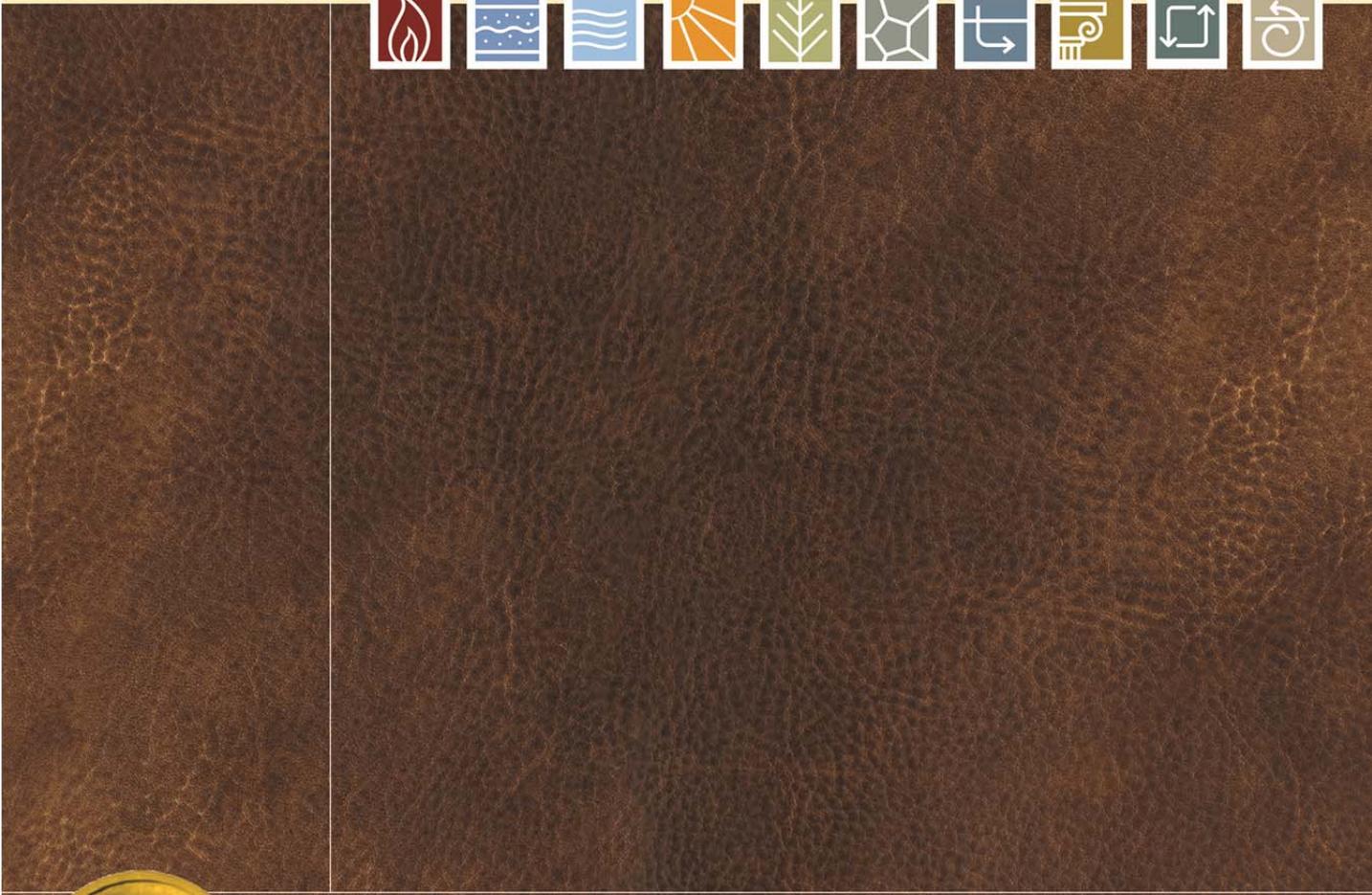


SCHOOL OF ENERGY RESOURCES

# 2011 Annual Report: The University of Wyoming School of Energy Resources



UNIVERSITY OF WYOMING

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**2011 ANNUAL REPORT OF  
THE UNIVERSITY OF WYOMING  
SCHOOL OF ENERGY RESOURCES**

**1 October 2011**  
(W.S. 21-17-117f)

**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  
Fourth Annual Report, 1 October 2010**  
[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 reports accomplishments of the School of Energy Resources (SER) at the University of Wyoming during Fiscal Year 2011. 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. The University of Wyoming Energy Resources Council (ERC) provides direction to SER regarding the identification and prioritization issues that should be targeted for research and outreach.

Major accomplishments and updates during FY2011 include:

### **Academics**

- 7 fellowships to undergraduate students, 2 to graduate students and 2 to junior faculty in UW energy disciplines were awarded. The Fellowships were funded by income from generous gifts from the Nielson family and Anadarko.
- SER competitively awarded a total of 65 graduate assistants (GAs) for the Academic Year (AY) 2010-11 and AY 2011-2012 to 6 colleges and units across the campus: College of Engineering and Applied Science 26; College of Arts and Sciences 28; College of Agriculture 2; College of Education 3; College of Law 4 and Haub School of Environmental and Natural Resources 2. GA awards are for 2 years and include a monthly stipend, tuition and fees, and health insurance.
- A proposal for a Professional Master's degree in Energy Resource Science was submitted to Academic Affairs and is in the process of review.
- 8 Energy Resource Science students completed internships during the 2011 summer.
- A master's degree program in Energy Economics and Management is under development with the College of Business.
- SER organized a 1-week Energy Summer Institute. Twenty-one high school students from across Wyoming participated.

- International agreements were developed for collaboration between UW/SER and University of Queensland and Queensland University of Technology.
- The Energy Resource Science BS degree program enrolled 50 students for Fall 2011. This is an increase of 29 students from AY 2009/2010 and an increase of 43 students from AY 2008/09.
- SER supported three visiting professors.

### **Research**

- Hired Deputy Director of Research – Diana Hulme.
- Facilitated further awards from the Clean Coal Technology Fund.
- Awarded funds for research from the Uranium Research Fund.

### **Outreach**

- SER organized two and conducted one major conference(s) during the year.
- Finalized branding of the School and Centers of Excellence.
- SER organized and/or sponsored 4 other major energy outreach events during the year.
- Participated in 6 energy conferences.
- Three colloquium speakers were sponsored by SER.
- Led 2 initiatives – Compressed Natural Gas Vehicles and College of Law Energy and Policy Initiative.

### **Development Activities**

- SER and the UW Foundation continued the campaign to raise \$2 million in private donations for the “Energy Resources Technology Enterprise Fund”. Gifts stand at just over \$1.5 million toward a goal of \$2 million. Fund is being matched by the state 1:1.
- Celebration organized by UW Foundation in Houston to recognize the special contributions and the relationship of the energy industry with the University of Wyoming.

### **The Energy Resources Center**

- Official Groundbreaking took place on November 19, 2010. Construction began in mid-2011. Anticipate completion in 3<sup>rd</sup> Quarter 2012.

### **Financial**

- During the 2010 Legislative Budget Session, the legislature appropriated \$17,400,000 for the FY2011-12 biennium from the AML Fund and approved up to \$2,000,000 to be

carried over from unspent appropriations from the prior (FY2009-2010) biennium. The actual amount carried over at the end of FY2010 was \$1,865,683.

- SER's expenditures for FY2011 were \$7,016,918 (additional commitments were made that will be finalized in FY2012).

**This report is organized as follows:**

- I.** The UW Energy Resources Council
- II.** Academic Programs
  - A. Overview
  - B. Undergraduate Education
  - C. Graduate Education
  - D. SER Faculty Performance
  - E. K12 Energy Education
- III.** Research
  - A. Centers of Excellence
    - 1. Coal Bed Natural Gas Center
    - 2. Center for Energy Economics and Public Policy
    - 3. Center for Fundamentals of Subsurface Flow
    - 4. Carbon Management Institute
    - 5. Center for Photoconversion and Catalysis
    - 6. Wyoming Reclamation and Restoration Center
    - 7. Wind Energy Research Center
    - 8. Enhanced Oil Recovery Institute
  - B. Matching Grant Fund Program
  - C. Uranium Research Fund
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- IV.** Outreach Initiatives
  - A. Major Conferences Conducted by SER
  - B. Branding of SER and the Centers of Excellence
  - C. Other Significant Energy Outreach Offerings
  - D. Colloquium Speaker Series
  - E. Participation in Conferences, Exhibitions, and Trade Fairs
  - F. Other Activities
- V.** Development Activities
- VI.** The Energy Resources Center
- VII.** Financial Report

## **INTRODUCTION**

Fiscal Year 2011 was the fifth full year of operation of the School of Energy Resources (SER) at the University of Wyoming (UW). Significant progress continued in the areas of Academics, Research, and Outreach. In addition, construction of the Energy Resources Center building commenced. The UW Energy Resources Council met four times during the year as they continue to provide guidance and direction in the areas of research and outreach.

## I. UW Energy Resources Council

The UW Energy Resources Council (ERC), appointed by Wyoming's governor, is responsible for prioritization of research and outreach activities for SER. Governor Mead appointed Paul Matheny, to fill the position vacated by Keith Rattie. Senator Kit Jennings is the newly-appointed designee from the Wyoming Senate. In 2011, the UW Board of Trustees appointed David Palmerlee to serve as its ex-officio member. He joined the Council in May, 2011.

At the end of FY2011, the standing members of the University of Wyoming Energy Resources Council are:

Ron Harper – Chairman	<i>CEO and GM, Basin Electric and Basin Cooperative</i>
Rep. Tom Lockhart – Co-Chairman	<i>Wyoming Legislature – Co-Chairman, Joint Minerals, Business and Economic Development Committee</i>
Carl Bauer	<i>President, Bauer Consulting, Inc. and Former Director, National Energy Technology Laboratory, US DOE</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>
Sen. Kit Jennings	<i>Wyoming State Senator</i>
James Kleckner	<i>VP of Operations, Anadarko Petroleum Corp.</i>
Paul Lang	<i>Executive Vice President Operations, Arch Coal Inc.</i>
N. Maha Mahasenan	<i>Principal Advisor, Rio Tinto</i>
Paul Matheny	<i>Vice President-Rockies Region, QEP Resources, Inc.</i>
David Palmerlee	<i>UW Trustee</i>
Rob Wallace	<i>Manager, Government Relations, GE Energy</i>

## II. Academic Programs

### A. Overview

The overarching mission of SER Academics is to develop an innovative, competent and performance-driven 21<sup>st</sup> century energy sector workforce. Positioning graduates for long term competitive success demands not only content knowledge but competencies that allow

adaptation to new areas of proficiency and rapidly changing technologies. SER Academics seeks to establish, guide and coordinate the energy educational continuum in Wyoming from K12 through undergraduate and graduate programs. This is achieved, in part, through 5 primary functions:

1. Recruitment and cultivation of talented faculty and students.
2. Competitive allocation of resources.
3. Development of a cohesive, contemporary and relevant curriculum.
4. Expansion of comparative advantage, opportunity creation and entrepreneurship.
5. Establishing a scholarly environment focused on outcomes, accountability, competitive success and a sense of urgency.

All SER academic initiatives are guided by a focus on rigor and high standards, continual inspection and modification, and student learning outcomes designed for sustained competitive success and the needs of the Wyoming energy enterprise. This report summarizes outcomes from 4 main elements of the academic mission: **Undergraduate Education, Graduate Education, Faculty Performance and K12 Energy Education**. In addition, a culminating planning section links 2011 outcomes with projected initiatives for the coming year.

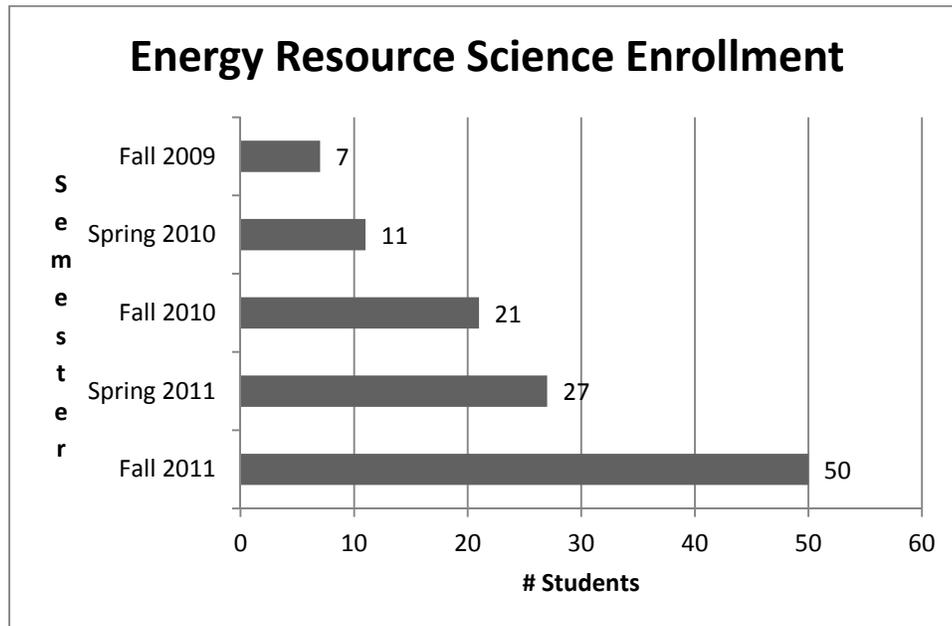
## B. Undergraduate Education

The B.S. degree program in Energy Resource Science (ERS) offers interdisciplinary energy curriculum that integrates engineering, geology, policy, economics, business, law, and natural resources content. Increasingly, decision-making related to energy asset life cycle and valuation requires the collection, analysis and synthesis of diverse inputs and significant data sets. In recognition of the rapid change and increasing complexity that energy professionals must continually deal with, the ERS program provides experiences and training that explicitly teach process skills such as communication, creative problem-solving, entrepreneurship, teamwork, critical analysis and self-directed, life-long learning. As a priority, the ERS degree program seeks to connect the acquisition of knowledge gained in the classroom and lab with practical and authentic application and problem solving; to link the university experience with the public and private sector energy industry. And it provides training for students consistent with the work ethic expected of professionals in the energy industry.

The ERS degree began in 2009 and has increased substantially in enrollment, an indication of student demand (see below). However, increasing numbers alone does not provide the gold standard metric for program assessment. Industry acceptance and demand for ERS graduates and their long-term performance are paramount, and SER is committed to increasing awareness of this new program in the energy sector and to continual inspection in order to ensure top level career placement and performance of graduates.

- **Student enrollment.** The program began with 7 students in Fall 2009 and 50 students are projected to major in the program for Fall 2011 (based on pre-enrollment numbers).

The significant increase in ERS student numbers indicates that the program remains very appealing and relevant to students.



- **Degree awarding.** ERS is an interdisciplinary, cross-college degree and, as such, does not have a traditional college “home” where the degree is awarded. In response to student demand and the core contribution of engineering courses to the curriculum, ERS graduates (first class in Fall 2011) will be awarded their degrees in conjunction with the College of Engineering and Applied Sciences.
- **Curriculum modification.**
  - ✓ The ERS curriculum constantly undergoes formative evaluation to identify strengths and weaknesses and to address deficiencies that are emerging after 3 years of implementation. In particular, program requirements are being adjusted to focus on core competencies; to contain more upper level courses and eliminate duplication; to integrate additional experiences in policy, economics and energy management; to allow greater flexibility; to add new courses to better prepare students for emerging changes in the energy sector; and to maximize the connection between content and application.
  - ✓ New courses in 2011: an energy-focused Calculus 1, 2 and 3 series, an internship course, a course in international energy experience, and an energy solar conversion course. Additional course development is outlined in the planning section.
  - ✓ Modification of existing courses is being encouraged to instill greater connection with energy issues and to focus on inquiry, problem solving and self-directed learning.
- **Mentoring and tutoring.** A formal process of tutoring, including peer tutoring among ERS students and mentoring by UW faculty and industry professionals, has been established to provide every opportunity for students to succeed. It is our goal to provide

an industry professional as a mentor for each ERS student in addition to the traditional faculty advisor.

- **ERS student advising.** To date, the Associate Director for Academics served as the advisor for all ERS students. This duty has now been transferred to SER faculty.
- **Energy Resource Club.** All UW students with an interest in energy now have a formally recognized club to coordinate activities and develop a sense of community. It is supervised and resourced by SER. Approximately 25 students were involved with the club in AY 2011. Activities included the following:
  - ✓ Resume presentation by the Center for Advising and Career Services
  - ✓ Accessible Energy Brown Bag Lunch Series with presentations by
    - Dr. Bruce Parkinson
    - Dr. Tim Considine
    - Dr. James Myers
  - ✓ Film Festival co-sponsored by the Energy Resource Club and the Reclamation and Restoration Outreach Club
  - ✓ Workforce preparation and planning workshop by the SER Associate Director
- **Fellowships, scholarships and external gifts.** With a focus on accountability, significant new academic awards have been supported by external donors. Rather than utilizing the funds as traditional scholarships, the donations have been structured to provide funding for innovative academic experiences. The fellowships are competitively awarded and open to students in energy fields across multiple departments at UW. In 2011, 6 undergraduate fellowships were awarded by the Nielson fund. The Anadarko fund supported 1 undergraduate fellowship, 2 graduate fellowships, and 2 junior faculty fellowships.
- **Student recruitment.** Aggressive efforts have been made to increase awareness of the ERS degree program and recruit top quality students. Efforts have focused on Wyoming and the surrounding region where community colleges, high school counselors, and community contacts have been made and materials distributed. In addition, a national initiative is being implemented to increase access and awareness for veterans, women and minorities.
- **Internships.** A new course has been approved to provide ERS students with credit for internship experiences. Internships are viewed as vital components of the ERS degree program. Formal accountability metrics for the student and the employing energy enterprise have been developed to ensure appropriate learning experiences. Examples of ERS student placement in 2011 internships include:
  - ✓ 3 students with EnCana Natural Gas
  - ✓ 1 student each with Halliburton, Intertech Environmental Engineering, and Questar
  - ✓ 1 student with Dr. Kristina Hufford – ecology and restoration
  - ✓ 1 student with Dr. KJ Reddy – water quality and flue gas

- **International experiences.** Formal memoranda of understanding have been signed with University of Queensland and Queensland University of Technology in Brisbane, Australia. Other arrangements are in the planning stage. The purpose of these arrangements is to provide opportunities for students in UW energy disciplines to gain international exposure to energy. The initial phase will involve semester long or variable length experiences. Future plans call for development of joint degree programs and in-depth research and discovery experiences.
- **Workshops.** Several student workshops were presented or coordinated by SER.
  - ✓ The Research Mini-Symposium was held to provide information to students about the energy-related research being conducted on campus. All SER faculty, center directors and adjunct faculty gave 10-15 minute summaries of their research.
  - ✓ Several ERS Advising Preparation sessions during the Spring 2011 semester provided students with curriculum requirements and tips for scheduling classes.
  - ✓ Workshops were held in January and February 2011 to work with students on improving their resumes.
- **Development of private and public sector partnerships.** Academic representatives met with the Southeast Wyoming Oil and Gas Partnership program formed to review workforce needs for companies exploring the Niobrara play.
- **Community college interactions.** Interactions with Wyoming community colleges have explored the feasibility of establishing an Associate's degree in ERS and measures to enhance the pipeline from the community colleges (including transfer of courses) into the UW ERS degree program.

### C. Graduate Education

To date, the primary SER role in graduate education has been to competitively allocate resources in support of graduate assistantships (GAs) focused on energy (see **Appendix A-1** for details). Talented graduate students working under the direction of UW's faculty are essential to the university's research enterprise. Recruitment of talented and nationally competitive graduate students requires the provision of a graduate assistantship.

All SER GAs and their faculty mentors are required to submit annual reports of work completed in the past year. In addition to the written reports, the students present their research in either an oral or a poster presentation at the annual Graduate Research Symposium.

- In response to faculty proposals, SER has competitively allocated 65 total graduate assistantships to students in 6 colleges and units across the campus: College of Engineering and Applied Science (n=26); College of Arts and Sciences (n=28); College of Education (n=3); College of Law (n=4) and Haub School of Environmental and Natural Resources (n=2); College of Agriculture (n=2). The GAs are awarded for 2 fiscal years and include a stipend, tuition and fees, and health insurance.
- In 2011, a more direct involvement has been proposed for SER in graduate education. A Professional Master's degree proposal has been submitted to Academic Affairs. (See

**Appendix A-2** for proposal details). The program is workforce-focused and designed to train participants in advanced skills necessary for an energy asset manager.

#### D. SER Faculty Performance

SER has 11 faculty members and 6 adjuncts that hold joint appointments with a “home” department. One open SER faculty position remains, and a national search will be initiated as the SER strategic plan identifies an appropriate focus area.

- **Curriculum development.**
  - ✓ Dr. Felipe Pereira developed a 3 semester Calculus sequence focused on energy and physical applications. This is as rigorous as the standard course, but in addition to new elements in differential equations and spreadsheet utilization, it is connected to application examples in energy and physical sciences.
  - ✓ Dr. Bruce Parkinson developed a course in Photovoltaics.
  - ✓ Internship, international experience in energy and a special topics course for undergraduate research courses were developed and approved.
- **Faculty development.** The Deputy Director for Academics established a new process to promote collaboration between SER and colleges and to identify and address developing faculty issues. Biannually, the Deputy Director meets with each SER faculty member and adjunct and their respective department heads and college deans to review performance and set expectations for the coming year.
- **Workshops.**
  - ✓ An Intellectual Property workshop was offered in conjunction with the UW Office of Research and Economic Development.
  - ✓ In order to promote more effective teaching with a focus on problem solving and project based learning, a workshop on Elements of Effective, Inquiry-based Teaching was delivered by the Associate Director for Academics
  - ✓ In the transition to SER faculty advising, a workshop delivered information about the advising process, mechanics and best practices to SER faculty.
- **Visiting Faculty.** In 2011, SER supported three visiting professors: Dr. Li Deng in Mathematics for the full FY2011; Dr. Perangelo Masarati in Mechanical Engineering; and Dr. Dennis Stickley in the College of Law for the AY 2011.

#### E. K12 Energy Education

SER is committed to coordinating and sustaining statewide efforts to enhance opportunities in energy education by establishing a portfolio of relevant, place-based and inquiry driven energy education options for K12. The structure of school-based programs can be flexible depending upon the degree of local involvement; however, the framework has the following objectives:

- Enhance student motivation to further learning by participation in activities and projects focused on energy that are problem-based, experiential, and relevant. All materials focus

on enhancing curiosity, entrepreneurial thinking, critical analysis, self-directed learning and team concepts to solve problems.

- Increase awareness of the vast career opportunities available in the public and private energy sector. In conjunction with this goal, guidance on academic preparation and training from grade 7 onward are provided.
- Increase in-service teacher training in energy issues and motivating inquiry-based pedagogy.
- Provide contemporary lesson plans of varying duration for integration into the curriculum.
- Connect engaging curriculum and project based learning with applications and practice in the field.

To this end 2011 initiatives included:

- **Summer Energy Institute** – In conjunction with the UW Science Posse (see [www.scienceposse.org](http://www.scienceposse.org)), 21 high school sophomores and juniors attended the fifth annual Energy Summer Institute held June 12-17, 2011 at UW. Students learned about challenging energy problems facing Wyoming and the world and exciting solutions on the horizon. In addition to the relevant programmatic content, the ESI also exposed participants to higher education and the excitement of being on the UW campus.
- **SER support for other science/energy focused K12 programs** – SER provided support and coordination for several UW-based K12 programs, including the NSF sponsored Science Posse and the Energy and Environmental Nanotechnology program, the WY Geographic Alliance, and the NASA sponsored science education program.
- **Simulation development** – A 10th-12th grade focused computer simulation “game” is under development by Dr. Po Chen, an SER faculty member. It is designed to provide a virtual experience to understand fluid flow in reservoirs.
- **Energy academies** – SER is cooperating with school systems in Rock Springs and Gillette to establish/sustain energy academies that utilize energy concepts and issues to frame delivery of content necessary for statewide academic testing.
- **Involvement of graduate students in the 7<sup>th</sup>-12<sup>th</sup> grade classrooms.** Graduate students in energy fields (including those supported by SER) discuss, explain and showcase their research to teachers and students.

### III. Research

#### A. Centers of Excellence

The Centers of Excellence are established with seed funding from the School of Energy Resources (SER) budget. Each Center of Excellence strives to achieve support through outside funding, an accomplishment that may take several years. Centers of Excellence bring together faculty and graduate students from multiple disciplines to develop important energy research

programs. 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. Eight Centers of Excellence were active in FY2011.

### **1. Coal Bed Natural Gas Center – Dr. Michael A. Urynowicz, Director**

#### Center Mission:

The Coal Bed Natural Gas Center (CBNGC) exists to develop and commercialize technologies that enhance the production of renewable, clean-burning natural gas by indigenous microorganisms found in coal seams and other fossil fuel reservoirs. The Center's primary objective is to add value to Wyoming's vast energy resources by revitalizing economically depleted production wells using natural, environmentally friendly processes.

#### Contributing Faculty:

Dave Bagley, Patricia Colberg, and Franco Basile

#### FY2011 Achievements:

- The CBNGC is currently working on a Research Partnership to Secure Energy in America (RPSEA) project with the Colorado School of Mines and the United States Geological Survey.
- The CBNGC has one provisional patent application entitled, "Biomass-Enhanced Natural Gas from Coal Formations," which was filed on March 31, 2011 in the U.S. Patent and Trademark Office.
- ENWYO, LLC, a Laramie based start-up company was established in 2010 to commercialize patented and patent pending technologies developed at the University of Wyoming. The company is currently negotiating an exclusive licensing agreement with the Office of Research & Economic Development at the University of Wyoming and was recently awarded a Small Business Innovation Research and Technology Transfer (SBIR/STTR) grant funded in part by the Wyoming Business Council.
- The CBNGC is working to achieve financial independence through the recruitment of industry sponsors, many of whom will participate in the upcoming International Conference on Unconventional Biogenic Natural Gas.

#### Research Activities:

- The Coal Bed Natural Gas Research Consortium is currently developing several new and innovative technologies, one being cellulosic coalbed natural gas, designed to bring economically coal depleted reserves back into production and extend their productive life indefinitely.
- "Comprehensive Investigation of the Biogeochemical Factors Enhancing Microbially Generated Methane in Coal Beds," Dr. Michael Urynowicz, principal investigator. This project, funded by the RPSEA, aims to develop techniques to enhance the in-situ depolymerization and solubilization of coal, to identify the coal-derived substrates generated from these techniques, and to evaluate coal-treatment interactions. The project will be completed in December 2011.
- "Powder River Basin Coal Conversion Project," Dr. Michael Urynowicz, principal investigator. This project, funded by the Clean Coal Technology Fund, seeks to investigate

potentially inhibitory compounds generated from techniques used to depolymerize and solubilize coal and will be completed in September 2012.

Publications:

The CBNG Center has one publication pending and two in preparation.

Outreach Activities:

The CBNG Center is working with SER to host the International Conference on Secondary Biogenic Coal Bed Natural Gas in Laramie on June 20-21, 2012. The conference will be used to further develop partnerships with industry, government agencies and other academic institutions.

**2. Center for Energy Economics and Public Policy – Dr. Timothy J. Considine, Director**

Center Mission:

The mission of the Center for Economics and Public Policy (CEEPP) is to provide objective information and analysis for energy policies at the state, national, and international levels that strive to balance economic and environmental considerations.

Contributing Faculty:

Roger Coupal, David Finnoff, Robert Godby, Charles Mason, Owen Phillips, Denise Stickley, and Klass van 't Veld

FY2011 Achievements:

- CEEPP collaborated with the Manhattan Institute in New York City to produce a report on the economic opportunities of shale energy development.
- Other collaborations include those with the Wyoming Mining Association, American Enterprise Institute, American Petroleum Institute, Marcellus Shale Coalition, Quebec Oil and Gas Association, Pennsylvania State University, and the University of Southern California.
- CEEPP is developing marketing materials and will be working with the University of Wyoming Foundation to obtain long-term financial support from corporations and foundations.

Research Activities:

- “The Economic Impacts of the Marcellus Shale,” Dr. Tim Considine, principal investigator. This report, funded by the Marcellus Shale Coalition and Pennsylvania State University, surveys drilling and development, estimates economic impacts, and forecasts future industry activity in the Marcellus Shale. The project will be completed in July 2011 and will result in a report and conference presentations.
- “Arizona’s Energy Future: Costs and Impacts of Renewable Energy Portfolio Standards and Other Energy Choices,” Dr. Tim Considine, principal investigator. This project, funded by SER and The Communications Institute, updates a study completed two years ago forecasting the future demand for energy in Arizona and how this energy could be supplied. The project will be completed in August 2011 and will result in a publication in a peer-reviewed journal.
- “Powering California,” Dr. Tim Considine, principal investigator. This project, funded by SER and The Communications Institute, compares the economic and environmental impacts

of energy development, including renewable energy and oil and gas drilling. The project will be completed in October 2011 and will result in a report and conference presentations.

#### Publications:

- “Balancing Economic Benefits with Environmental Impacts from Shale Energy Development,” Dr. Timothy J. Considine, principal investigator. This project, funded by the Manhattan Institute and completed in June 2011, estimates the benefits of shale energy development and compares them with the value of the environmental impacts. The project resulted in a report titled, “The Economic Opportunities of Shale Energy Development” and can be found at [http://www.manhattan-institute.org/html/eper\\_09.htm](http://www.manhattan-institute.org/html/eper_09.htm).

The video of Dr. Considine’s presentation can be seen at:

<http://www.manhattaninstitute.org/video/energy/index.htm?c=060711CEPE>

#### Outreach Activities:

A new CEEPP webpage has been released (<http://www.uwyo.edu/cee/>) and a marketing brochure for the Center is in production.

### **3. Center for Fundamentals of Subsurface Flow – Dr. Felipe Pereira, Director and Dr. Mohammad Piri, Associate Director**

#### Center Mission:

The Center for Fundamentals of Subsurface Flow (CFSF) advances scientific understanding of subsurface flows and develops the tools and knowledge necessary to predict its behavior - an essential component of both carbon recovery from unconventional resources and storage.

#### Contributing Faculty:

Vladimir Alvarado, Craig Douglas, Frederico Furtado, Victor Ginting, Lamia Goual, John Kazuba, Felipe Pereira, Mohammad Piri, Guan Qin, Brian Towler, Shunde Yin, and Ye Zhang.

#### FY2011 Achievements:

- Professors Mohammad Piri and Felipe Pereira have established a new international collaboration with the Brazilian National Lab for Scientific Computing (LNCC) through a project supported by the Clean Coal Technology Fund. Total project budget is \$2,815,000.
- Professor Guan Qin is building collaboration with Peking University, China focused on numerical modeling and fluid flow simulation in multi-scale fractured media, which addresses an important aspect of unconventional gas development. Discussions are also underway with PetroChina on a potential research collaboration that will be partially funded by its shale gas research center.

#### Research Activities:

- In the period covered by this report, CFSF members were awarded over \$5,700,000 in external funds for research through the University of Wyoming.
- A request for proposals was issued on April 1, 2010 for Geologic Sequestration of Greenhouse Gases and Recovery of Unconventional Gas. The focus of the research is in two topic areas: 1) Sequestration of greenhouse gas and associated impurities (GGI) in geologic formations; 2) Recovery of natural gas from unconventional reservoirs characterized by low permeability. SER-derived funds were awarded to the following proposals:

- ✓ "Impact of Co-Contaminants Injected with Supercritical CO<sub>2</sub> on Fundamental Flow Properties of Sequestration Schemes in Deep Saline Aquifers: Experimentation & Modeling," Mohammad Piri, principal investigator.
- ✓ "Simulation of CO<sub>2</sub> Injection in Deep Saline Aquifers with Mathematical Verification & Physical Validations," Frederico Furtado, principal investigator.
- ✓ "Fundamental Investigation of Wettability in Supercritical-CO<sub>2</sub>/Brine/Rock Systems at Reservoir Conditions: Impact of Contaminants," Lamia Goual, principal investigator.
- ✓ "On the Development of the UW-team Simulator for the Injection of CO<sub>2</sub> in Deep Saline Aquifers," Felipe Pereira, principal investigator.
- ✓ "Multi-scale & Multi-physics Modeling of Unconventional Gas Development," Guan Qin, principal investigator.
- ✓ "High Performance Computing for Subsurface Flow Simulation," Craig Douglas, principal investigator.
- ✓ "A Bayesian Framework for Enabling Predictive Simulation & Uncertainty Quantification in History Matching Geologic Models for CO<sub>2</sub> Injection," Victor Ginting, principal investigator.
- ✓ "An Integrated Well Location Optimization Study for Commercial-Scale CO<sub>2</sub> Storage in a Deep Saline Aquifer," Ye Zhang, principal investigator.
- "Maximization of Permanent Trapping of CO<sub>2</sub> and Co-Contaminants in the Highest-Porosity Formations of the Rock Springs Uplift (RSU): Experimentation and Multi-Scale Modeling," Dr. Mohammad Piri, principal investigator. This project, funded by the Department of Energy (DOE), aims at making accurate predictions for the trapping of injected mixed scCO<sub>2</sub> in the deep saline aquifers of the Rock Springs Uplift (RSU) in Southwest Wyoming. This project will be completed in September 2013.
- "Pore-to-Core-to-Reservoir Modeling of Geologic Storage of Supercritical CO<sub>2</sub> in Deep Fractured Saline Aquifers," Dr. Mohammad Piri, principal investigator. This is an interdisciplinary research project aimed at making accurate predictions about the storage of supercritical CO<sub>2</sub> (scCO<sub>2</sub>) in naturally-fractured saline aquifers of the State of Wyoming. The project is funded by the Clean Coal Technologies Fund and will be completed in June 2014.

#### Publications:

CFSF faculty members have published 17 papers and 12 refereed conference proceedings in the last year.

#### Outreach Activities:

The CFSF held a four day workshop, attended by 38 UW faculty and students, April 19-22, 2011 in Laramie, WY focused on "Multiphase Flows in Fractured Porous Media." Dr. Pierre Adler, Ingénieur de l'Ecole Centrale de Paris, Docteur es-Sciences Physiques de l'Université de Paris, who is a Senior Scientist at the Centre National de la Recherche Scientifique, was a visiting instructor for the workshop.

#### Patents, Licenses, Commercialization Successes:

Mohammad Piri - Recirculating, Constant Back Pressure Core Flooding Apparatus and Method, (2010).

#### 4. Carbon Management Institute – Ron C. Surdam, Director and Shanna C. Dahl, Deputy Director

##### Center Mission:

The Carbon Management Institute (CMI) strives to keep the University of Wyoming at the forefront of geological CO<sub>2</sub> sequestration research and development.

##### Contributing Faculty:

Subhashis Mallick, Jimm Myers, Erin Campbell-Stone, John Kaszuba, Guan Qin, Vladimir Alvarado, and George Vance

##### FY2011 Achievements:

- CMI forged new partnerships with Lawrence Livermore National Laboratory to develop strategies for managing reservoir fluids displaced during CO<sub>2</sub> injection, and Praxair, which will supply 40,000+ tonnes of CO<sub>2</sub> – along with all necessary transportation and injection infrastructure and services – for a proposed small-scale field test of CO<sub>2</sub> injection.
- CMI also pursued several external funding opportunities, receiving \$5 million in supplemental American Recovery and Reinvestment Act (ARRA) funding in September of 2010, and will assume the lead role in the Shaanxi/Wyoming CCS Partnership (\$250,000).

##### Research Activities:

- “Site Characterization of the Highest-Priority Geologic Formations for CO<sub>2</sub> Storage in Wyoming,” Ron Surdam, principal investigator. This project, funded by DOE, the State of Wyoming and industry partners, will provide a detailed site characterization of two deep saline aquifers in the Rock Springs Uplift (RSU) for potential pilot- and commercial-scale CO<sub>2</sub> sequestration. A primary goal is to acquire the technical knowledge base required to plan and execute a CO<sub>2</sub> storage demonstration on the RSU and produce a detailed characterization and evaluation of the Rock Springs Uplift as a potential commercial-scale CO<sub>2</sub> storage site. The project should be completed by December 2012.
- “US-China Clean Energy Research Center, Advanced Coal Technology Consortium,” Ron Surdam, principal investigator. This project, funded by DOE and SER, seeks to build the scientific, technological, and engineering framework necessary for the safe, permanent storage of commercial quantities of anthropogenic CO<sub>2</sub> in the Majiagou Limestone of the Ordos Basin, Shaanxi Province, China. The two project goals are to use CO<sub>2</sub> from the coal-to-chemical industry and integrate geological CO<sub>2</sub> storage with CO<sub>2</sub>-EOR projects. This project will produce a preliminary treatise on assessment methodology and guidelines for site characterization; an inventory and prioritization of potential geological CO<sub>2</sub> sequestration sites in China’s Shaanxi Province; and a detailed site characterization for the Majiagou Limestone near Yulin in Shaanxi Province. This project should be completed by September 2015.
- Other CMI Research Initiatives include:
  - ✓ Natural Gas Storage Evaluations in Wyoming. Transition from characterization to injection of CO<sub>2</sub>: direct injectivity and fracture measurements in two of the highest-priority CO<sub>2</sub> storage reservoirs in the Rocky Mountain region.
  - ✓ Shaanxi/Wyoming CCS Partnership.

Outreach Activities:

Over the past year, CMI researchers and staff presented papers and posters at a variety of conferences, including:

- The 10<sup>th</sup> International Conference on Greenhouse Gas Control Technologies in Amsterdam (4 papers).
- DOE's 10<sup>th</sup> Annual Conference on Carbon Capture and Sequestration in Pittsburgh (2 poster presentations).
- The 3<sup>rd</sup> US-China CO<sub>2</sub> Emission Control Science and Technology Symposium (Hangzhou, China).

In addition, CMI implemented an aggressive outreach effort designed to connect with and inform as many stakeholders as possible. Over the last year, CMI held two public meetings (one in November of 2010 and one in March of 2011) in Rock Springs, two open houses in Laramie for state and federal regulators, legislators, UW faculty and staff, non-governmental organizations (NGOs), and other interested parties (October 2010 and April 2011); and two one-day workshops (December 2010) for state and federal agencies and NGOs.

CMI staff and affiliated faculty gave presentations to the Wyoming Farm Bureau, Wyoming State Water Forum, Rock Springs High School Energy Academy, Yanchang Petroleum Research Institute, University of Beijing, Northwest University (Xian, China), regional and national meetings of the Geological Society of America and American Association of Petroleum Geologists, the Joint Minerals Committee of the Wyoming State Legislature, the UW Energy Resources Council, and the UW board of trustees.

Please see the Wyoming Carbon Underground Storage Project (WY-CUSP) report filed under separate cover to the Wyoming Legislature for plans and details.

#### **5. Center for Photoconversion and Catalysis – Dr. Bruce Parkinson, Director and Dr. Carrick Eggleston, Associate Director**

Center Mission:

The Center for Photoconversion and Catalysis' (CPAC) goal is to find new ways of generating and using energy, emphasizing conversion of light into both electrical and chemical energy and on the closely related catalytic chemistry needed to use new and conventional energy forms more cleanly and efficiently. Resulting knowledge will help minimize energy losses and maximize yields in processes such as biomass conversion, the production of photogenerated fuels and transformations of fossil energy sources into cleaner fuels.

Contributing Faculty:

John Ackerman, Milan Balaz, Edward Clennan, Yuri Dahnovsky, Debashis Dutta, Carrick M. Eggleston, Maohong Fan, John Hoberg, Joseph Holles, Patrick Johnson, Brian Leonard, Mark Mehn, Bruce Parkinson, Jon Pikal, Jinke Tang, Wenyong Wang, and Jing Zhou

FY2011 Achievements:

- CPAC was instrumental in obtaining UW support to improve the research infrastructure with the planned purchase of a new state of the art transmission electron microscope that will greatly aid catalysis and energy related research at UW.

Research Activities:

- “Quantum Dot Sensitized Solar Cells Based on Ternary Metal Oxide Nanowires,” Wenyong Wang, principal investigator. The goal of this project, funded by DOE, is to develop novel, high-efficiency quantum-dot sensitized photovoltaic cells along with laboratory-scale samples. The project started in September 2010 and should be completed by September 2013.
- “Nanostructured photovoltaics for space energy applications,” Wenyong Wang, principal investigator. Funded by the National Aeronautics and Space Association (NASA), the goal of this project is to develop nanostructured quantum-dot sensitized photovoltaic cells for space-based applications. This project is on-going and should be completed in June 2013.
- In its first six months of operation, CPAC issued a request for proposals (RFP) for seed money to fund promising new ideas in areas of interest to the Center. The RFP attracted eight proposals of which six were funded at a total amount of \$75,000. The funded projects are listed below.
  - ✓ “Correlated Electron Dynamics in Quantum-Dot Sensitized Solar Cells and Simulations of Electrochemical Reactions in Ultramicroband Electrode Arrays,” Yuri Dahnovsky, principal investigator.
  - ✓ “Isoprene Synthesis by the Anoxygenic Phototrophic Bacterium *Rhodobacter sphaeroides*,” Mark Gomelsky, principal investigator.
  - ✓ “Computationally Guided Search for Multi-Metallic Carbide Materials as Inexpensive and Robust Fuel Cell Catalysts,” Brian Leonard, principal investigator.
  - ✓ “ALD Modified Tungsten Carbide Catalyst on PolyTetraFluoroEthylene (PTFE)/Nafion Membrane,” Dongmei Li, principal investigator.
  - ✓ “Investigation of Efficient Ce/Eu Sensitized Quantum Cutting Luminescent Thin Films for Solar Concentrator Applications,” Jinke Tang, principal investigator.
  - ✓ “Visualization of Water-Gas Shift Reaction on Ceria-Supported Metal Catalysts by STM,” Jing Zhou, principal investigator.

Outreach Activities:

Professor Hans Queissar, a world famous solid-state physicist and author of the first detailed analysis on the theoretical efficiencies of photovoltaic cells, was the first CPAC Lecturer during the spring semester of 2011.

**6. Wyoming Reclamation and Restoration Center – Dr. Pete Stahl, Director**Center Mission:

The mission of the Wyoming Reclamation and Restoration Center (WRRC) is to educate students, professionals and the general public on the topics of land reclamation and ecosystem restoration; facilitate research and disseminate information on effective technologies and best management practices for reclamation of disturbed lands in Wyoming; and provide assistance to clientele seeking practical solutions for restoring or reclaiming disturbed lands.

Contributing Faculty:

Kristina Hufford, Stephen Williams, K.J. Reddy, George Vance, Ann Hild, Jay Norton, Jeffrey Beck, Ginger Paige, Kelli Belden, Thomas Thurow, Rachel Mealor, Roger Coupal, Matthew Andersen, Brian Mealor, Urzula Norton, Mike Urynowicz, Bill Lauenroth, and Indy Burke

FY2011 Achievements:

- The number of undergraduate and graduate students enrolled in the Land Reclamation Science minor continues to rise. Five graduate certificates were earned in 2010 and 2011.
- There are currently 15 graduate students working on reclamation/restoration related projects in the College of Agriculture and Natural Resources and approximately 15 undergraduate students working towards the minor in Land Reclamation Science.
- Almost all of the students graduating with minors or certificates find jobs working in reclamation/restoration with energy companies, mining companies, reclamation/restoration contractors, or state or federal agencies. Most of our students are also employed in the summer in intern positions with many of the same companies and agencies.
- Again this year, UW students were well represented at the American Society of Mining and Reclamation (ASMR) Awards Banquet with Cally Driessen winning an ASMR Memorial Scholarship (M.S. level) for \$1000, and Lisa Cox and Kyle Lilly both winning ASMR travel awards each for \$250.

Research Activities:

- “Impacts of Gasfield Soil Management Practices on Soil Properties and Plant Establishment,” Dr. Jay Norton, principal investigator. This project is funded by Encana, QEP, and BP.
- “Energy Development and Wildlife Habitat Database Organization,” Dr. Pete Stahl, principal investigator. This project funded by the Wyoming Game and Fish Department (WGFD) collects data throughout Wyoming.
- “Analysis of Remediation Strategies for Radionuclide Contaminated Soils in Uranium Mining,” Dr. Pete Stahl, principal investigator. This project is funded by the Wyoming Mining Association (WMA).
- “Coalbed Natural Gas Co-produced Water Impacts on Soils,” George Vance, principal investigator.
- “Greater Sage-grouse and Wind Energy: Potential Effects of Development on Populations,” Dr. Jeff Beck, principal investigator.
- “Supplemental Irrigation on Jonah Field Wellpads,” Dr. Pete Stahl, principal investigator. This project is funded by Encana and WRRC.
- “Use of Sterile Triticale to Immobilize Nitrogen and Prevent Weed Invasion,” Dr. Pete Stahl, principal investigator. This project is funded by BP, KC Harvey and WRRC.
- “Quantifying Sagebrush Structure on Ecological Sites in the Upper Green River Basin,” Dr. Ginger Paige, principal investigator. This project is funded by the T. Thorne Sage Grouse Conservation Fund.

Outreach Activities:

Over the last two years, WRRC has developed a Reclamation Workshop series and a Reclamation Extension Bulletin Series. The Reclamation Workshop Series currently includes

two different workshops: Reclamation 101: Critical Components of Successful Reclamation and Reclamation 201: Predisturbance Site Assessment. Reclamation 101 Workshops have been presented in Ucross (Buffalo), Cheyenne, Cody, Fort Washakie, Gillette, Kemmerer, Laramie, Pinedale, Rawlins, and Worland. Reclamation 201 Workshops have been presented in Rawlins and Rock Springs. All Reclamation 101 and 201 Workshops have been well attended. A Special Topic Workshop on Native Shrub Reestablishment was organized by WRRC and presented in Casper in April, 2011 in the Agricultural Resource and Learning Center at the Natrona County Cooperative Extension Office. This workshop was attended by over 80 people from across the state of Wyoming and was highly praised for its content.

The Reclamation Extension Bulletins have been authored by a number of UW faculty, research scientists, and graduate students and provide important information on issues critical to successful reclamation in Wyoming. Reclamation Extension Bulletins published to date include:

- B-1202: Overview of Critical Components of Successful Reclamation
- B-1222: Identifying Suitable Soil for Salvage Prior to Disturbance
- B-1212: Predisturbance/Baseline Inventory
- B-1209: Reducing Impacts of Energy Development to Sagebrush Wildlife Habitats
- B-1204: Seeding Essentials for Reclaiming Disturbed Lands
- B-1206: Plant Species Available for Revegetation/Restoration

## 7. Wind Energy Research Center – Dr. Jonathan Naughton, Director

### Center Mission:

The vision of the Wind Energy Research Center (WERC) is to establish an internationally-recognized program for conducting wind-energy-related research and education and to collaborate with other groups at the University of Wyoming to provide service to the state and the nation. WERC strategically partners with other academic institutions, federal laboratories, and companies with complementary capabilities. Coupled with this research mission is the commitment to produce a part of the workforce necessary to the large-scale penetration of wind into the energy market.

### Contributing Faculty:

David Walrath, Dimitri Mavriplis, Jay Sitaraman, Jennifer Tanner, John O'Brien, Margareta Stefanovic, Mark Garnich, Bob Kelly, Scott Morton, Stefan Heinz, Suresh Muknahallipatna, Tom Parish, William Lindberg, and Zhien Wang

### FY2011 Achievements:

- This year, WERC continued to build its alliances with both large and small wind energy companies, including GE, Siemens, and Z4 energy.
- WERC continues to work with the National Wind Technology Center (NWTC) located at the National Renewable Energy Laboratory (NREL) and Sandia National Laboratories on existing collaborative projects.
- Ongoing projects with the National Center of Atmospheric Research (NCAR) on atmospheric boundary layers have continued in the hope of leveraging the new NCAR-Wyoming Supercomputing Center (NWSC) when it comes online.

- WERC also started new relationships with Los Alamos National Laboratory (LANL) and Lawrence Livermore National Laboratory (LLNL), who both have wind energy initiatives.
- Ties with several new academic entities were also pursued, with an initial effort with Montana State University concerning the development of a regional effort in the Rocky Mountains.
- Gift funds from the Walter Scott foundation were used to fund three instrumentation projects: partial funding of a new computer cluster in the Mechanical Engineering Department, purchase of a stereoscopic Particle Image Velocimetry (PIV) system (in part funded by SER), and purchase and installation of a meteorological tower to be installed later this month at the UW Animal Science Livestock Center (ASLC).
- UW was selected as one of the partners in a National Rotorcraft Center (Mavriplis, Roget, Sitaraman), and the computational work that occurs in this Center will directly impact our simulation capability for wind turbines.

#### Research Activities:

Through the Center's BP gift fund, 11 research projects were supported. These projects were selected based on proposals reviewed by WERC's executive committee and are listed below:

- "Numerical Simulation of the Flow Field in a Wind Farm Using a Unified URANS-LES Model," Dr. Stefan Heinz, principal investigator.
- "Characterization and Control of Two-Dimensional Flat-Back Wind Turbine Blade Flows," Dr. Jonathan Naughton, principal investigator. This project will be completed in the fall of 2011.
- "Flow Physics of Two-Dimensional Wind Turbine Blades," Dr. Jonathan W. Naughton, Principal Investigator.
- "Turbine Wind Inflow Modeling," Dr. Jonathan Naughton, Principal Investigator.
- "Advanced Control Theory for Improved Pitch Control of Wind Turbines," Dr. John O'Brien, principal investigator.
- "Fine-Scale Wyoming Wind Resource Assessment and Forecasting," Dr. Tom Parish, principal investigator.
- "Adaptive/Distributed Control and Systems Health Management for Large Scale Wind Turbine Condition Monitoring and Efficiency Enhancement," Dr. Margareta Stefanovic, principal investigator.
- "Development and Application of Aerodynamic Prediction Tools for Wind Turbine Micro-siting," Dr. Jay Sitaraman, principal investigator.
- "Influence of Wind Farms on Power Network Stability during Small and Severe Disturbances," Dr. Suresh Muknahallipatna, principal investigator.
- "Bend-Twist Coupling for Aeroelastic Blade Design," Dr. David Walrath, principal investigator.
- "Winds and Turbulence at WERC Site," Dr. Robert Kelly, principal investigator.

#### Outreach Activities:

WERC's research activities have resulted in the publication of approximately 20 wind energy related conference and journal articles, including 9 presented this past January at the wind energy symposium. These 9 papers represented over 1/8 of the entire number of papers presented at this conference, which is the premier wind energy science conference in the U.S.

## 8. Enhanced Oil Recovery Institute – David Mohrbacher, P.E., Director

### Center Mission:

The Enhanced Oil Recovery Institute (EORI) and UW scientists and engineers from various disciplines work with oil producers to assist with recovery of Wyoming's stranded oil through:

- Technology application - apply existing Enhanced Oil Recovery (EOR) technology and create new knowledge when necessary.
- Technology demonstration- facilitate the testing, evaluation and documentation of EOR technologies in real world settings.
- Technology transfer – benchmark innovative petroleum industry practices and transfer “know how” to Wyoming operators through workshops and conferences.
- Economic development – maximize economic potential for application of EOR in Wyoming.

### Contributing Members:

EORI is funded primarily by an appropriation from the Wyoming State Legislature. EORI is overseen by the Enhanced Oil Recovery Commission (EORC) which was created in 2004. The EORC consists of eight commissioners appointed by the Governor. In FY2011, the commission included the following members:

- Governor Matt Mead, *ex-officio*
- Senator Eli Bebout, *ex-officio*
- Wallace Ulrich, State Geologist, *ex-officio*
- Lynne Boomgaarden, Belcher & Boomgaarden, LLP
- Betty Fear, Sublette County Commissioner
- Bern Hinckley, Geologist, Hinckley Consulting
- Tom Fitzsimmons, Iron Creek Energy Group
- Peter Wold, President, Wold Oil Properties

Please see the EORI 2011 Annual Report filed separately with the Wyoming Legislature for complete details.

## **B. Matching Grants 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. 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.

SER's call for proposals for the FY2011 MGF was issued in November. In this round, 10 proposals were submitted and 4 were approved for commitments. 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 significant 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 into the following year.

**MGF Commitments:** Commitments have been made to provide matching funds through this program in FY2007, 2008, 2009, 2010 and 2011 (Appendix B).

1. Ten projects received funding from those committed to in FY2007.
  - a. \$510,200 in SER funds captured \$1,480,600 in outside funding for a total research value of \$1,990,800.
  - b. Overall leverage of SER funds was 3:1.
  - c. One successfully completed project ("Integration of a Structural Water Gas Shift Catalyst with a Vanadium Alloy Hydrogen Transport Device") was the recent recipient of a \$1.5 million DOE grant for scale-up engineering.
2. Twelve projects received funding from those committed to in FY2008.
  - a. \$829,022 in SER funds captured \$3,217,327 in outside funding for a total research value of \$4,046,349.
  - b. Overall leverage of SER funds was 4:1.
3. Seven projects received funding from those committed to in FY2009.
  - a. \$438,952 in SER funds captured \$1,460,401 in outside funding for a total research value of \$1,899,353.
  - b. Overall leverage of SER funds was 3:1.
  - c. The outside award for one project proposal from FY2009 is still pending. SER still has a \$100,000 commitment to this project.
4. To date, nine projects have received funding from those committed to in FY2010.
  - a. \$756,976 in SER funds captured \$2,842,302 in outside funding for a total research value of \$3,599,278 for the nine funded projects.
  - b. Overall leverage of SER funds was 4:1.
  - c. SER's remaining commitment from FY2010 is \$1,293,160.
5. SER made commitments to four proposals in FY2011
  - a. SER committed \$468,108 to seek \$3,315,448 in outside funding for a total research value of \$3,783,556.
  - b. Overall leverage of SER funds would be 7:1 if all submittals were successful.
  - c. At the end of FY 2011, 1 project did not receive funding leaving 3 projects pending.
  - d. SER's remaining commitment from FY2011 is \$418,108.

**Research Topics:** There is a stipulation in each call for proposals to the MGF program that research must be energy related. Understandably, the range of research topics has been diverse. To date, topics have included the following:

- Clean coal research
- Flow through porous media
- CO<sub>2</sub> sequestration in deep aquifers
- Biological degradation of organic waste for fuel cell development
- Impact of foreign policy on energy security in the USA
- Groundwater monitoring and management
- Arid lands reclamation – soils, microbes, and vegetation
- Solar energy: photoelectrochemical- and organic-based cells
- Aerodynamics and control of wind turbines
- Oil and gas production and recovery
- Air quality monitoring of oil and gas production areas in Southwest, WY
- Economic impact of enhanced oil recovery and carbon capture storage
- Drivers of electrical energy demand
- Soil and plant reclamation
- Biogenic enhancement of methane production from coal
- 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
- Idaho National Laboratory
- Bureau of Land management
- Environmental Protection Agency
- Center for Revolutionary Solar Photo-Conversion
- Wyoming Wildlife and Natural Resources Trust Fund

With five 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 maximum rate of 4-to-1 for successful projects. 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.

### **C. Uranium Research Fund**

In the 2009 General Session, the Legislature of the State of Wyoming appropriated \$1.6 million to the University of Wyoming, School of Energy Resources (SER) for activities related to the development of uranium through in-situ recovery (ISR) in Wyoming. SER has used that appropriation toward the following outreach and research activities:

- September 22, 2009 - Uranium Extraction Workshop, Cheyenne, WY
- October 2009 –Research Priorities for In-Situ Uranium Recovery in Wyoming – report of findings
- *Public Opinion in Wyoming about In Situ Uranium Recovery*, WYSAC. (2010). Wyoming Survey & Analysis Center, University of Wyoming

- August 4, 2010 – The Future of Uranium Production in Wyoming – A Public Forum on In-Situ Recovery, Laramie, WY
- Analysis of Remediation Strategies for Radionuclide-Contaminated Soils in Uranium Mining – graduate student research project in progress

Approximately \$1.4 million of the original \$1.6 million appropriation remains to fund research projects. The legislation authorized SER to use the funds, “under the direction of the University of Wyoming Energy Resources Council and in consultation with the Wyoming mining industry,” in part, to develop a research program for uranium that, “shall focus on optimizing the economic recovery of the resource through ground water restoration, research on waste water management and the development of a seminar to educate the public and the industry about uranium and uranium extraction.” (Legislature of the State of Wyoming during the 2009 General Session – Chapter 159 Section 339 c iii, and 2011 General Session Chapter 88 Section 350 (a) (i)).

On March 31, 2011, in accordance with the legislation, SER issued an RFP for research focused on in-situ uranium extraction with a proposal submission deadline of May 6, 2011. Proposals for the ISR of Uranium Research Program were solicited from academic institutions and private industry and were evaluated competitively based upon their probable benefits to the State of Wyoming in areas broadly related to ISR of uranium. The RFP allowed funding requests between \$50,000 - \$400,000 and demonstration of a 25% match. It also stated that the results from all projects are to be made available to the public and will be presented at a workshop to be held in November 2013. In addition, all projects must be completed by the fund reversion date of June 30, 2013.

The ISR of Uranium Research Program RFP listed specific areas of research identified in the September 2009 workshop and August 2010 public forum. The research focuses on specific areas of challenge and opportunity to enhance cost effective strategies for ISR of uranium in Wyoming. The research areas identified were:

- Exploration and ore body delineation.
- Ore body characterization and uranium recovery.
- Water management, treatment and disposal.
- Cost efficient aquifer restoration technologies and practices.
- Investigation of the impact of existing regulatory requirements on the economics and timing of ISR uranium projects in Wyoming.

Eight proposals requesting a total of \$1,668,622 were submitted by the deadline and each was reviewed and scored by two independent outside reviewers. The proposals recommended for funding from the ISR of Uranium Research Program are listed below.

1. “Enhancing Bioremediation of In-Situ Uranium Aquifers through Uranium and Carbon Isotopic Tracing of Biologic Activity,” submitted by University of Wyoming, Kevin Chamberlain, Principal Investigator. This project focuses on studying restoration of uranium aquifers using bioremediation at the Cameco Smith Ranch-Highland Ranch in-situ uranium mines near Douglas, WY. They have requested \$100,000 in funding and are providing an

outside match of \$25,000 for a project total of \$125,000. This project is estimated to take 24 months to complete.

2. “Testing the Chemical and Biological Efficacy of Cupric Oxide Nanoparticles to Remove Contaminants from Uranium ISR Produced Water,” submitted by University of Wyoming, Suzanne Clark, Principal Investigator. This project used cupric oxide nanoparticles to remove arsenic from production bleed water. This contaminant removal process effectiveness will be compared to other water decontamination systems currently used in the industry. They have requested \$100,000 in funding and are providing an outside match of \$25,000 for a project total of \$125,000. This project is estimated to take 24 months to complete.
3. “Field Evaluation of the Restorative Capacity of the Aquifer Downgradient of a Uranium ISR Mining Site During Mining Operations,” submitted by Los Alamos National Laboratory, Paul Reimus, Principal Investigator. This project proposes to predict the degree of natural attenuation of uranium and other constituents of concern as groundwater migrates downgradient of an ISR operation. This will be done at a field site at the Cameco Smith Ranch-Highlands in-situ uranium mine near Douglas, WY. They have requested \$399,400 in funding and are providing an outside match of \$100,000. This project is estimated to take 24 months to complete.
4. “The Mineralogy and Provenance of Wyoming Uranium Roll Front Deposits and Their Significance to In-Situ Recovery Mining Processes,” submitted by University of Wyoming, Susan Swapp, Principal Investigator. This project will use various analytical methods to identify and characterize uranium deposits and their sources. They have requested \$227,449 in funding and are providing an outside match of \$92,400. This project is estimated to take 24 months to complete.

The total cost to fund these four proposals is \$826,849, leaving \$579,499 in the ISR of Uranium Research Account. SER will issue an additional RFP in September 2011.

#### **D. Clean Coal Research Fund**

Activities under the Clean Coal Research Fund are reported separately to the Joint Minerals, Business and Economic Development Interim Committee. See 2011 Report of Clean Coal Task Force submitted under separate cover to the Wyoming Legislature.

#### **E. Carbon Management Fund**

Please see the Wyoming Carbon Underground Storage Project (WY-CUSP) report filed under separate cover to the Wyoming Legislature for plans and details.

### **IV. OUTREACH INITIATIVES**

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 FY2011, SER was very active in carrying out that mission.

**A. Major conference conducted by SER:**

**The Future of Uranium Production in Wyoming: A Public Forum on In-Situ Recovery** was held on August 4<sup>th</sup> to fulfill the 2009 General Session budget footnote to provide members of the public and industry an opportunity to learn about this process. The conference was attended by 281 individuals. Senator Eli Bebout opened the forum and speakers included:

- Dr. Susan Griffin, Senior Toxicologist, U.S.EPA
- Tom Cannon, General Manager, Smith Ranch Highland Operation, Cameco Resources
- Keith McConnell, Deputy Director, Decommissioning and Uranium Licensing Directorate, Nuclear Regulatory Commission
- Steve Jones, J.D., Watershed Protection Program Attorney, Wyoming Outdoor Council
- Marion Loomis, Executive Director, Wyoming Mining Association
- Glenn Catchpole, CEO, Uranerz Energy Corporation.
- John Corra, Director, Wyoming Department of Environmental Quality
- Rob Hurless, Energy & Telecommunications Advisor, Governor's Office, Wyoming

Video proceedings and program summary report are accessible at <http://www.uwyo.edu/ser/uraniumforum>.

**B. Branding of SER and the Center of Excellence:**

An extensive project for FY 2011 was the branding and unifying the suite of Centers of Excellence and the School of Energy Resources. The branding consists of unified presentation, icons unique to each center, brochures, PowerPoint templates, and website deployment under the umbrella organization of the School of Energy Resources. This project continues and will be strengthened by a communications plan for statewide, national and international reach.

**C. Other Significant Energy Outreach Offerings:**

The following events benefitted from SER support and coordination in collaboration with other entities:

1. Global Competition for Energy Symposia directed by Dr. Jean Garrison of International Studies Program. These traveling symposia were presented in Jackson, Riverton, Rock Springs and Cheyenne.
2. Oral History Project – Sublette County: Energy Boom 1995-2010: co-sponsored by the UW American Heritage Center's Alan K. Simpson Institute for Western Politics and Leadership, Wyoming Humanities Council and SER. Held in Pinedale and Laramie.
3. Wyoming Geologic Alliance (WGA) with SER hosted a five day workshop in Laramie on geographic literacy and energy education for statewide teachers. Fifteen K-12 teachers attended. The effort was funded by the James E. Nielson Excellence Fund.
4. 2011 State Science Fair: SER assisted in sponsoring the fair and dinner which had 360 student contestants and 48 teachers in attendance. SER also sponsored awards in the new category of "Energy & Transportation."

**D. 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 FY2011, the following lectures were sponsored on campus:

1. Dr. Michael Bickle, “Carbon Sequestration: The Fate of CO<sub>2</sub> in Saline Aquifers, Physics and Chemistry.”
2. Dr. Jinchao Xu on computational mathematics. He studies numerical methods for partial differential equations, and in particular, in finite element methods.

**E. 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 FY2011. These include:

- Global New Energy Summit – Colorado Springs, CO.
- Energy Exposition 2011, Gillette, WY,
- American Agricultural Economics Association-Energy Tour across Wyoming
- Wyoming Association of County Officers Annual Conference, Laramie, WY
- Greenbuild 2010 International Conference, Chicago – Sponsored 12 engineering students to attend
- AAPG, Rocky Mountain Section 2011 Annual Meeting, Cheyenne, WY

**F. Other Activities:**

1. Compressed Natural Gas as a Transportation Fuel Initiative - UW SER is a member of the Wyoming Natural Gas Vehicle & Infrastructure coalition. UW is investigating a plan to switch over fleets to CNG. SER is working to support the introduction of CNG in Wyoming’s transportation system.
2. Sponsorship of six College of Law Students to investigate energy policy issues.

**V. DEVELOPMENT ACTIVITIES**

With the successful completion of the campaign to raise private support for the Energy Resources Center, the focus of effort shifted to the “Energy Resources Technology Enterprise Fund.” The goal is to raise \$2 million in private donations to be matched equally by the state for a total of \$4 million. SER plans to leverage the funds to create partnerships with technology equipment manufacturers and software developers to obtain the technology required to power the state-of-the-art 3D visualization center and collaboration center in the building.

Additional follow-up occurred after the kickoff event in Denver in April 2010. More than \$1.5 million was pledged or donated during FY2011. Achieving the goal of \$2 million is the objective in the coming year.

In February, the UW Foundation organized a celebration at the Houston Petroleum Club. The event was an “evening to celebrate the special contributions and the relationship of the Energy Industry with the University of Wyoming.” The event featured keynote speaker Wyoming

Governor Matt Mead and included retired U.S. Senator Alan Simpson, former Wyoming Governor Dave Freudenthal, and UW President Tom Buchanan. The event was attended by representatives and university supporters from 42 energy companies, by UW Foundation Board members and their spouses, by the key leaders from the Wyoming House and Senate, by a number of senior UW academic leaders, and numerous UW supporters in the Houston area. Additional conversations with partners – existing and potentially new – have been furthered by the celebration.

The School of Energy Resources experienced a growth in the number and dollar total of annual gifts from individuals who are learning more about its mission and activities across the state. This trend is expected to continue.

## **VI. The Energy Resources Center**

A total of \$25.4 million was available at the start of the project to design and build the Energy Resources Center (private funds, state match, and interest). The UW Board of Trustees approved GSG Architecture of Casper, in association with HOK Inc. of St. Louis, to be the architect/engineer for the planned Energy Resources Center (ERC) at its January 2010 meeting. The Board of Trustees approved G. E. Johnson Construction Co. of Jackson as the construction manager at risk for the center during its meeting in March 2010. Work on design and cost of the center is progressing. The total construction cost is estimated to be just over \$20 million.

Ceremonial groundbreaking for the Energy Resources Center was held on November 19<sup>th</sup>, 2010. Final design and engineering work was completed in March 2011. Construction commenced in July 2011. Expected completion date of the building is August 2012.

Currently, the building calls for approximately 30,000 square feet of assignable space (50,000 square feet, gross). The building will be located between 10<sup>th</sup> and 11<sup>th</sup> Streets on the south side of Lewis Street. The Energy Resources Center will become the permanent home of the School of Energy Resources and the Enhanced Oil Recovery Institute.

The overall theme of the building is to provide energy research and collaboration assets to the campus. It will provide 12,000 square feet of rapidly reconfigurable lab space for advance coal technology research, reservoir characterization research, alternative energy research, and instrumentation development. There will also be a state-of-the-art 3D Visualization research facility, a fully capable classroom/auditorium for up to 60 participants, and a 3,000 square foot reconfigurable “collaboratorium” for fully interactive distance collaboration.

## **VII. Financial Report**

The Wyoming State Legislature provided funding for SER over the 2011-12 Biennium in the 2010 Legislative Budget Session. This funding was comprised of two parts. First, the legislature appropriated \$17,400,000 from the Abandoned Mine Lands Fund. Second, the Legislature approved the carryover of up to \$2,000,000 of unspent monies appropriated for the support of

SER in the 2008 budget session. The actual amount carried over at the end of FY2010 was \$1,865,683.

Combined, these two sources of funds provide \$19,265,683 to operate SER for the 2011-12 Biennium.

Expenditures for the 2011 Fiscal Year totaled \$7,016,917. Of that total, SER spent:

- \$3.4 million for salaries and benefits for SER staff, 11 faculty, 3 visiting faculty.
- \$609 thousand for start-up commitments made to SER faculty
- \$1.13 million to support research activities of the 8 Centers of Excellence
- \$85 thousand for the Matching Grants Fund
- \$110 thousand for Outreach events
- \$1.68 million for remaining expenses that include graduate assistantships, recruiting, travel, publications, Energy Summer Institute, office support, etc.

See Table VII- I for more details on expenditure.

**Table VII - I . School of Energy Resources 2011 Fiscal Year Expenditures**

<b>Academics</b>	<b>Fiscal Year 2011</b>
Salary/Fringe	\$ 1,879,385
Startup	\$ 609,650
Other support & Programs	<u>\$ 1,306,791</u>
<b>Subtotal Academics</b>	<b>\$ 3,795,826</b>
<b>Research</b>	
Salary/Fringe	\$ 758,945
Matching Grant Funds	\$ 85,000
Center Support	\$ 1,130,244
Other support & Programs	<u>\$ 30,609</u>
<b>Subtotal Research</b>	<b>\$ 2,004,798</b>
<b>Outreach</b>	
Salary/Fringe	\$ 314,529
Sponsorships	\$ 51,779
Publications & Materials	\$ 207,113
Distinguished Speakers	\$ 2,383
Workshops	\$ 56,142
Other support & Programs	<u>\$ 50,665</u>
<b>Subtotal Outreach</b>	<b>\$ 682,611</b>
<b>Administration</b>	
Salary/Fringe	\$ 431,436

Other support & Programs	\$	<u>102,246</u>
Subtotal Administration	\$	<u>533,682</u>
<b>Total Expenditures for Fiscal Year</b>	\$	<b>7,016,917</b>

# Appendix A - 1

## Graduate Assistantships

## **SER Competitive Graduate Assistantship Allocation**

### **I. Summary**

The School of Energy Resources (SER) facilitates interdisciplinary energy focused research and teaching programs across the University. To promote energy based research, technology development and transfer, and curriculum development, SER sponsors an annual competitive GA program. This competitive allocation program is guided by four principles. First, proposals must contribute to the research and teaching mission of the university. Second, allocations are student centered; except under extenuating circumstances, the GA follows the student. Third, the program will enhance diversity and promote interdisciplinary collaboration. Fourth, allocations will be awarded on a competitive basis and be accountable with specific deliverables and require a culminating report on outcomes. A summary of projected student learning outcomes and a plan for evaluation are required.

### **II. Program specifics**

1. Awards are limited to 2 academic years and summer salary is not covered. Thus, faculty are required to support students in summer research and education projects, if appropriate, and for any time beyond the 2 AY SER sponsored commitment.
2. A total of 15 GA will be awarded annually to include a base stipend of \$18,000/AY (and a \$4500 Ph.D. enhancement), tuition & mandatory fees for up to 12 credit hours/semester, and health insurance.
3. A primary program goal is to enhance recruitment of new graduate students.
4. GA awards follow the student (given satisfactory performance). If the student graduates, transfers to another university or into a non-energy focused degree program, the GA allocation reverts to SER for re-allocation.
5. SER graduate assistants are required to commit 2 weeks annually to the SER Energy Academy that is designed to enhance awareness and learning of energy in the K12 educational continuum. Appropriate training, guidance and supervision will be provided to GAs to ensure that this experience will contribute to graduate student learning outcomes and will provide comparative advantage in the workforce.
6. An annual performance summary report will be required.

### **III. Proposal requirements and review criteria**

Faculty should submit proposals to the department head for review and ranking by **Nov. 1**. Departments will forward their ranking to the respective college Dean no later than **Nov. 15**. Colleges will provide a brief rationale and ranking of all college applications to SER by **Dec. 1**. Proposals should be sent to the Associate Director of SER as a pdf file ([rothdon@uwyo.edu](mailto:rothdon@uwyo.edu)) or as a hard copy. Proposals will be reviewed by a committee consisting of the Associate Director of SER and 4 SER faculty representatives. Colleges and departments will be notified of results no later than **Dec. 15**. Proposals should follow the format described below:

1. **Rationale and Significance.** Describe the need of the GA with respect to prospective research and teaching. What is the current status and gaps addressed by this proposal? What are the projected contributions to energy scholarship at the local, state, national

and international arenas? How will the proposal contribute to the student's professional development?

2. **Goals and Program of Study.** Outline the nature and scope of the research and teaching, plans for dissemination, interdisciplinary collaborations and, if applicable, commercialization.
3. **Student recruitment, retention and mentoring.** Present a plan to ensure competitive recruitment (especially to maximize the applicant pool of women and minorities), student learning outcomes and student professional development.
4. **Assessment metrics.** Outline projected outcomes and measures to evaluate performance.
5. **Faculty curriculum vitae including past graduate student outcomes.**
6. **Student qualifications.** The GA program seeks to enhance recruitment, especially of women and minorities. If available for a prospective student include GPA, ACT/SAT, resume, 2 letters of reference, and a brief student description of career planning and goals.

**School of Energy Resources  
Graduate Assistantships 2010-2011**

<b>Student</b>	<b>Level</b>	<b>Faculty Advisor</b>	<b>College</b>	<b>Department</b>	<b>Project Title</b>
Cox, Lisa	Masters	Stahl, Peter	Agriculture	Renewable Resources	Radium Soil Project
Mason, Amber	PhD	Norton, Jay	Agriculture	Renewable Resources	Understanding Disruption & Recovery of Ecological Structure & Functioning for Restoration of Disturbed Wyoming Ecosystem
Sargsyan, Gevorg	PhD	Balaz, Milan	Arts & Sciences	Chemistry	Influence of Supramolecular Organization on Energy Transfer Properties of Chromophore-DNA Arrays
Choi, DaeJin	PhD	Parkinson, Bruce	Arts & Sciences	Chemistry	Quantum Dot Sensitization: Strategies for Increases in Photovoltaic Solar Cell Efficiencies
Gruver, Brian	PhD	Roddick, Dean	Arts & Sciences	Chemistry	New Catalyst Strategies for Selective Coal Modification & Liquefaction
McCarney, Mary	Masters	Loffrada, Beth	Arts & Sciences	English-Creative Writing	Opportunity Creation GA
Dongre, Arjun	Masters	Prager, Steven	Arts & Sciences	Geography	Enhancing the School of Energy Resources Geospatial Capacity
Mu, Dawei	PhD	Chen, Po	Arts & Sciences	Geology & Geophysics	Addressing the Computational Challenges of Time-Lapse, Full-Wave Seismic Imaging Using Hybrid Cluster of GPUs & CPUs

**School of Energy Resources  
Graduate Assistantships 2010-2011**

<b>Student</b>	<b>Level</b>	<b>Faculty Advisor</b>	<b>College</b>	<b>Department</b>	<b>Project Title</b>
Hansen, Steve	PhD	Dueker, Ken	Arts & Sciences	Geology & Geophysics	Monitoring of Hydrocarbon & Carbon Sequestrated Formations Using Time-Lapse Seismic & Electromagnetic Data
Chopping, Curtis	Masters	Kaszuba, John	Arts & Sciences	Geology & Geophysics	Co-sequestration of CO <sub>2</sub> -SO <sub>2</sub> Mixtures Emitted from Coal-Fired Power Plants
Padhi, Amit	PhD	Mallick, Subhashis	Arts & Sciences	Geology & Geophysics	Monitoring of Hydrocarbon & Carbon Sequestrated Formations Using Time-Lapse Seismic & Electromagnetic Data
Leal, Allan	Masters	Douglas, Craig	Arts & Sciences	Mathematics	Center for Subsurface Flow GA
Cerwinsky, Derrick	PhD	Douglas, Craig	Arts & Sciences	Mathematics	Douglas Startup
Ramaeker, Pamela	PhD	Pereira, Felipe	Arts & Sciences	Mathematics	Opportunity Creation GA
Tilaye, Swapnil	PhD	Pereira, Felipe	Arts & Sciences	Mathematics	Opportunity Creation GA
Rigelo, Joyce	PhD	Pereira, Felipe	Arts & Sciences	Mathematics	Center for Subsurface Flow GA
Qualin, Sara	Masters	Lockwood, Jeff	Arts & Sciences	Philosophy	Opportunity Creation GA
Chepko, Corin	PhD	Tang, Jinke	Arts & Sciences	Physics & Astronomy	Research & Course Development in Thermal & Electrical Transport in Energy Materials

**School of Energy Resources  
Graduate Assistantships 2010-2011**

<b>Student</b>	<b>Level</b>	<b>Faculty Advisor</b>	<b>College</b>	<b>Department</b>	<b>Project Title</b>
Lu, Liyou	PhD	Wang, Wenyong	Arts & Sciences	Physics & Astronomy	Ternary Metal Oxide Nanowires for Power Applications
Lyons, Daniel	PhD	Mayes, Robert	Education	Secondary Education	ERS Capstone Course Development & Energy Academies
Ramsey-Walters, Sarah	PhD	Mayes, Robert	Education	Secondary Education	Energy Academy Pilot Program
Yourkowski, Eden	Masters	Mayes, Robert	Education	Secondary Education	ERS Capstone Course Development & Energy Academies
Sturtevant, Thomas	Masters	Field, Robert	Engineering	Atmospheric Science	Contrast Data-Ozone, methane and non-methane hydrocarbons
Bidhendi, Mehrnoosh	PhD	Alvarado, Vladimir	Engineering	Chemical & Petroleum Engineering	Water Chemistry Modification for Improved-Oil Recovery: Chemical, Interfacial & Rheological Mechanisms in Porous Media
Schaffers, William	PhD	Bell, David	Engineering	Chemical & Petroleum Engineering	Wyoming Coal Gasification Economics, Kinetics & Process Technology
Saraji, Sohei	PhD	Goual, Lamia	Engineering	Chemical & Petroleum Engineering	Characterization & Bio-Remediation of Dissolved Organic Matter in Wyoming Oilfield Waters
Lee, Joo Seob	PhD	Johnson, Patrick	Engineering	Chemical & Petroleum	Carbon Dioxide Capture Via Enzyme

**School of Energy Resources  
Graduate Assistantships 2010-2011**

<b>Student</b>	<b>Level</b>	<b>Faculty Advisor</b>	<b>College</b>	<b>Department</b>	<b>Project Title</b>
				Engineering	Nanoparticle Biocatalysis
Park, Hee Joon	PhD	Johnson, Patrick	Engineering	Chemical & Petroleum Engineering	Enzyme Nanoparticle Synthesis & Characterization for Biofuel Cells & Cellulose Hydrolysis
Aghaei, Arash	PhD	Piri, Mohammad	Engineering	Chemical & Petroleum Engineering	CO2 Sequestration in Deep Saline Aquifers
Ovaysi, Saeed	PhD	Piri, Mohammad	Engineering	Chemical & Petroleum Engineering	Multiphase Flow in Fractured Hydrocarbon Reservoirs
Zhang, Qing	PhD	Puckett, Jay	Engineering	Civil & Architectural Engineering	Building Green & Building Performance-Demonstration & Validation of Predictive Energy Conservation Models
Huang, He	PhD	Wang, Liqiang	Engineering	Computer Science	Addressing the Computational Challenges of Time-Lapse, Full-Wave Seismic Imaging Using Hybrid Cluster of GPUs & CPUs
Ma, Hongyi	PhD	Wang, Liqiang	Engineering	Computer Science	Addressing the Computational Challenges of Time-Lapse, Full-Wave Seismic Imaging Using Hybrid Cluster of GPUs & CPUs
Deshpande, Sameep	Masters	Zheng, Yuan	Engineering	Mechanical Engineering	Zheng Startup

**School of Energy Resources  
Graduate Assistantships 2010-2011**

<b>Student</b>	<b>Level</b>	<b>Faculty Advisor</b>	<b>College</b>	<b>Department</b>	<b>Project Title</b>
Dobric, Nickolas	Masters	Burke, Ingrid	Haub School	Environment & Natural Resources	Course Development: Environmental & Natural Resource Science
Richardson, Brie	PhD	Burke, Ingrid	Haub School	Environment & Natural Resources	Environment & Natural Resources Capstone Series-Approaches to Environment & Natural Resources Problem Solving
Simpson, Kelsey	Masters	Burke, Ingrid	Haub School	Environment & Natural Resources	Environment & Natural Resources Capstone Series-Approaches to Environment & Natural Resources Problem Solving
Czapla, Kacie	JD	Easton, Stephen	Law	Law	Uranium Mining & Research for Mining Law
Davenport, Adam	JD	Easton, Stephen	Law	Law	Landowner's Permitting Manual
McDonough, Crystal	JD	Easton, Stephen	Law	Law	Wind Energy Project
Transtrom, Tina	JD	Easton, Stephen	Law	Law	Landowner's Permitting Manual

## Appendix A - 2

# Professional Master's Degree Proposal

## **Professional Masters of Science in Energy Resources Science**

**Program Justification and Demand.** Economic development and prosperity in Wyoming, the US and the world are dependent upon a vibrant, innovative and competitive energy sector. Wyoming is the epicenter of energy production in the US. As an independent country, Wyoming would rank in the top 10 global exporters of energy and would be the top exporter to the US. And Wyoming's contribution will undoubtedly increase in parallel with worldwide energy utilization that is projected to increase by 50% in the next 15 years. The escalating requirement for talented, highly trained professionals to meet the rising demand for energy will create an acute workforce pipeline challenge. Intensifying this situation is the forecast that 50% of the leadership and professional expertise in the energy arena will retire within the next 10 years.

The fundamental competencies required for sustained competitive success in the energy workforce are evolving as the technological sophistication and scope of energy sector accelerate. Finding solutions to increasing complex issues will demand an interdisciplinary perspective, creative problem solving skills, and the ability to critically and quantitatively analyze, synthesize and communicate information. Deep discipline knowledge is foundational; however, self-directed learning skills will be an irreplaceable asset to maintain professional relevance.

The vast majority of students (>80%) entering master's programs seek advanced training for competitive success in the workforce as opposed to a pathway to the doctorate or academia. These students view the master's as a terminal degree and recognize that technical depth and process skills that enable application of knowledge are essential components of comprehensive workforce preparation. In science and technology, advanced training beyond the bachelor's degree is an increasingly important entry level requirement. Additionally, in order for in-service energy professionals to advance in the energy sector, an advanced skill set provided by a professionally-oriented master's degree program is required.

**Energy Resource Science (ERS) Professional Masters** is designed specifically to address emerging workforce demands. The ERS Professional Masters degree is rigorous, comprehensive and content driven. It focuses on creating a professional workforce capable of connecting sophisticated and complex technologies, and balancing economics and business acumen, policy and law perspective, engineering, land and water management, geology/geophysics and other relevant scientific inputs. It also provides training in process skills such as decision making, communication, teamwork, and leadership that enable effective integration of knowledge and practice. Thus, graduates will have skills, knowledge and experience to connect teams from diverse energy disciplines in project or energy asset management.

Implementation of the ERS masters program will enhance recruitment of highly talented students, and increase energy research capabilities and commercialization potential at UW. It will catalyze cross college collaborations bringing synergies to the UW energy focus. Importantly, at the national level, over 60% of graduates from professional science and technology master's programs remain in the state in which they graduated. Thus, the ERS professional master's program is an innovative program that will attract students from across the nation and contribute to placing them in the Wyoming energy workforce.

The ERS professional masters degree will be at the leading edge of energy graduate programs in the US although several universities have similar but less comprehensive programs. For example, Stanford has a MS in Energy Resources Engineering combining energy engineering with public affairs, economics or natural resources as dual degree programs. UT Austin has a geosciences and public affairs dual degree in Energy and Earth Resources designed for students with career plans in business, finance, and planning areas. Columbia has an earth & environmental engineering M.S. designed for engineers and scientists who plan to pursue careers in management.

### **Program Goals and Student Learning Outcomes**

The increasing sophistication and complexity of energy challenges will be best addressed with integrated technologies and information from different disciplines. Responding effectively to the dramatically increasing acceleration of information will require, not only a foundation of discipline knowledge but competency in critical analysis to filter relevant information, recognize patterns, make connections, identify strengths, weaknesses and gaps, and to synthesize and advance creative solutions. The professional masters program in ERS is distinguished by:

- 1) Rigorous interdisciplinary content.
- 2) A defined time to degree.
- 3) Early immersion into meaningful professional practice.
- 4) Collective mentoring by program faculty.
- 5) Development of an intellectual community focused on integrative learning.
- 6) A commitment to the calibration of outcomes.
- 7) Transparency in the program of study.

The program has four overarching goals:

- 1) To provide students with advanced knowledge and training in energy sciences.
- 2) To produce creative problem solvers capable of self directed, life-long learning.
- 3) To prepare influential and talented future leaders of the energy sector.
- 4) To train a skilled workforce capable of leading expert teams in developing strategies to comprehensively manage energy assets from discovery through production and stewardship.

The program will create and foster a culture of examination, entrepreneurship, accountability, urgency, and rigor. The program will emphasize ethical conduct and foster an environment that strives for the highest performance standards.

Graduates will be characterized as:

- **Competent, interdisciplinary experts in energy resource sciences.** Advanced content expertise will be gained in a diverse profile of disciplines including geology, geophysics, engineering, land & water management, computer simulation & modeling, economics and business, policy and law that define energy resource science. The program is designed to provide a core curriculum that defines energy

resource science and appropriate flexibility to allow specialization in a focused topic area.

- **Workforce ready creative problem solvers and entrepreneurs.** The program will be significantly project based and authentic; providing repeated opportunities for development of creative problem solving and decision-making skills. Graduates will understand and apply a broad spectrum of energy technologies and have the ability to design, plan and execute energy asset management strategies.
- **Critical, analytical thinkers.** Competitive success in the energy workforce is dependent upon deep analysis, independent, objective thinking, and the ability to make rational decisions under dynamic and uncertain conditions characterized by the intersection of technology, policy and business. Graduates will have the ability to critically & quantitatively analyze data, make connections, identify, filter, synthesize and communicate information.
- **Effective communicators.** The ability to logically and unambiguously communicate to diverse audiences is an essential skill for advancement in the professional workforce. Graduates will have the ability to construct and articulate arguments to a wide range of audiences.
- **Responsible, self-directed leaders.** Competitive success will require ability to effectively lead interdisciplinary teams, inspire performance, assume responsibility, and demonstrate a commitment to performance and accountability. Graduates will have skills in effective decision-making, scenario planning, organizational management and program assessment.

### **Program Foundation**

In recognition of the central role that energy has in the state and the critical mass of faculty and resources across the University, Academic Plan 3 highlights energy science and technology as an area of distinction. Action item 42 specifically refers to “energy related teaching and research”. The School of Energy Resources (SER) is charged with promoting and coordinating energy research, teaching and outreach across the University. SER provides resources and expertise to facilitate cross college collaborations, in part, through 9 centers of excellence. The program is intentionally designed to provide interdisciplinary breadth, recognizing that depth of expertise consistent with workforce needs is also vital.

The University has a critical mass of highly talented faculty in the energy area with excellent infrastructure and resources. Forty faculty members in 15 departments and 6 colleges have necessary energy expertise to participate in the program and are among the most accomplished at UW in terms of professional contributions, external funding, and involvement in graduate education.

In order to formally participate in the ERS professional masters program, faculty must demonstrate an interest in energy resource sciences, substantially and actively contribute to the program, and have a publication record in their area of expertise.

### **Resources & Cost**

Current resources and courses are adequate to initiate this graduate program. The curriculum will be modified in a staged approach to ensure integration, cohesiveness and interdisciplinary perspective. No new faculty positions are requested. SER will dedicate a pool of 6 GAs in

support of the program and faculty are expected to generate external funding that will enhance the GA pool and provide appropriate research support. GAs will be allocated by the Steering/Admissions committee to the home department of the faculty member mentoring the ERS student. The 2 yr GA commitments will be allocated in support of teaching and research missions with an energy focus. SER faculty will develop and deliver any new course for this program as part of their hiring agreement; thus, departments will not be responsible for extending the teaching duties for their faculty. Adequate library and technical facilities are in place, particularly with the new Energy Resources building.

### **Program of Study**

**A. Admission Standards.** Graduate student applicants for the professional M.S. program in ERS will have an undergraduate degree based in the sciences, engineering or natural resource areas. The program of study is sufficiently flexible to provide access to qualified students from diverse academic backgrounds. In general the applicants will have foundational courses in advanced mathematics, physics, chemistry, thermodynamics, and natural resources. However, students may be required to complete prerequisite courses deemed essential by their graduate committee.

Entry requirements for the M.S. in ERS will include:

- A minimum undergraduate GPA of 3.25
- A minimum GRE score of 1100 (quantitative and verbal scores combined)
- Three positive letters of recommendation
- Applicant letter of intent describing interests and reasons for seeking the degree

Applicants who do not meet the minimum requirements for entry into the program may be accepted on a provisional basis at the discretion of the Admissions/Steering Committee

**B. Application Processing.** All applications will be sent directly to the SER Associate Director for Academics and initially screened by the Admissions/Steering Committee to ensure that minimum admission criteria are met. The Committee may elect to schedule an interview either by phone or on-campus. The committee will also review any request for a graduate assistantship and make a recommendation on that request. The final recommendation will be made to the SER Director. Following provisional admittance by SER, the applicant will formally apply to UW. When a student is formally accepted into UW, the Associate Director will write a letter of acceptance and make any assistantship offers with a copy going to the Committee. Students who are not accepted into the program will be informed in a letter by the Associate Director on behalf of the Committee.

**C. Organization and Management Structure.** The Associate Director for Academics will have direct responsibility for administration of the graduate program and will be advised by a Steering/Admissions Committee consisting of 5 faculty members elected by the faculty participating in the ERS graduate program. The Associate Director will serve as Chair of the Steering/Admissions Committee. Committee members will serve a two-year term with the opportunity for a one term extension. The Committee will meet at least twice a year and will advise the Associate Director on policies and procedures. Additionally, it will serve as the

screening committee for evaluation of applications for faculty to the program. The Committee will oversee all activities pertaining to the recruitment and admission of students into the program.

Each student will have a **Master's Advisory Committee** that will consist of the student's advisor/mentor and three other faculty members in the program. The committee will assist in developing the student's Program of Study, mentor the professional development of the student and conduct the final examination.

Faculty who participate in the program will be active researchers in energy-related areas. The faculty will advise ERS masters students in the program, participate in interdisciplinary seminar/course offerings, serve on committees, and vote on program policies. Doctoral-level faculty in energy sciences from other academic institutions, government or from private industry may apply to be affiliate faculty of the ERS graduate program. Applications including a professional resume, statement of collaboration and goals, and 3 letters of reference will be initially reviewed by the Admissions/Steering committee who will provide a recommendation to the general ERS graduate faculty. Approval will require a majority affirmative vote by the faculty and the Director of SER will have final decision-making authority. Affiliates will be permitted to co-advise doctoral students with a program faculty member and participate in faculty meetings, but they will not be voting members of the faculty.

Graduate assistantships allocated by SER will be limited to 2 academic years. Financial support beyond 2 AY and in the summer is the responsibility of the student and advisor.

#### **D. Program of Study**

The professional masters program is highly flexible and responsive to student workforce goals within constraints outlined above. The program of study will be designed to address background deficiencies, and provide advanced and sophisticated knowledge in energy sciences. However, all graduate will meet learning outcomes in core areas with electives focusing on a specialization within energy resource sciences. All electives contributing to the formal program of study must be at the 4000 or 5000 level. Time to degree normally will be 4 academic semesters and one summer.

- **Core Courses** - 12 credit hours: Principles of Energy Asset Management (3), Energy Resource Science Seminar (3), ERS Capstone (3), Internship and/or International Experience in ERS (3)
- **Electives:** minimum 18 credit hours.
- **Masters project:** 3 credit hours.
- **Total credit hours:** minimum 33

Sample program of study:

#### **Semester 1**

Principles of Energy Asset Management

Seminar

Electives

## **Semester 2**

Seminar

Electives

## **Summer**

Internship

## **Semester 3**

Electives

## **Semester 4**

Capstone

Summary project

Seminar

Electives

The summary project will be a discovery-based, authentic, open-ended research project undertaken by the student in conjunction with an SER faculty member, faculty affiliated with one of the SER Centers of Excellence or faculty active in energy-related research. The intent of the project is to transition students from novice to more expert scholars. The project will integrate classroom learning with application, teach students the fundamentals of scholarship and the scientific method, foster independent, creative problem solving skills, and provide students practice at thinking on the frontiers of knowledge. Although 3 CH are assigned to the summary project in the final semester, it is anticipated that the project will be an ongoing activity beginning at the end of the first semester or beginning of the second semester. The summary project outline will be submitted to the Associate Director of SER for review and approval no later than the end of the first semester of the program. Students will utilize the project prospectus as the basis for a seminar in semester 1 or 2. In the final semester, students will provide a concluding seminar on project results. Immediately following the culminating seminar, the committee will hold the degree defense.

**E. Suggested Electives.** The list below is not exclusive; depending upon student workforce goals, the evolving array of energy related courses and authorization by the graduate committee other courses can be applied to the program of study.

NASC 5700 Topics in STEM Education

REWM 4051 Environmental Politics

REWM 4052 Federal Land Politics

SOIL 5130 Chemistry of the Soil Environment

SOIL 5180 Chemistry and Remediation of Environmental Contaminants

GEOL 5430 Applied Geostatics

GEOL 5030 Groundwater Flow and Solute Transport Modeling

GEOL 5190 Petroleum Geology

GEOL 5191 Methods in Petroleum Geology

GEOL 5444 Geohydrology  
GEOL 5835 Applied Exploration Geophysics  
GEOL 4990 Gravity Prospecting  
GEOL 5216 Global Seismology  
ECON 4410 Natural Resource Economics  
ECON---- Energy Economics  
PETE 4030 Rock and Fluid Mechanics  
PETE 4060 Flow Through Porous Media  
PETE 4200 Natural Gas Engineering  
PETE 4225 Well Test Analysis  
PETE 4250 Drilling Engineering  
PETE 4320 Well Log Interpretation  
PETE 4340 Petroleum Economics  
PETE 5010 Transport Phenomena  
PETE 5015 Secondary Recovery  
PETE 5050 Structure and Properties of Porous Media  
PETE 5060 Flow in Porous Media  
CE 4800 Hydrology  
ME 4360 Introduction to Nuclear Energy  
ME 4380 Steam Plant Engineering  
ME 4460 Solar and Geothermal Engineering  
ME 4470 Wind Ocean Engineering  
ME 4490 Modeling and Optimization of Energy Systems  
ME 5446 Turbulence

#### **F. Program benchmarks**

- Committee formation, meeting & program of study development – **end of first semester**
- Special project proposal – **beginning of second semester**
- Initial seminar outlining program of study and special project – **second semester**
- Culminating seminar on special project – **fourth semester**
- Final defense – **fourth semester**

#### **G. Recruitment and Retention**

Entry into the master's program will typically occur at the beginning of the fall semester and applications will be due by February 28 of each year. In order to identify the strongest candidates for the program, however, completed applications will be reviewed by the Admissions/Steering Committee on an on-going basis as complete applicant packets are received. Applicants may be supported with a graduate assistantship, or may be supported by personal funds, or scholarships from public or private foundations.

An aggressive marketing and recruiting campaign will be initiated. This will include a program website, promotional materials, posters and brochures. These will be disseminated to select university programs, appropriate governmental and private sector energy companies in the region, at national and international levels.

## **H. Mentoring**

The Chair of each student's Committee will serve as the student's primary mentor, however, all members of the Committee will also be expected to provide informal mentoring throughout the student's program of study. Students and their advisor will form a committee based upon student graduate program and workforce goals. The committee will be established during the first semester of full-time study and an initial meeting will be held to identify the student's educational goals, determine deficiencies, and an appropriate curriculum. The determination of content area weaknesses will be made through transcript analysis and committee discussion.

Student progress toward degree completion will be continuously monitored. Formal review by the entire faculty will occur annually. The review will include student performance in (1) coursework, (2) master's project (3) internship/international experience portfolio, (4) presentations. Advisors will provide their advisees with a written summary of the annual review. The summary will be signed by the student and a copy placed in his/her student file.

## **I. Assessment**

The ERS program will be judged based upon graduate's placement and success in the workforce and by the attributes of the participating faculty and program. These are the prerequisites for creating a faculty, student body, and environment consistent with excellence in education. Assessment metrics will also include:

### **1. Metrics of student learning outcomes.**

- Course evaluations
- Exit surveys
- Alumni surveys (3 years post graduation)
- Time to degree/program attrition
- Publications, abstracts, regional and national paper and poster presentations
- Workforce placement

### **2. Program assessment metrics.**

- The program is committed to fostering student career development. Services will be offered to students that permit identification of financial aid opportunities, internships/international experiences, access to constructive criticism and feedback, contacts with potential employers, career counseling, and the provision of other services that benefit individuals while students or once launched into their careers.
- Faculty will be assessed primarily by their ability to successfully mentor students through the program including publication of relevant results in peer reviewed journals or in other outlets, development of intellectual property or other metrics as appropriate.
- The program will evaluate its ability to attract and retain students, time-to-degree, number of degrees awarded, and student performance. Graduate success in workforce placement will be monitored. In addition to these general metrics, the program will establish a database of all graduates who will be surveyed 3 and 6 years post graduation to identify programmatic strengths and weaknesses.

# Appendix B. Matching Grants Fund Details

## Appendix B

### Matching Grants Fiscal Year 2007

Detail as of 6/30/2011

Proposal	Department	Project Title	Total Research Funds	Outside Granting Agency Funds	SER Obligation	SER Payments	Remaining Obligation
07-001	Chemical Engineering	Model Development: Fischer-Topsch Synthesis & Product Refining	\$170,000.00	\$120,000.00	\$50,000.00	\$ (50,000.00)	-
07-002	Geology	Shapes, Scales, & Spacings of Channel-belt Sand Bodies in Avulsion-dominated Alluvial Basins	\$150,000.00	\$100,000.00	\$50,000.00	\$ (50,000.00)	-
07-006	Chemical Engineering	Three-Phase Relative Permeabilities for Enhanced Oil Recover Schemes	\$480,000.00	\$400,000.00	\$80,000.00	\$ (80,000.00)	-
07-007	Physics	Investigation of nanospheres for general lighting application	\$170,000.00	\$120,000.00	\$50,000.00	\$ (50,000.00)	-
07-008	Plant Sciences	Plant pathogen threat to oilseed biodiesel crop development in Wyoming	\$32,000.00	\$16,000.00	\$16,000.00	\$ (16,000.00)	-
07-009	Chemical Engineering	Integration of a Structural Water Gas Shift Catalyst with a Vanadium Alloy Hydrogen Transport Device	\$200,000.00	\$100,000.00	\$100,000.00	\$ (100,000.00)	-
07-010	Geology	Fault Seal on Low-Angle Normal Faults	\$30,000.00	\$15,000.00	\$15,000.00	\$ (15,000.00)	-
07-011	Chemical Engineering	Nonthermal Plasma Reactors for the Decomposition of Hydrogen Sulfide	\$50,000.00	\$25,000.00	\$25,000.00	\$ (25,000.00)	-
07-015	Chemical Engineering	Recoverable Enzyme Nanoparticle Systems for Cellulose Hydrolysis	\$336,200.00	\$284,600.00	\$51,600.00	\$ (51,600.00)	-
07-016	Mechanical Engineering	Sensitivity Analysis for Uncertainty Quantification & Improved Accuracy in Nuclear Reactor Core Simulations	\$372,600.00	\$300,000.00	\$72,600.00	\$ (72,600.00)	-
		<b>Totals</b>	<b>\$1,990,800.00</b>	<b>\$1,480,600.00</b>	<b>\$510,200.00</b>	<b>\$ (510,200.00)</b>	

## Appendix B

### SER Matching Grants Fiscal Year 2008

Detail as of 6/30/2011

Proposal	Department	Project Title	Total Research Funds	Outside Granting Agency Funds	SER Obligation	SER Payments	Remaining Obligation
08-000	Mechanical Engineering	Aerodynamics & Control of Wind Turbines	\$615,520.00	\$515,520.00	\$100,000.00	(\$100,000.00)	-
08-009	Chemical Engineering	Mercury Removal from Flue Gas Derived from Oxygen Combustion of Coal	\$50,000.00	\$25,000.00	\$25,000.00	(\$25,000.00)	-
08-012	Renewable Resources	Identifying Disturbance Mechanisms Influencing Habitat Selection by Elk in Natural Gas Development Fields	\$336,402.00	\$276,402.00	\$60,000.00	(\$60,000.00)	-
08-019	Geology	Evaluation of Model Uncertainty in CO2 Sequestration in Deep Aquifers	\$164,900.00	\$82,450.00	\$82,450.00	(\$82,450.00)	-
08-030	Chemical Engineering	Energy from Organic Waste Degradation Using Biological Fuel Cells	\$250,000.00	\$150,000.00	\$100,000.00	(\$100,000.00)	-
08-031	Geology	Pilot study to assess the utility of Pb isotope analyses for improved monitoring of aquifer interactions in the in-situ U mining industry	\$10,000.00	\$5,000.00	\$5,000.00	(\$5,000.00)	-
08-038	Chemistry	Highly Oxidizing Ligand-to-metal Charge Transfer Excited States for Solar Energy Conversion	\$433,000.00	\$345,000.00	\$88,000.00	(\$88,000.00)	-
08-040	Wyoming Coop	Identifying mule deer migration routes to and from the Pinedale Anticline Project Area	\$133,720.00	\$77,000.00	\$56,720.00	(\$56,720.00)	-
08-042	Atmospheric Science	Upper Green River Basin Ozone Monitoring Study	\$195,904.00	\$97,952.00	\$97,952.00	(\$97,952.00)	-
08-047	WRI/Chemical Engineering	Capture and Control of Emissions in Combustion and Gasification Environments	\$1,519,103.00	\$1,419,103.00	\$100,000.00	(\$100,000.00)	-
08-051	Renewable Resources	Effects of Natural Gas Well Development & Reclamation Activities on Topsoil Properties	\$147,800.00	\$73,900.00	\$73,900.00	(\$73,900.00)	-
08-056	Renewable Resources	Identifying Habitats for Greater Sage-Grouse Population Persistence within the Atlantic Rim, Wyoming Coalbed Methane Field	\$190,000.00	\$150,000.00	\$40,000.00	(\$40,000.00)	-
		<b>Totals</b>	<b>\$4,046,349.00</b>	<b>\$3,217,327.00</b>	<b>\$829,022.00</b>	<b>(\$829,022.00)</b>	

## Appendix B

### SER Matching Grants Fiscal Year 2009

Detail as of 6/30/2011

Proposal	Department	Project Title	Total Research Funds	Outside Granting Agency Funds	SER Obligation	SER Payments	Remaining Obligation
09-001	Chemistry	Optimizing Cu <sub>2</sub> ZnSnS <sub>4</sub> -based Photovoltaic Devices: An Approach to Inexpensive and Scalable Thin Films and fundamental Studies of Semiconducting Properties	\$100,000.00	\$75,000.00	\$25,000.00	(\$25,000.00)	-
09-005	Cooperative Extension Service	Off-the-Grid Home Energy Demonstration Project	\$58,280.00	\$34,140.00	\$24,140.00	(\$24,140.00)	-
09-008	Mechanical Engineering	Achieving Petaflops Level Parallelism for Simulation-Based Engineering Problems in Fluid Dynamics	\$393,082.00	\$293,716.00	\$99,366.00	(\$99,366.00)	-
09-015	Wyoming Geographic Information	Multi-agency Collaborative Effort to Model Salt Loading in Energy Development Areas	\$132,840.00	\$42,840.00	\$90,000.00	(\$90,000.00)	-
09-026	Economics	Subsidies and Taxes in the Markets for Enhanced Oil Recovery and Carbon Capture Storage	\$366,466.00	\$332,770.00	\$33,696.00	(\$33,696.00)	-
09-028	Management & Marketing	Drivers of Electrical Energy Demand in the rocky Mountain Region	\$250,672.00	\$182,672.00	\$68,000.00	(\$68,000.00)	-
09-029	Atmospheric Science	Novel approaches to improving air pollution emission information for oil and gas development	\$598,013.00	\$499,263.00	\$98,750.00	(\$98,750.00)	-
			<b>\$1,899,353.00</b>	<b>\$1,460,401.00</b>	<b>\$438,952.00</b>	<b>(\$438,952.00)</b>	

## Appendix B

### SER Matching Grants Fiscal Year 2010

Detail as of 6/30/2011

Proposal	Department	Project Title	Total Research Funds	Outside Granting Agency Funds	SER Obligation	SER Payments	Remaining Obligation
10-003	Geology	A Geochemical and Experimental Evaluation of Geologic co2-so2 Co-Sequestration"	\$200,000.00	\$100,000.00	\$100,000.00	(\$100,000.00)	-
10-004	Physics	Quantum Dot Sensitized Solar Cells Based on Ternary Oxide Nanowires for Space Energy Apps	\$1,754,596.00	\$1,504,596.00	\$250,000.00	(\$250,000.00)	-
10-009	Chemical Engineering	Cost-Effective Gasification of Wyoming Coal with the Help of Nano-Dispersion Catalysts	\$300,000.00	\$200,000.00	\$100,000.00	(\$100,000.00)	-
10-018	Civil	Treatment and Beneficial Reuse of Produced Waters Using A Novel Pervaporation-Based Irrigation Technology.	\$515,326.00	\$417,231.00	\$98,095.00	(\$34,524.00)	\$63,571.00
10-021	Renewable	Habitat and Population Evaluation for Greater Sage-Grouse in the Simpson Ridge Wind Resources Area, WY	\$27,500.00	\$15,000.00	\$12,500.00	(\$12,500.00)	-
10-023	Physics	Quantum Dot Sensitized Solar Cells Based on Ternary Oxide Nanowires for Space Energy Applications	\$849,706.00	\$749,706.00	\$100,000.00	(\$100,000.00)	-
10-028	Chemistry	Studies of Photoinduced Electron Transfer from Dyes, Polmers & quantum Confined Systems into Semiconducting Oxide Single Crystals	\$953,464.00	\$765,674.00	\$187,790.00		\$187,790.00
10-029	Geology	Fracture characterization of the southcentral Seminoe Mountains, WY	\$6,000.00	\$3,000.00	\$3,000.00	(\$3,000.00)	-
10-030	Plant Sciences	Developing weed management strategies to improve desirable species establishment in reclamation of disturbed lands	\$175,000.00	\$90,000.00	\$85,000.00	(\$34,000.00)	\$51,000.00
10-038	Plant Sciences	A facility for study of photosynthetic carbon sequestration & flue gas remediation at Mountain Cement Corporation	\$60,000.00	\$30,000.00	\$30,000.00	(\$30,000.00)	-
10-045	WYGISC	Research & Development of a GIS-Based Wildlife Resource Management & Mitigation Decision Support System Tool	\$226,476.00	\$150,000.00	\$76,476.00	(\$76,476.00)	-
			<b>\$5,068,068.00</b>	<b>\$4,025,207.00</b>	<b>\$1,042,861.00</b>	<b>(\$740,500.00)</b>	<b>\$302,361.00</b>

**Appendix B**  
**SER Matching Grants Fiscal Year 2011**  
 Detail as of 6/30/2011

Proposal	Department	Project Title	Total Research Funds	Outside Granting Agency Funds	SER Obligation	SER Payments	Remaining Obligation
11-001	Atmospheric Science	Data Warehouse	\$3,109,534	\$2,861,769	\$247,765		\$247,765.00
11-003	Geology & Geophysics	A Response-Surface Based Novel Uncertainty Analysis for CO2 Sequestration Modeling in Geological Formations	\$299,022	\$203,679	\$95,343		\$95,343.00
11-006	Civil & Architectural Engr	Laboratory Companion to In-Situ Coal Depolymeration/Solubilization Field Demonstration	\$225,000	\$150,000	\$75,000		\$75,000.00
			<b>\$3,633,556.00</b>	<b>\$3,215,448.00</b>	<b>\$418,108.00</b>	<b>\$0.00</b>	<b>\$418,108.00</b>

\$16,638,126.00 = Total Research Funds (all years)  
 \$13,398,983.00 = Total Captured Research Dollars (all years)  
 \$3,239,143.00 = Total SER Obligation (all years)  
 \$720,469.00 = Total Remaining Commitments (all years)