will be held in various locations around Wyoming over a two year period. Dr. Jean Garrison, Director of the International Studies Program conceived of and is leading this endeavor. The first symposium was held in Sheridan on March 5, 2009. Other sessions are planned for Cody and Casper in the Fall 2009.
- Laramie County Community College sponsored a program entitled **Learning in Fun Environments** in April 2009. SER contributed four lectures under the title “Energy Development in Wyoming”. Drs. Northam, Considine, Fan and Stahl delivered lectures covering a variety of energy development topics.
- SER provided support for 15 teachers from UW and from Wyoming Community Colleges and high schools to attend a workshop entitled “**Teaching About Energy in Geoscience Courses**” held in Laramie May 17th to 19th. The workshop was sponsored by a grant from the National Science Foundation, and UW Professor of Geology Jim Meyers was one of four conveners of the workshop. SER’s support made it possible for Wyoming educators to attend and interact with educators from around the nation.
- The UW Enhanced Oil Recovery Institute convened the **3rd Annual Wyoming CO₂ Conference** in Casper on June 23-34, 2009. SER sponsored and participated in the conference.
- 2009 General Session House Bill No. 295 authorized the convening of a **Western States Energy and Environment Symposium**, appointed a steering committee, and authorized a budget (\$450 thousand) and directed SER to coordinate the activities to plan the symposium. The symposium is scheduled to be held on October 25-27, 2009 in Jackson. Significant SER staff resources have been required to coordinate weekly steering committee meetings, arrange hotel and meeting facility logistics, recruit keynote speakers, panelist and participants, and manage out-sourced activities of event planning, (Hip Performance Group), facilitation (Meridian Institute) and public relations (Brimmer Communications). A written report of the symposium is due on December 11, 2009 to the legislatures of the western states.

3. Colloquium Speaker Series

SER also coordinates visits to UW by experts in energy areas to deliver lectures of interest to faculty, students, and the general public on campus. In FY2009, the following lectures were sponsored on campus:

- Dr. Hilikka Kenttamaa, Department of Chemistry, Purdue University. “Petroleum Characterization by Laser-induced Acoustic Desorption/Chemical Ionization/FT-ICR Mass Spectrometry” – Laramie, WY November 13, 2008
- Dr. Paul Massarotto, Principal Research Fellow, School of Engineering, University of Queensland. “Feasibility of a Large-Scale Project for CO₂ Capture and Geosequestration in Coal Seams – An Australian Study” – Laramie, WY December 1, 2008
- Dr. Rajesh J. Pawar, Senior Project Leader, Los Alamos National Laboratory. “An overview of CO₂-PENS Framework for Assessment of Engineered Geologic CO₂ Storage Sites” – Laramie, WY January 14, 2009
- Dr. Benoit Noetinger, Associate Director, Institute Francais du Petrole. “Up scaling Flow in Random Porous Media: Some Recent Achievements & Issues” – Laramie, WY January 29, 2009
- Dr. Dongwoo Sheen, Chair of Interdisciplinary Program in Computational Science and Technology, Seoul National University. “P₁ Nonconforming Quadrilateral Finite Element Methods for the Stokes Problem” – Laramie WY January 29,

4. Participation in Conferences, Exhibitions and Trade Fairs

As part of its outreach mission, SER participated in a number of external conferences, exhibitions and trade fairs in FY2009. These include:

- RETECH 2009 – Renewable energy conference, Las Vegas, NV Feb 25-27, 2009
- Global New Energy Summit – Santa Fe, NM, March 23-24, 2009
- WindPower 2009 Conference, Chicago, IL, May 4-7, 2009
- Global Uranium 2009 Annual Conference, Keystone, CO May 10-13
- Energy Exposition 2009, Gillette, WY, June 2-4, 2009

D. 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 2009, \$20.5 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 Center. 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 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 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 \$170 thousand to help construct the Center.
- Marathon Oil Company pledged \$250 thousand to help construct an Interdisciplinary Fossil Fuel Research Lab as part of the Center.
- Questar Corporation gifted \$80 thousand to help fund the Center.
- Arch Coal, Inc. pledged a total of \$1.5 million to UW, an amount that will be matched by the state. Half will be used to help construct the Center. The remaining amount will endow the Clean Coal Technology Center referenced above.

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.
- Peabody Energy pledged \$2 million (to be matched by the state) to the UW School of Energy Resources for as yet unspecified endowment.
- Ultra Petroleum pledged \$1 million (to be matched by the state) to the UW School of Energy Resources for as yet unspecified endowment.

Significant conversations with several other companies are ongoing.

E. Financial Report

The Wyoming State Legislature provided authorization and funding for 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. The 2008 SER Annual Report provided full details of the expenditure of funds from the initial Biennium. That report can be found by following this link: (<http://www.uwyo.edu/sersupport/docs/SER%20Annual%20Rpt%202008%20Final.pdf>).

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.

Expenditures for FY2009 totaled \$4,542,454. Expenditures are made from four operational accounts to coincide with major activities in the focus areas. The following sums have been spent in each of these areas:

- Academics - \$3,507,746
- Research - \$327,030
- Outreach - \$217,505
- Administration - \$490,173

Projection of the FY2009 budget allocated \$8,255,567 for expenditure spread across these accounts as follows:

- Academics - \$4,625,357
- Research - \$2,091,599
- Outreach - \$899,600
- Administration - \$639,008

Clearly, the level of expenditures during the past fiscal year fell short of expectation. Several factors contributed to lower than expected expenditures.

FY2009 Expenditures – Academics

Major academic expenditures for the fiscal year are summarized as:

- \$1,847,844 for salary and benefits for the SER Faculty, visiting faculty, and staff
- \$1,120,720 for SER Faculty start-up obligations
- \$402,841 for Graduate Assistantships
- \$96,240 for the Energy Summer Institute.
- \$40,101 for other activities.

Academics fell short of expected expenditures by about \$1.1 million due mainly to the following factors:

- Delayed arrival of two faculty members and failure of one faculty search impacted salary, benefits, and start-up spending.
- Three visiting faculty were budgeted for in FY2009. Dr. Jim Douglas was on campus for the full academic year. Dr. Akl Forgi Zaid failed to arrive due to problems with obtaining a visa. He is now expected to join UW for one year in January 2010. We were not successful in arranging for the 3rd visiting faculty.
- Release Time Funds in the amount of \$300,000 were budgeted. Release Time used to secure teaching and research time of non-SER faculty while contributing to SER projects. We found it unnecessary to spend these funds this year.

- SER budgeted \$128,000 for Distinguished Teaching Internships that were to be awarded to Wyoming secondary school teachers. During the course of the year, we came to realize that these positions are impractical due to commitments of targeted teachers. Budgeted funds were reallocated toward establishing Energy Academies at several Wyoming Community Colleges. Staff shortages have delayed start-up of the academies.
- Course development work in the amount of \$130,000 has been delayed.

FY2009 Expenditures – Research

Major research expenditures for the fiscal year are summarized as:

- \$174,580 to support Research Centers
- \$102,450 to for Matching Grants Fund commitments
- \$50,000 for Carbon Sequestration Research by the Wyoming State Geologic Survey

Research fell short of expected expenditures by nearly \$1.8 million due primarily to the following factors:

- SER budgeted \$1 million for the Matching Grants Fund in FY2009. Even though funds were committed for over \$1.4 million in FY2008, grant capture fell far short of expectations. Funds released from commitment will be rapidly redeployed in FY2010 to support energy research at UW. We are currently revising our process for the MGF so that we have more certainty in expenditure of these funds.
- SER budgeted \$750 thousand to support new and existing research centers. Four of those centers are still heavily engaged in organizing and were not in a position to use the funding. One center was essentially dormant due to the sudden passing of the director. All five of those centers will see significant activity in FY2010 so that the unspent funds will be deployed.
- SER budgeted \$340 thousand for half-time faculty and students to conduct research. This aspect of our program has not been developed yet.

FY2009 Expenditures – Outreach

Major outreach expenditures for the fiscal year are summarized as:

- \$81,703 in salaries and benefits
- \$55,740 for workshops
- \$42,000 for publications and marketing materials

Energy Outreach fell short of expected expenditures by nearly \$682 thousand due primarily to the following factors:

- SER budgeted \$166 thousand to support consultants, and \$80 thousand for UW faculty expected to contribute workshop development. We were able to conduct much of that work utilizing UW faculty without the need to pay for Release Time.
- SER budgeted \$156 thousand for workshop logistics. Several workshops that were planned were postponed due to redirection of effort to organize the Western State Energy and Environment Symposium.
- SER budgeted \$145 thousand to support other organizations in conducting workshops, symposia, and trade shows in the energy sector. A much smaller set of opportunities developed than expected.
- SER budgeted \$62 thousand to pay for lecturers. Most of those funds were not used.
- SER budgeted \$35 thousand to begin setting up Energy Academies at Wyoming Community Colleges. That work has been delayed.

With the hiring of the Associate Director of Energy Outreach, we expect the outreach activities to accelerate in FY2010 and beyond.

FY2009 Expenditures – Administration

Major administration expenditures for the fiscal year are summarized as:

- \$490,173 in salaries and benefits for the director, the business manager, and the staff assistant.
- \$89,272 for general office support

FY2009 Expenditures - Summary

FY2009 expenditures fell substantially short of expectations. Most of the factors contributing to the lower than expected spending are outside of the control of SER. We are revising some of the substantially-funded programs (Matching Grants Funds, visiting faculty, research appointments, and research centers) to provide more certainty in the use of funds. The main change will be to consider a greater number of options and alternative uses for the funds. In addition, added staff will more aggressively develop programs that have not yet materialized. Hiring of top talent remains problematic and has been exacerbated by the downturn in the state and national economies.

Table E-1. School of Energy Resources Fiscal Year 2009 Budget Detail

	Fiscal Year 2009 Proposed	Fiscal Year 2009 Expenditures
Academics		
Salary & Benefits	\$ 187,716	\$ 235,133
Office Support Expenses	\$ -	\$ 22,388
Distinguished Faculty Salary & Benefits	\$ 1,619,026	\$ 1,531,263
Distinguished Faculty Startup	\$ 1,455,865	\$ 1,120,720
Recruiting	\$ 50,000	\$ 22,807
Release Time Funds	\$ 300,000	\$ -
Undergrad Research Fellowship Stipends	\$ -	\$ 11,635
Graduate Assistantships	\$ 332,390	\$ 402,841
Visiting Professorships	\$ 301,200	\$ 59,060
Distinguished Teaching Internships	\$ 128,800	\$ -
Other Support (Course Dev, Faculty Searches)	\$ 179,000	\$ 177
Research Experiences for Undergraduates (REU)	\$ -	\$ 2,505
Equipment Requests	\$ -	\$ 2,976
Energy Summer Institute	\$ 71,360	\$ 96,240
Subtotal Academics	\$ 4,625,357	\$ 3,507,746
Research		
Half-time Faculty Appointments	\$ 299,999	\$ -
Graduate Research Assistants	\$ 41,600	\$ -
WSGS- Carbon Sequestration	\$ -	\$ 50,000
Matching Grant Funds	\$ 1,000,000	\$ 102,450
Research Centers	\$ 750,000	\$ 174,580
Subtotal Research	\$ 2,091,599	\$ 327,030
Outreach		
Salary & Benefits	\$ 124,800	\$ 81,703
Consulting Specialists	\$ 166,400	\$ -
Release Time For Faculty Contributors	\$ 80,000	\$ -
General Office support	\$ 78,000	\$ 7,759
Travel	\$ 20,800	\$ 16,813
Contributions to Others	\$ 145,000	\$ 10,425
Publications	\$ 31,200	\$ 42,000
Lectures	\$ 62,400	\$ 3,065
Energy Academies	\$ 35,000	\$ -
Workshops	\$ 156,000	\$ 55,740
Subtotal Outreach	\$ 899,600	\$ 217,505
Administration		
Salary & Benefits	\$ 405,008	\$ 400,901
General Office support	\$ 234,000	\$ 89,272
Subtotal Administration	\$ 639,008	\$ 490,173
Total Fiscal Year 2009	\$ 8,255,564	\$ 4,542,454