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2013 Annual Report

University of Wyoming
School of Energy Resources

2013 ANNUAL REPORT OF THE UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES

30 September 2013

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

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The seventh year of the University of Wyoming School of Energy Resources marked a significant milestone. At the end of 2012, we were pleased to start moving into the Energy Innovation Center (EIC) to oversee the finishing work and the installation of major research equipment and technology.

The EIC gives the School of Energy Resources (SER) a permanent home, but more importantly, the building, its research facilities and capabilities, and its links to high-performance computing facilities will propel energy programs at the University of Wyoming (UW) to the forefront of energy research. It will also support the work now under development to build a Tier 1 engineering program at UW; a strong correlation exists between SER's Strategic Areas of Concentration and the engineering initiative.

During the year, the Energy Resources Council (ERC) welcomed a new chairman, Paul Lang, chief operating officer and executive vice president of Arch Coal. He fills the vacancy created when Ron Harper, who has served the council so ably as chairman since the start of the council, stepped down.

In FY2013, SER underspent the planned budget of $10.2 million by $3.3 million, due to extended faculty searches, greater reliance on grant funding, and several deferred actions. SER also reduced the size of the budget for FY2014 ($10.2 million) by 6 percent, which amounts to $612,000, leaving a total 2013-2014 biennial budget of $19,788,000. It is anticipated that SER will spend its full approved amount in FY2014.

SER's academic programs continue to expand and attract more students. During the year, we were pleased to receive accreditation from the American Association of Professional Landmen for the Professional Land Management concentration under the Energy Resource Management and Development BS degree program, making UW's program only the seventh accredited program in North America. The Energy MBA degree, offered in collaboration with the UW College of Business, added two options – an MBA with Energy Management Concentration and an MBA in Energy Management. In the Spring semester of 2013, there were 55 students enrolled in the undergraduate program and there have been 14 graduates all of which who attempted to enter the job market found employment.

As mentioned above, the research capabilities offered at the EIC are expanding with continuing investment in technology and equipment. The Centers of Excellence continue to pursue financial independence. One center is self-supporting.

The Energy Outreach Program continues to deliver events and presentations, including highly attended events that attract international attendees, host invited speakers and collaborate on events that help advance the mission of SER.

In support of SER's investment in Strategic Areas of Concentration, $10.9 million in new financial commitments from six oil and gas companies were secured against the state's $15 million funding match during the year, and discussions on collaborative research with private sector partners are maturing. Faculty searches continue. Research and teaching assets continue to secure funding support and are under development.

With work substantially complete, a ribbon cutting at the EIC was held in September 2013.

SECTION 1 – INTRODUCTION

The University of Wyoming Energy Resources Council (ERC) was established by statute (W.S. 21-7-117) (e) to provide direction to the School of Energy Resources in identifying and prioritizing issues that should be targeted for research and outreach. The ERC consists of 11 members:

- Seven members representing diverse components of Wyoming's energy industries appointed by the Wyoming governor with the consent of the Wyoming Senate; these members serve three-year terms.
- UW president and director of the Haub School (ex-officio)
- A member of the UW Board of Trustees at the invitation of the ERC to allow greater communication between the two boards
- One member each of the Wyoming Senate (appointed by the president of the Senate) and the Wyoming House of Representatives (appointed by the speaker of the house)

Administration and Organization

The council self-selects its chairman and vice chairman.

The ERC meets at least quarterly, including one meeting a year with the UW Board of Trustees in November.

The ERC is supported by the SER director and staff.

The ERC is represented by the UW General Counsel.

In the last year, the ERC's longtime chairman, Ron Harper, stepped down. Paul Lang was named chairman. The ERC welcomed three new members: Wyoming State Sen. Jim Anderson (SD2), Thomas Botts and David Emery.

The members of the Energy Resources Council are:

Paul Lang – Council chairman
COO and executive vice president, Arch Coal, Inc.
Tom Lockhart – council vice chairman
Wyoming State Representative, chairman, House Minerals, Business and Economic Development Committee
Robert Sternberg
President, University of Wyoming
Ex-officio
Indy Burke
Director, Haub School of Environment and Natural Resources, Wyoming Excellence Chair

Ex-officio

David F. Palmerlee
UW Board of Trustees
Ex-officio

Jim Anderson
Senator, Wyoming State Legislature

Carl Bauer
President, C.O. Bauer Consulting, Inc.

Thomas M. Botts
Retired executive vice president, Royal Dutch Shell

David Emery
President and chief executive officer, Black Hills Corporation

Jeane Hull
Executive vice president Technical Services, Peabody Energy

Rob Wallace
Managing partner, Rob Wallace Group

Martha B. Wyrsch
Executive vice president and general counsel, Sempra Energy

The Energy Resources Council met:

- August 24, 2012
  UW Conference Center at the Hilton Garden Inn
  Laramie
- November 16, 2012
  Hilton Garden Inn
  Laramie
- March 22, 2013
  UW Conference Center at the Hilton Garden Inn
  Laramie
- May 17, 2013
  Energy Innovation Center
  Laramie

For more information, please visit the SER website at www.uwyo.edu/ser.

SECTION 2 – FINANCIAL SUMMARY

The Wyoming State Legislature provided funding for SER over the 2013-14 biennium in the 2012 Legislative Budget Session in the amount of $20,400,000. At the beginning of the biennium, SER anticipated that approximately equal amounts would be spent in each fiscal year of the biennium. During the course of FY2013, SER was asked to reduce the budget for FY2014 by 6 percent, which amounts to $612,000, leaving a biennial budget of $19,788,000. Budget reductions were achieved by eliminating one unfilled faculty position, one visiting faculty position, reducing facilities support, and a variety of small reductions in research and outreach programs.

Expenditures for the 2013 Fiscal Year totaled $6,886,184. Of that total, SER spent:

- $3.45 million for salaries and benefits for SER staff and 11 faculty
- $150,000 for start-up commitments made to SER faculty
- $1.38 million to support research activities of the eight Centers of Excellence
- $257,000 for the Matching Grants Fund
- $317,000 for Outreach events
- $1.33 million for remaining expenses that include graduate assistantships, recruiting, travel, publications, Energy Summer Institute, office support, etc.

Fiscal Year 2013 – Variance Report

Academics	**FY 2013 Spent**	**Planned**	**Variance**
Salary/Fringe	$ 1,792,662	$ 2,262,873	$ 470,211
Startup	$ 149,841	$ 310,000	$ 160,159
Other support & Programs	$ 781,398	$ 1,774,942	$ 993,544
Subtotal Academics	$ 2,723,902	$ 4,347,815	$ 1,623,913
Research			
Salary/Fringe	$ 660,719	$ 970,468	$ 309,749
Matching Grant Funds	$ 257,332	$ 214,769	$ (42,563)
Center Support	$ 1,384,106	$ 2,650,070	$ 1,265,964
Other support & Programs	$ 432,162	$ 50,000	$ (382,162)
Subtotal Research	$ 2,734,319	$ 3,885,307	$ 1,150,988
Outreach			
Salary/Fringe	$ 309,874	$ 228,090	$ (81,784)
Other support & Programs	$ 317,791	$ 635,000	$ 317,209
Subtotal Outreach	$ 627,665	$ 863,090	$ 235,425
Administration			
Salary/Fringe	$ 682,969	$ 635,463	$ (47,506)
Other support & Programs	$ 117,329	$ 500,000	$ 382,671
Subtotal Administration	$ 800,298	$ 1,135,463	$ 335,165
Totals	$ 6,886,184	$ 10,231,675	$ 3,345,491

In Fiscal Year 2013, spending fell short of expectations. The primary areas of under-expenditure include:

- $779,000 for salaries and benefits, $470,000 due to extended faculty searches in FY2012, and $309,000 due to research salaries that were charged to grants
- $160,000 for faculty start-up due to extended faculty searches in FY2012
- $1.26 million for support of centers of excellence, primarily due to:
  - $700,000 reduction of funds for the Carbon Management Institute due to activity of the Wyoming Carbon Underground Storage DOE Grant and the Joint US/China Clean Energy Research Consortium grant.
  - $438,000 under-expended by Centers of Excellence
  - $100,000 in funding for a Center for Energy Regulation, Policy, and Law redirected to fund a future faculty position in the College of Law
- $317,000 deferred spending for sponsorships, promotions, and workshops in SER's Outreach program
- $382,000 in planned support for the Energy Innovation Center was deferred due to 6-month delay in occupying the building

We anticipate that spending in FY2014 will accelerate and that the biennial state appropriation of $19,788,000 will be spent.

SECTION 3 – ACADEMIC PROGRAMS

The overarching mission of SER Academics is to develop an innovative, competent and performance-driven 21st century energy sector workforce. Positioning graduates for long-term competitive success demands both content knowledge and behaviors that allow adaptation to new areas of proficiency, rapidly changing technologies and competencies. All SER academic initiatives are guided by a focus on rigor and high standards, continual inspection and modification, student learning outcomes designed for sustained competitive success and the needs of the Wyoming energy enterprise. This report summarizes 2013 outcomes from four main elements of the academic mission: K12 Energy Education, Undergraduate Education, Graduate Education, and Faculty Performance.

K12 Energy Education

SER is committed to coordinating statewide efforts in energy education to enhance the workforce pipeline and promote general energy literacy among all students. Specifically, activities are targeted to increase awareness of the vast career opportunities available in the public and private energy sector, to promote in-service teacher training in energy issues and motivating inquiry-based pedagogy, to provide cutting-edge, energy-based lesson plans, to connect engaging curriculum and project-based learning with field trips and practical experience, and to connect industry and community efforts with K12 energy initiatives.

Activities in 2012-2013 included:

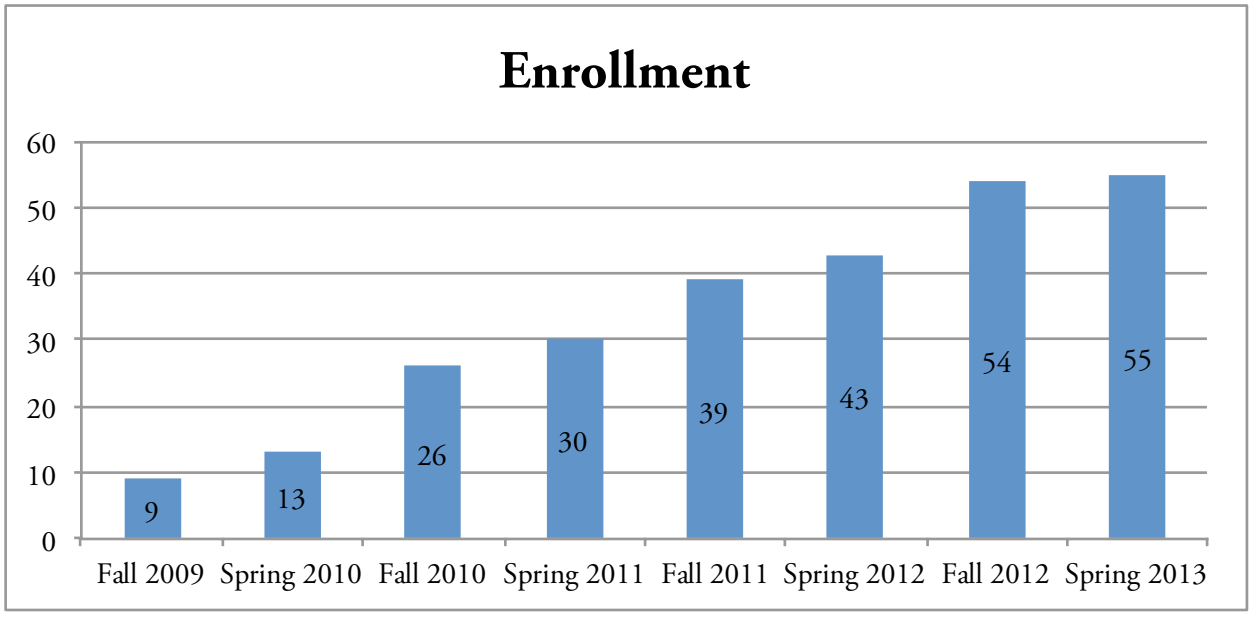
- ExxonMobil grant – SER received a grant for $100,000 to expand the scale and scope of K12 Energy Literacy initiatives in Wyoming. Multiple new activities, including a new ExxonMobil Challenge day modeled after the Intel science program, are in development.
- Summer Energy Institute – In conjunction with the UW Science Posse (see www.sciencepos-se.org) and EE Nanotechnology (see www.uwyo.edu/nanotech), 18 high school sophomores and juniors attended the seventh annual Energy Summer Institute held June 16-21, 2013 at UW.
- Summer Science Camp – In partnership with Teton Science School and the Science Posse, a one-week discovery based science camp was delivered at the Kelly, Wyo., campus. Twenty-two students from across Wyoming attended; capacity was filled approximately 1 hour after online registration opened.
- 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, the Energy and Environmental Nanotechnology program, and the NASA-sponsored science education program. Activities included campus lab visits, a summer teacher training program, near-peer mentoring in classrooms throughout Wyoming, curriculum development, and online expertise delivery. All activities are formally assessed to establish outcomes based on defined metrics.

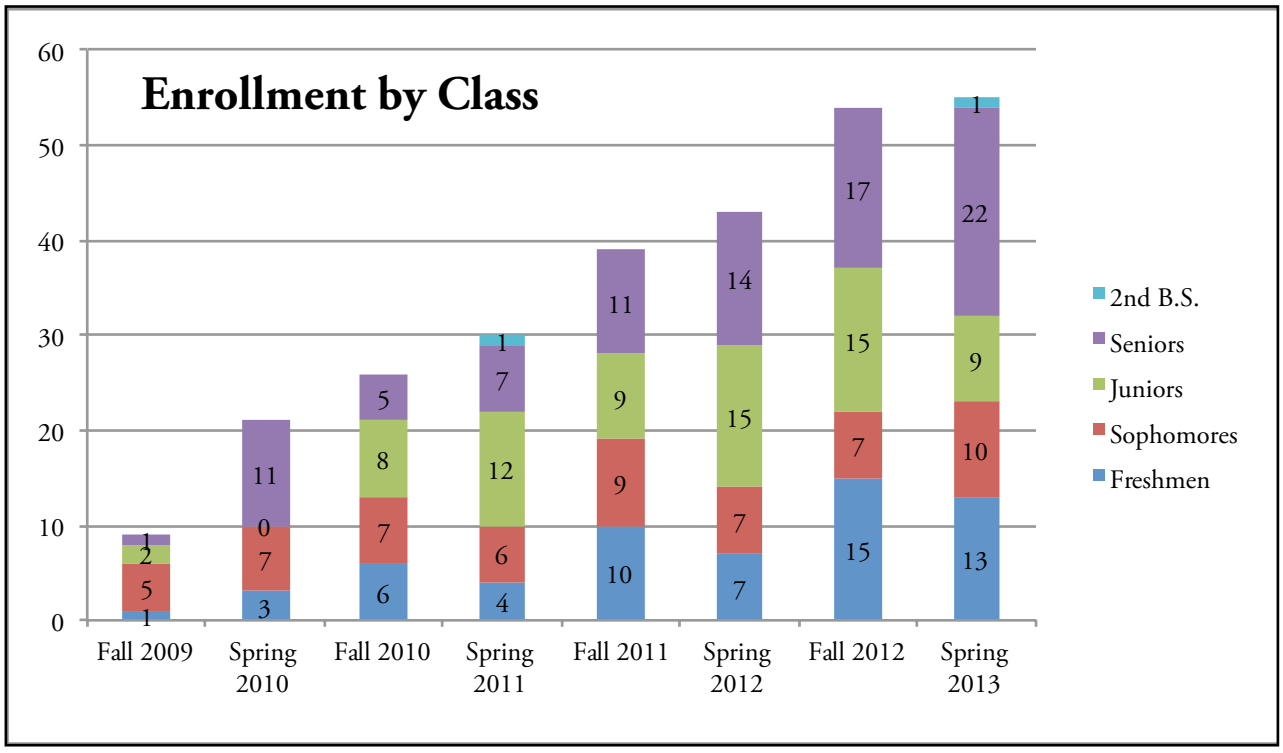
- Energy clubs – SER is cooperating with the Gillette school system and a community coordinating committee in a pilot effort to establish energy clubs in the middle school and high school.
- Energy academies – The Rock Springs school district has an established energy academy and SER is assisting with development and delivery of activities, guidance, and coordinating UW field trips.
- Involvement of graduate students in the 7th-12th grade classrooms. Graduate students in energy fields (including those supported by SER) discuss, explain and showcase their research to teachers and students.

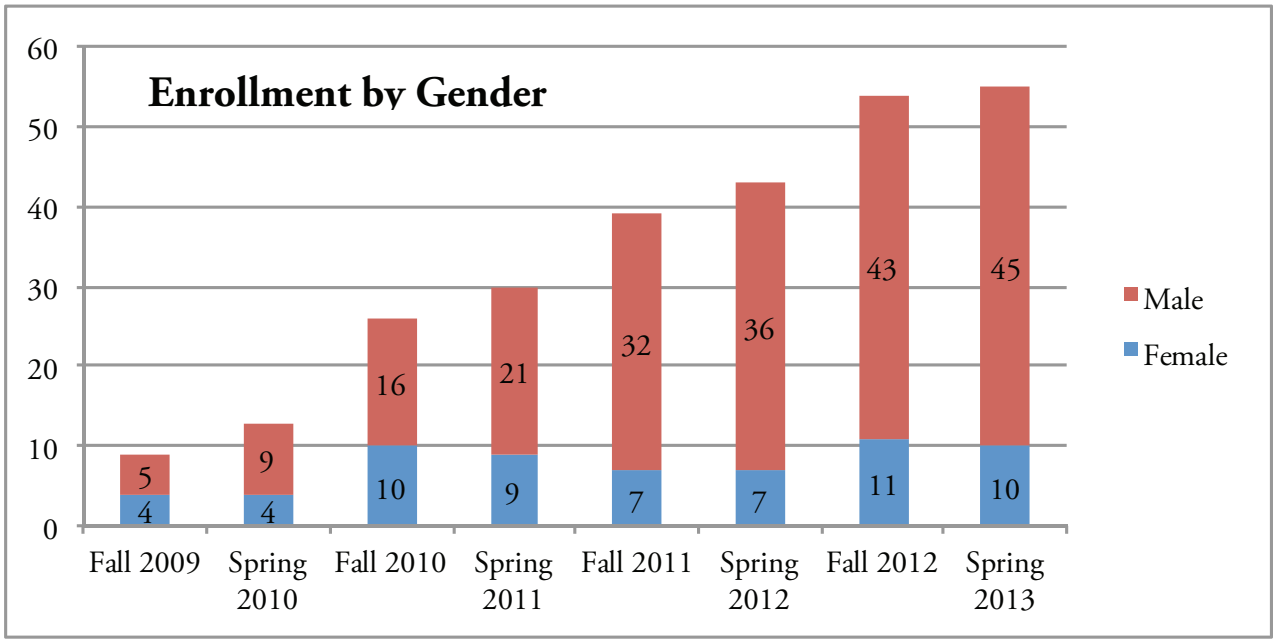
Undergraduate Education

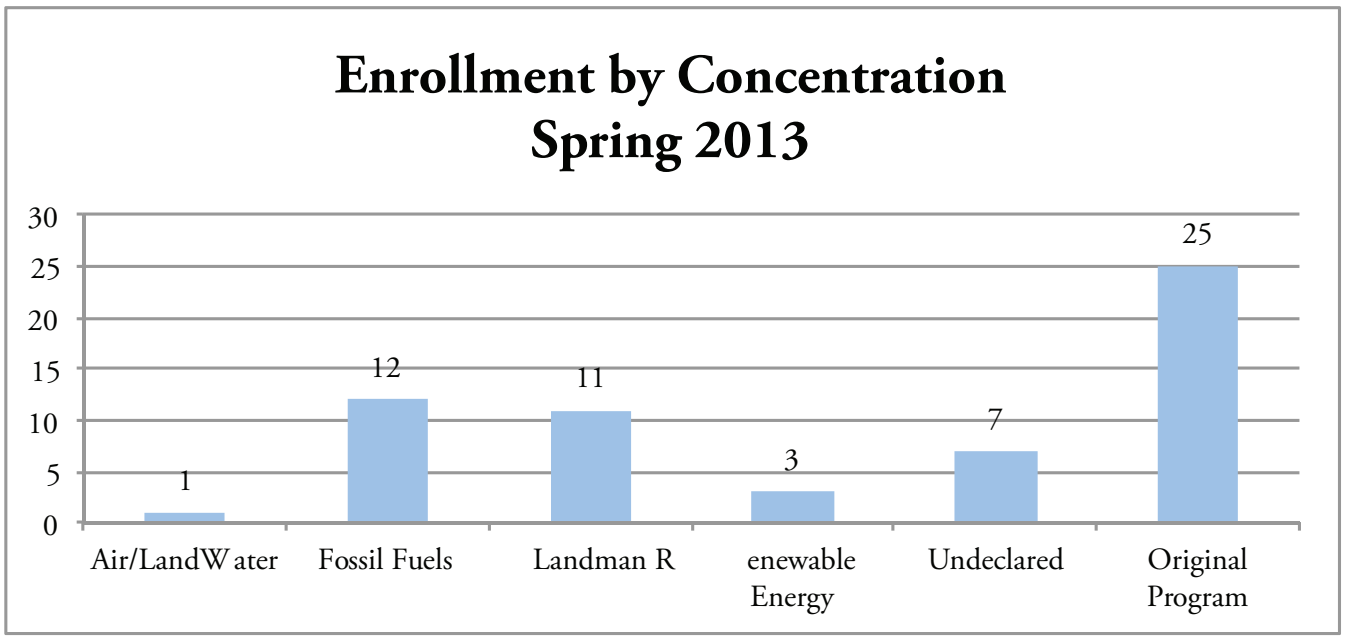
The Energy Resource Management and Development program (ERMD) is an interdisciplinary energy BS degree program that integrates training in engineering, geology, policy, economics, business, law, and natural resources content. It is a workforce directed degree that connects energy sector solutions based problem-solving experiences with classroom learning.

- Four concentrations are included in the program: Fossil Fuels; Renewable Energy; Energy Air, Land and Water Management; and Professional Land Management (PLM). The PLM program was formally accredited in December 2012 by the American Association of Professional Landmen (AAPL) and is the seventh accredited program in North America.
- The BS degree began in 2009 and has increased substantially in enrollment, an indication of student demand (see below).




Enrollment by Class
60
50
40
30
20
10
0
Fall 2009
Spring 2010
Fall 2010
Spring 2011
Fall 2011
Spring 2012
Fall 2012
Spring 2013
2nd B.S.
Seniors
Juniors
Sophomores
Freshmen


Enrollment by Gender
60
50
40
30
20
10
0
Fall 2009
Spring 2010
Fall 2010
Spring 2011
Fall 2011
Spring 2012
Fall 2012
Spring 2013
Male
Female

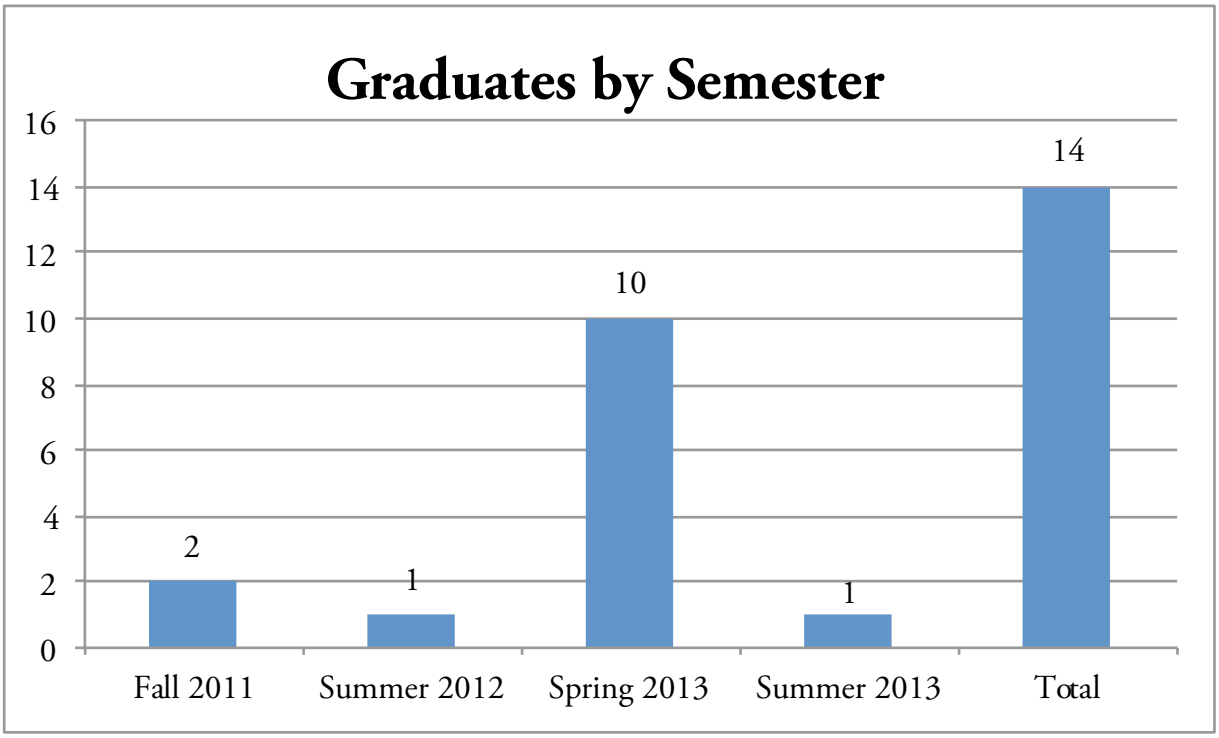


Graduates

Fourteen students graduated as of August 2013. Ten graduates received job offers, three students are continuing their education, and one student has decided to travel.

Employers: DCP Midstream, Encana, Halliburton, InterTech Environmental & Engineering, Chesapeake Oilfield Services/Nomac Services, PacifiCorp

- Job Titles: Wireline and Perforating Field Engineer, Production Enhancement Field Engineer, Air Quality Analyst, Cement Field Engineer, Environmental Services Technician, Associate Supervisor for Wind Operations, Environmental Compliance Coordinator, Environmental Analyst, Field Geologist
- Locations: Colorado, North Dakota, Oklahoma, Texas, Wyoming
- Graduate School: University of Wyoming (Water Quality, 2nd Bachelors Petroleum Engineering), South Dakota School of Mines (Geomechanics)



Honor Rolls: Students in the Energy Resource Management and Development program are being named to the University of Wyoming Honor Rolls. Requirements to be met are as follows:

- President's – 4.0 GPA and complete a minimum of 12 credit hours
- Dean's – 3.4 or better GPA, above freshman standing, and complete a minimum of 12 credit hours
- Dean's Freshman – 3.25 or better GPA and complete a minimum of 12 credit hours
- Provost's – 3.5 or better GPA and complete 6 to 11 credit hours

Honor Roll	Spring 2009	Fall 2009	Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012	Spring 2013
President		1	1				3		2
Dean		1	2	2	2	9	4	13	8
Freshman	1	1	1			1	2	3	1
Provost						2			1
Total	1	3	4	2	2	12	9	16	12
% ERM&D Students	50.0	33.3	30.8	7.7	6.7	30.8	20.9	28.6	21.8

Internship and research experiences: Students are strongly encouraged to complete internships and undergraduate research projects. Placement opportunities are being expanded yearly to accommodate all student requests. Below are academic year 2013 placements.

- 1 student with QEP – Biology and Reclamation Intern
- 1 student with TIC – Environmental Health and Safety
- 1 student with Solvay -- Lab Technician
- 2 students with Marathon – Environmental Health and Safety
- 1 student with Legacy Reservoirs – GIS Technician
- 1 student with Tata Chemicals – Lab Technician
- 1 student with a graduate student in UW Geology and Geophysics – Field Assistant
- 1 student with Dr. Kristina Hufford, Department of Ecosystem Science and Management – Seeds of Success program with the Bureau of Land Management
- 1 student with Enhanced Oil Recovery Institute

Energy Resource Club: A formally recognized UW club focused on energy has been established. It is supervised and funded by SER. Approximately 33 students were involved with the club in the 2013 academic year. Activities included student presentations from internship experiences, study groups, and UW faculty presentations.

Professional Landman Club: Students in the Professional Land Management concentration organized a Recognized Student Organization that will become active in Fall 2013.

Fellowships, scholarships and external gifts: Significant new academic awards have been supported by external donors. Awards are competitively allocated and open to students/faculty in energy fields from multiple departments at UW.

- The Anadarko Fellowships supported the research experiences of three undergraduates in Energy Resource Management and Development, one undergraduate in Chemical Engineering, and two graduate fellowships in petroleum engineering and one graduate fellowship in economics. The Junior Faculty fellowship was awarded to Dr. Po Chen, SER Assistant Professor in the Department of Geology and Geophysics.
- One Nielson Fellowship was awarded to a student in Chemistry.
- One Professional Land Management student received a highly competitive scholarship from the Wyoming Association of Professional Landmen.
- One Professional Land Management student received a scholarship from the Denver Association of Professional Landmen.
- Two Energy Resource Management and Development students received the York Future of Energy Scholarship.
- One Energy Resource Management and Development student received the Cameco Corporation Scholarship.
- ExxonMobil K12 Energy Literacy gift - $100,000

International programs

- As a result of agreements between UW and China (Northwest University and China University of Petroleum) four visiting scholars and one MS student are working on energy research projects with SER faculty at UW.
- Agreements to establish a 3+2 BS degree program between UW and China University of Petroleum and Northwest University, Xian, China were approved. The program would allow students to attend the first three years at their home university and the following two years at the reciprocal institution. Up to 15 Chinese students per year are anticipated to take part in this program.
- One ERM&D student completed a study abroad experience with the University of Queensland, Australia.

Community college interactions: Discussions with Wyoming community colleges have established a foundation to develop an associate's degree in Energy Resource Management and Development and to enhance the pipeline from the community colleges (including transfer of courses) into the UW undergraduate degree program.

Graduate Education

Graduate assistantships: SER competitively allocated 10 graduate assistantships (GAs) for energy education and research. GAs were allocated for the 2013 academic year to faculty in the departments of Chemistry (3), Geology and Geophysics (1), Physics and Astronomy (2), Chemical and Petroleum Engineering (2) and Computer Science (1). Since 2007, 102 graduate assistantships have been awarded by SER.

MBA in Energy: The College of Business in collaboration with SER Academics has established a new MBA program focused on energy (see http://www.uwyo.edu/mba/energy-management/). Two tracks are available – a full Energy MBA and an MBA with an energy emphasis.

Center for Law and Energy Resources in the Rockies: The College of Law with SER support has established a new center to promote energy law, regulation and policy. Currently a nationwide search is under way to fill a new position in energy law with emphasis in oil and gas.

SER Faculty Performance

Eleven SER faculty and five adjunct SER faculty published more than 50 research articles in nationally refereed journals. They were principal investigators or co-investigators on multi-year extramural grants totaling more than $20 million. In addition, they participated in a variety of professional conferences, presentations, non-technical reports, book chapters, various media events, legislative testimonials, industry based reports, and popular press releases.

Faculty Hiring: In support of the SER strategic plan, faculty searches in Energy Finance, Energy Accounting, Energy Law, High Temperature Catalysis, Geomechanics, and Petroleum Systems have been initiated. A new hire (PhD from Stanford) in the area of Petrophysics will start fall 2013.

SECTION 4 – RESEARCH

State-of-the-art research is a requirement for preserving and growing the value of Wyoming's energy resources while protecting the state's natural wonders. The ability of UW faculty to seek and obtain external research grant funding is greatly enhanced by SER's commitment to provide competitively-awarded matching funds through the Matching Grant Fund program, the Advanced Conversion Technology Fund, and the Uranium Research Center. These highly leveraged funds, along with the new Shell 3-D Visualization Laboratory, provide UW with excellent opportunities and facilities to compete in a broad spectrum of research endeavors across energy sectors important to the state – natural gas, petroleum, coal, uranium, wind, and solar. In addition, research Centers of Excellence have been formed under SER to facilitate interdisciplinary research in program areas that are critical to advancing energy technology.

Centers of Excellence

The Centers of Excellence were established with seed funding from the School of Energy Resources. Each center strives to achieve support through outside funding, which may take several years. Centers 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 FY2013.

The Wyoming Center Restoration and Reclamation Center is now self-sustaining and no longer receives support from SER.

Center for Biogenic Natural Gas Research– Dr. Michael A. Urynowicz, director

Center Mission:

The Center for Biogenic Natural Gas Research (CBNG) explores and develops novel methods for production of renewable, clean-burning natural gas from depleted hydrocarbon reserves using indigenous microorganisms.

FY2013 Achievements:

- The CBNG developed an Industry Affiliates Program (IAP) to enable companies to sponsor research performed through the Center. The program enables the CBNG to receive financial support from industry partners in exchange for CBNG-related services. These services include membership on the IAP advisory board, invitations to attend CBNG events, and the opportunity to help guide commercialization efforts.
- The Wyoming Department of Environmental Quality is funding the CBNG to complete a project titled, "Laboratory Study Evaluating the Energy Value of Coal Following Microbial Conversion."

- The CBNG applied for a patent for a project titled, "Enzymatic Transformation of Chemically Treated Coal and Coal Derived Constituents." To date, research performed through the center has resulted in the filing of three non-provisional patents.

Center for Energy Economics and Public Policy – Dr. Timothy J. Considine, director

Center Mission:

The Center for Energy Economics and Public Policy (CEEPP), working with other leading academic and research centers, provides objective information and analysis for energy policies at the local, state, national, and international levels. Its goal is to support policy decision-making that balances economic, environmental, and social considerations, through research studies and programs, estimating the costs and benefits of energy technologies and policies.

FY2013 Achievements:

- The CEEPP funded six research projects in FY2013 for a total of $1,086,704. Five of the six projects will extend through FY2014. The projects funded through CEEPP explore wind power development, natural gas markets, economic co-optimization of oil recovery and CO_2 sequestration, ecological externalities associated with energy development, cost analysis of shale energy production, and potential impacts of alternative policy schemes on energy markets using experimental economics.
- The CEEPP hosted two conferences in 2012: "Power Generation and Environment: Choices and Economic Trade-offs" in Teton Village, Wyoming, and "Powder River Basin Coal: Domestic Challenges and International Opportunities" in Gillette, Wyoming.
- Proposals have been submitted to The World Bank and NERD Gas to capture external funds. The CEEPP also plans to pursue funding with the U.S. Fish and Wildlife Cooperative Landscape Conservation and Adaptive Science program.

Center for Fundamentals of Subsurface Flow – Dr. Mohammad Piri, director and Dr. Felipe Pereira, associate director

Center Mission:

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

FY2013 Achievements:

CFSF researchers have developed collaborations with industry and are submitting grant proposals to funding agencies. A new $5 million collaboration with Hess Corporation on digital rock physics has been developed.

A major initiative to develop a multi-dimensional partnership with Saudi Aramco and King Fahd University of Petroleum and Minerals has been initiated. Moreover, Professors Piri and Pereira engaged some oil companies to establish research prospects contacts, collaborations, and contracts (Encana, Petrobras, Newfield, Halliburton, etc.).

The center has secured funding for these proposals:

- Maximization of permanent trapping of CO_2 and co-contaminants in the highest-porosity formations of the Rock Springs Uplift (Southwest Wyoming): Experimentation and multi-scale modeling.
  - Funding Opportunity: DOE-NETL
  - Total Project cost: $2,905,129
  - Matching funds from CFSF: $1,374,819.00
- Pore-to-Core-to-Reservoir Modeling of Geologic Storage of Supercritical CO_2 in Deep Fractured Saline Aquifers
  - Funding Opportunity: Clean Coal Technologies Research Program/SER
  - Total Project cost: $2,815,834
  - Matching funds from the Brazilian National Lab for Scientific Computing: $1,407,934
- Model Complexity in Geological Carbon Sequestration: A Response Surface Based Uncertainty Analysis
  - Funding Opportunity: DE-FOA-0000652
  - Total Project cost: $475,389
  - Requested funding from the DOE: $380,047 (SER match is $95,343)

CFSF researchers will continue to aggressively submit grant proposals to funding agencies and will keep working with scientists and managers of the energy industry aimed at obtaining funding for research.

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 in fundamentals of multiphase flow in porous media is in two topic areas:

- Sequestration of greenhouse gas and associated impurities (GGI) in geologic formations, e.g., deep saline aquifers and oil and gas reservoirs. Namely, research activities that aim at improving the current understanding of the underlying phenomena responsible for various GGI geologic storage mechanisms that can be used to develop or improve predictive modeling tools.
- Recovery of natural gas from unconventional reservoirs characterized by low permeability. Namely, research activities aimed at improving the current understanding of permeability distribution, connectivity, and flow pathways that can be used to improve reservoir models and field design.

These projects were evaluated at the end of Year 2 and received positive recommendations for the 2012 fiscal year.

- On the Development of the UW-team Simulator for the Injection of CO_2 in Deep Saline Aquifers
- Impact of Co-contaminants Injected with Supercritical CO_2 on Fundamental Flow Properties of Sequestration Schemes in Deep Saline Aquifers: Experimentation and Modeling

- Simulation of CO_2 injection in deep saline aquifers with mathematical verification and physical validation
- A Bayesian Framework for Enabling Predictive Simulation and Uncertainty Quantification in History Matching Geological Models for CO_2 Injection
- Fundamental Investigation of Wettability in Supercritical-CO_2/Brine/Rock Systems at Reservoir Conditions: Impact of Co-contaminants
- An Integrated Well Location Optimization Study for Commercial-Scale CO_2 Storage in A Deep Saline Aquifer

A new partnership has been established with the Brazilian National Lab for Scientific Computing through a project to explore pore-to-core reservoir modeling of geologic storage of supercritical CO_2 in deep fractured saline aquifers

Linda Zhang has filed patent of a new inverse method developed, with two of her students as co-inventors (Juraj Irsa and Jianying Jiao).

The center supported three visiting professorships during the fiscal year – Professor Pedro Rodelas from the University of Granada, worked with Prof. Pereira and his group on numerical methods for transport equations; Patrick O'Leary presented the conference "In Situ Analysis with ParaView Catalyst" in April; and S. Masjid Hassanizadeh presented the prestigious "Darcy Lecture" at UW: "Capillarity in Porous Media, on Micro- and Macro-scale, Revisited" in March.

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_2 sequestration research and development.

FY2013 Achievements:

U.S.-China Clean Energy Research Center

- CMI researchers continue to collaborate with researchers from Northwest University.
- Chinese researcher finished work at CMI with CMI researchers, cataloging the Ordos basin and identifying similarities between Ordos Basin and Rock Springs Uplift. The report was presented in China.
- Collaboration trip to China was made in June and six presentations were made to Chinese partners and collaborators
- Expanded work scope and budget has been submitted to SER and approved.

WY-CUSP – Phase I

3-D/EM Data

- The 3-D seismic model continues to be adjusted as new data is available. Additional data obtained from well re-entry is being integrated with core, log suites and fluid sample observations from the stratigraphic well in order to provide a more detailed understanding of the sub-surface at the Rock Springs Uplift.
- The EM data is currently being analyzed by WY-CUSP researchers and will be incorporated with additional well data. A collaboration contract was established with OSU to assist in analysis of EM data.

Well update

Supporting activities

- WY-CUSP researchers continue fluid analyses including rock/chemical reactions.
- Discussions continue with Baker Hughes to finalize implementation of digital geophones to record baseline microseismicity.
- Fluid samples are at Core Lab and Energy Lab for analysis.
- Additional core plugs were chosen and taken to Core Lab in Denver
- INL has received fluid samples. They will test for trace metals.
- Sandia has begun fluid testing and analysis.

DOE2

- Analysis work has begun on the seals.
- Fluid samples from RSU#1 are being analyzed.
- Checking for additional available fluid samples for Madison and Weber formation.
- RSU data has been reprocessed to focus on the seals. Analysis has begun.
- Continuation application has been submitted to DOE for project year 2.

CMI presentations (All presented on the collaboration trip in China)

- Detailed CO_2 storage reservoir/site characterization: the key to optimizing performance and maximizing storage capacity.
- The importance of CO_2 storage in designing strategies for the sustainable development of energy resources.
- The evolution from tight-sand gas to shale gas.
- Shale gas potential in Wyoming Laramide basins.
- Wind River Basin – An example of how to explore for Unconventional Energy Resources.

- Global Warming and Climate Change – 45-million-year-old rocks in Wyoming support the concept.

Budget

CMI Operating		
	Budget	$218,145
	Expended	$217,116
	Balance	$1,029
	Note: New Funding is anticipated for FY14.	
WY-CUSP		
	Budget	$16,952,572
	Expended	$15,697,646
	Balance	$1,254,926
CERC		
	Budget	$842,237
	Expended	$869,796
	Balance	$(27,559)
	Note: New Match for Project Year 3 is anticipated.	
DOE2		
	Budget	$284,998
	Expended	$205,917
	Balance	$79,081
	Note: Reflects only first year fiscal budget.	
WY-CUSP 2 - Well Expenses		
	Budget	$5,000,000
	Expended	$2,620,725
	Balance	$2,379,275

Center for Photoconversion and Catalysis – Dr. Bruce Parkinson, director and Dr. Carrick Eggleston, associate director

Center Mission:

The Center for Photoconversion and Catalysis (CPAC) promotes collaboration and experimentation in the fields of solar energy conversion, energy storage, and catalyst optimization. The center finds new ways of generating and using energy – emphasizing conversion of light into both electrical and chemical energy – and 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 the conversion of Wyoming's fossil energy sources into cleaner fuels.

FY2013 Achievements:

- The CPAC funded four seed grants in FY2013 for a total of $55,000 in the areas of computation modeling of solar-thermal aerosol reactors, solar conversion of water to fuels using photoactive metals, tunable organic light-harvesting nanostructures, and atomic layer deposition modified molybdenum carbide as a co-catalyst for various energy-related applications.
- Seed grant awardees from the CPAC's 2011 request for proposals have seen success in leveraging funds to further CPAC research.
- The CPAC hosted a summer lecture series titled, "Understanding and Manipulating Bulk and Surface Properties of Semiconductors for Solar Energy Conversion," by visiting scholar Dr. Katarzyna Skorupska. The nine-week lecture series began June 19, 2013.
- In March 2013, the CPAC hosted Professor Steve George from the University of Colorado to give a seminar titled, "Controlling Platinum Atomic Layer Deposition: From Platinum Nanoparticles to Continuous Platinum Thin Films."
- CPAC Associate Director Dr. Carrick Eggleston was awarded a Fulbright-Nehru fellowship from the U.S. State Department and the Government of India to conduct research and teach a course at Pondicherry University while on sabbatical leave during the spring semester of 2013.

Wyoming Reclamation and Restoration Center – Dr. Pete Stahl, director and Dr. Calvin Strom, associate director

Center Mission:

The Wyoming Reclamation and Restoration Center (WRRC) mission 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.

FY2013 Achievements:

With contributions by industry and federal and state agencies, the WRRC continues to be fully financially independent of support funds from SER. The WRRC remains responsive to the needs of the energy industry and government agencies to improve reclamation and restoration of disturbed lands in Wyoming.

Wind Energy Research Center – Dr. Jonathan Naughton, director

Center Mission:

The vision of WERC is to establish an internationally recognized program for conducting wind energy-related research and education and to collaborate with other UW groups to provide service to the state and the nation. The center will strategically partner with other academic institutions, federal laboratories, and companies with complementary capabilities to accomplish this work.

FY2013 Achievements:

- Publications:
  - Wind Energy Related Journal Articles: 2 articles published, but ~10 in various forms of review.
  - Wind Energy Related Conference Papers: ~40 papers at 13 conference presented over the past 2 years
  - Wind Energy Related Conference Posters: ~7 posters presented at 2 venues
- Awards
  - Nominated for Best Paper award presenting a wind energy related paper at the American Helicopter Society (AHS) Forum 69 (Naughton et al.)
  - 2013 Schroers Award for Outstanding Rotorcraft Research from the San Francisco Bay Area Chapter of the American Helicopter Society (Mavriplis and Sitaraman along with several others)
- New partnerships developed with industry, agencies, or other academic institutions
  - Revitalized interaction with GE
  - Continued discussion for major collaboration with Siemens
  - Developed a partnership with Oklahoma State University for a Track II EPSCoR Proposal (Naughton, Sitaraman, Mavriplis, $6 million)
  - Collaboration with Lawrence Livermore National Laboratory
  - Collaboration with NASA-Ames on Adaptive Health Monitoring of Wind Farms
  - Collaboration with Z4 Energy, Laramie, Wyo.
  - Collaboration with Winhyne Energy Group, Cheyenne, Wyo.
  - Discussions with NCAR about potential wind energy work
- Conferences, workshops, or symposia convened by the Center
  - International Conference on Future Technologies for Wind Energy with Danish Technical University (top two universities in Europe for wind energy research). The conference funded by SER, UW Mechanical Engineering, Danish Agency for Science Technology and Innovation, Technical University of Denmark, UW College of Engineering, Wind-EEE Research Institute (Canada). The conference has attendees from across the United States, Canada, Europe, India, and Asia. Seventy papers will be presented over 2 ½ days
- Publications:
  - Wind Energy Related Journal Articles: 2 articles published, but ~10 in various forms of review.
  - Wind Energy Related Conference Papers: ~ 40 papers at 13 conference presented over the past 2 years
  - Wind Energy Related Conference Posters: ~7 posters presented at 2 venues
- Awards
  - Nominated for Best Paper award presenting a wind energy related paper at the American Helicopter Society (AHS) Forum 69 (Naughton et al.)
  - 2013 Schroers Award for Outstanding Rotorcraft Research from the San Francisco Bay Area Chapter of the American Helicopter Society (Mavriplis and Sitaraman along with several others)

FY2013 Achievements:

The center captured or leveraged these grants with center funds:

- New project with Lawrence Livermore National Lab (Sitaraman, Coupled Mesoscale/Microscale Models). $88,000
- New grant with the Army Research Office (Sitaraman and Mavriplis, Massively Parallel Rotary Wing Computations – helicopter and wind turbine). $4 million
- New project with GE (Dave Walrath, Bend-Twist Coupling).
- Ongoing project with Wyoming Infrastructure Authority (WIA) received additional funding (Naughton, Wind Diversity).

Ten research projects were funded in 2012-13 through a gift from BP.

During the academic year, the center:

- Revitalized its interaction with GE
- Continued discussions for major collaboration with Siemens

Developed a partnership with Oklahoma State University for a Track II EPSCoR proposal, $6 million

Several members of the center have attended conferences and presented papers:

- American Physical Society Division of Fluid Dynamics Meeting
- ASME/AIAA Wind Energy Symposium
- American Helicopter Society Forum 69 (papers were about wind energy); one paper nominated for Best Paper (Naughton)
- North American Wind Energy Academy
- American Control Conference
- ASME Dynamic Systems and Controls Conference
- ASME Conference on Smart Materials, Structures and Intelligent Systems
- AIAA Infotech Conference
- AIAA Applied Aerodynamics Conference

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 enhanced oil recovery 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 enhanced oil recovery 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 FY2013, the commission included the following members:

- Governor Matt Mead, ex officio
- Tom Drean, State Geologist, ex officio
- Bruce Williams, Wyoming Oil and Gas Conservation Commissioner
- Aaron Otteman, Wold Oil Properties
- State Senator Eli Bebout
- John MacPherson, University of Wyoming trustee
- Jimmy Goolsby, Goolsby Finlay and Associations
- Tom Fitzsimmons, Fitzsimmons Energy, LLC

More details about this center can be found in the Enhanced Oil Recovery Institute annual report under separate cover.

Matching Grants Fund

Successful academic research programs require significant external funds in the form of grants and contracts to meet their objectives. This is especially true in the energy arena. External research dollars support undergraduate and graduate students, post-doctoral research staff, purchase of critical equipment, and summer salaries for principal investigators.

The national landscape for research funding is highly competitive. Proposals to national agencies such as the U.S. 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 SER's Matching Grant Fund (MGF) provides significant additional leverage to strong UW proposals, thereby improving the chances of capturing external funding.

Matching grant funds are committed at the time of a UW faculty member's proposal submission to the external agency to improve UW's success rate. A significant lag time exists between a research proposal's submission and when awards are announced by an external granting agency. This creates

uncertainty as to when SER can expect to distribute funds. Often, several vintages of MGF funds are 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 every year since FY2007. From 2007 to 2013, 42 of the 103 proposals that received matching commitments from SER were awarded external grants. Since 2007, $3,455,195 in SER Matching Grant Fund program funds have leveraged $11,549,601 in external funds. For every dollar of research funds committed by SER, between three to four dollars in external funding is captured.

Research Topics:

A stipulation exists in each call for proposals that research must be energy-related. Understandably, the range of research topics has been diverse, such as exploration, production, and improved recovery of oil and gas; aerodynamics of wind turbines; coal conversion technology; energy education and mitigation of environmental impacts.

Outside funding agencies for matching grants are diverse and include:

- U.S. Department of Energy
- American Chemical Society – Petroleum Research Fund
- National Science Foundation
- Idaho National Laboratory
- U.S. Bureau of Land Management
- Center for Revolutionary Solar Photo-Conversion
- Wyoming Wildlife and Natural Resources Trust Fund
- U. S. Environmental Protection Agency (EPA) STAR Program
- Advanced Research Projects Agency-Energy
- Lawrence Livermore National Laboratory
- American Chemical Society Petroleum Research Fund

In the first four years of the program, 33 percent of proposals approved obtained outside funding. In the last three years availability of research dollars, particularly from the federal government, has become limited, reducing the number of proposals that receive outside awards. SER will continue to monitor the program's success and implement revisions to the process as warranted to ensure funds are used to create an advantage for UW faculty.

Uranium Research Fund

In the 2009 General Session, the Wyoming State Legislature appropriated $1.6 million to the University of Wyoming, School of Energy Resources (SER) for activities related to the in-situ recovery of uranium (ISRU) in Wyoming. The legislation specifies these funds revert by June 30, 2013; however, in the 2012 budget session, the legislature extended the funds' reversion date to June 30, 2015 (House Enrolled Act 005) to allow more time to deploy the research funds.

SER used $194,537 of the $1.6 million appropriation toward the following outreach activities:

- September 22, 2009 – Uranium Extraction Workshop, Cheyenne, Wyoming
- 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, Wyoming
- Analysis of Remediation Strategies for Radionuclide-Contaminated Soils in Uranium Mining – a graduate student research project

The remaining funds ($1.4 million) have been dedicated to funding research related to ISRU. Under the direction of the University of Wyoming Energy Resources Council and in consultation with the Wyoming mining industry, SER developed a request for proposals to deploy the remaining $1.4 million for uranium research that focuses on optimizing the economic recovery of the resource.

The first RFP was released in March 2011 focusing on uranium exploration and ore body characterization and recovery; water management, treatment and disposal; cost effective aquifer restoration technologies; and investigation of the impact of existing regulatory requirements on the economics and timing of ISRU projects in Wyoming. Four proposals were awarded funding in the amount of $826,849, leaving $578,614 remaining in the fund.

To deploy the remaining funds, SER released another RFP on June 14, 2012. Three proposals were awarded funding in the amount of $578,557, leaving $57 remaining in the fund. Projects awarded funding will investigate enhanced bioremediation of in-situ uranium aquifers, processes for filtering trace metals from production bleed water, and evaluation of restoration by improving geochemical and toxicological characterization of baseline and post-mining site conditions.

All research projects funded through this program are required to submit a final report and to present results in a public forum.

Shell 3-D Visualization Laboratory

The Shell 3-D Visualization research laboratory located in the Energy Innovation Center opened in May 2013 as the only four-walled CAVE (Cave Automatic Virtual Environment) and 3-D visualization laboratory in Wyoming. The laboratory enables researchers to visualize and interact with highly complex data sets and visualize scenarios to further the research goals of SER and provide a unique resource to SER, the University of Wyoming community and other users. The laboratory connects to the NCAR Wyoming Supercomputing Center (NWSC) and UW's Advanced Research Computing Center (ARCC), which provides supercomputing power for faster processing of complex data and enhanced imaging.

Advanced Conversion Technologies Research Account

Activities of the Advanced Conversion Technologies Research Account are submitted under separate cover to the Joint Minerals, Business and Economic Development Interim Committee. For more information, see the 2013 Report of the Advanced Conversion Technologies Task Force.

Joint U.S.-China Clean Energy Research Center

The School of Energy Resources continues its work with the Advanced Coal Technology Center, which is part of the U.S.- China Clean Energy Research Center (CERC). The Clean Energy Research Center is a joint, 50-50 project of the United States and China. The U.S. membership consists of federal, private, public and other public sectors. The three work areas that have been defined are Building Energy Efficiency, Clean Vehicles, and Advanced Coal Technology. Every component of CERC has a related Chinese component.

For complete information about CERC, please visit:

http://www.us-china-cerc.org.

The United States and China are the top consumers of coal in the world, and Wyoming and China share many attributes –their economies are driven by coal, the precursors to value-added projects. Doing the research jointly leverages the funds we're spending. In addition, it is likely that commercial-scale projects that will be built in Wyoming will benefit from Chinese partnerships, both financial and technical.

The University of Wyoming is a partner in the Advanced Coal Technology Consortium, and provides $2.5 million in matching funds. These are the partners in the consortium:

- West Virginia, University Research Corporation, prime awardee
- Lawrence Livermore National Laboratory
- University of Wyoming
- The Wyoming State Geological Survey
- University of Kentucky
- Los Alamos National Laboratory
- World Resources Institute
- U.S.-China Clean Energy Forum, Washington State China Relations Council
- Indiana Geological Survey
- National Energy Technology Laboratory

Other entities providing money or other resources are:

- Babcock and Wilcox
- Duke Energy
- LP Anima

The U.S. China Clean Energy Research Center - Advanced Coal Technology Consortium advances the coal technology needed to safely, effectively and efficiently use coal resources, including the ability to capture, store, and use emissions from coal use in both member nations.

The Advanced Coal Technology consortium addresses technology and practices for advanced coal utilization and carbon capture, utilization, and storage. Joint research is conducted in the following areas: advanced power generation, clean coal conversion technology, pre-combustion capture, post-combustion capture, oxy-combustion capture, CO_2 sequestration, CO_2 utilization, simulation and assessment, and communication and integration.

The University of Wyoming School of Energy Resources is taking part in two identified work projects.

The first studies near-zero emission power generation technology based on integrated gasification combined cycle (IGCC). The key features of this project are gasification, gas cleanup, and CO_2 separation with many coal types and biomass.

The second is research on sequestration theory and simulation technology of CO_2 geological storage and large-scale storage strategy. The key features of this project are site characterization, modeling, risk assessment, and brine treatment, reservoir characterization and ranking, and monitoring planning and design.

The other joint research projects of this consortium are:

- Large-scale post combustion CO_2 capture, utilization, and storage technology
- Microalgae bio-sequestration of CO_2 from flue gas of power plant
- Theory and equipment development for oxy- fuel combustion
- Combined coal pyrolysis, gasification and combustion multi-generation technology

SECTION 5 – OUTREACH

Energy Outreach supports the mission of the School of Energy Resources to be a global leader in building a secure and sustainable energy future.

Events and Presentations

August 23, 2012
Laramie
The 2012 Clean Coal Technology Research Symposium was held at the UW Conference Center at the Hilton Garden Inn in Laramie. The symposium featured presentations of completed projects funded from 2007-2009 by the Advanced Conversion Technology Task Force (formerly known as the Clean Coal Task Force).

October 1-2, 2012
Teton Village, Wyoming
The Power Generation and the Environment: Choices & Economics Trade-Offs symposium was held in Teton Village, Wyoming. The symposium convened nationally acclaimed academic professionals, research scientists, policy makers, industry stakeholders, and the public to examine from an economic point of view the technological and policy options available to reduce carbon dioxide emissions from traditional power generation. Speakers addressed the challenges industry faces in developing solutions that balances economic feasibility and maximum technical performance. Scholars and industry experts examined the regulatory environment needed to advance fossil fuel combustion and alternative energy technologies. Seventeen papers were presented in five sessions. The event consisted of 17 paper presentations in five sessions. Conference attendance totaled 100 participants from 14 states and the United Kingdom, Denmark, and Italy.

December 13, 2012
Gillette, Wyoming
The "Powder River Basin Coal: Domestic Challenges and International Opportunities" coal industry roundtable event was held at the Gillette College Technical Education Center in Gillette, Wyoming. The event convened industry stakeholders, academic professionals, policy makers, and the public to examine the regulatory constraints and economic challenges facing the U.S. coal industry today. Co-hosted by the University of Wyoming's Center for Energy Economics and Public Policy (CEEPP) and SER, the event consisted of five presentations by academic and industry experts and a panel-led working roundtable discussion. Conference attendance totaled 96 participants primarily from Wyoming. A variety of sectors were represented at the event with the majority of attendees identifying themselves as industry representatives.

January 26, 2013
Gillette, Wyoming
Tim Considine, director of the SER Center for Energy Economics and Public Policy, presented "Environmental Management of Hydraulic Fracturing: A case study of the Marcellus Shale" at UW's Saturday University program.

Invited speakers

September 7, 2012
Distinguished UW Alum in Energy Speaker Series
Harold (Skip) York (BS Economics '85, MS Econ & Finance '86), vice president of Downstream Oil for Wood Mackenzie, presented to 16 MBA students and gave a talk on oil economics to a petroleum engineering class of 30 students.

September 24, 2012
Wil Burns of Johns Hopkins University discussed his research related to the European Union's cap and trade system. Approximately 60 students, faculty, and staff attended.

February 15, 2013
Gerald T. Schuster, professor of geophysics at King Abdullah University of Science and Technology and associate professor of geophysics at the University of Utah, spoke on seismic interferometry and harvesting signal from coherent noise. Craig Douglas, SER professor of mathematics hosted the distinguished speaker. Approximately 30 researchers, academics and students attended.

February 22, 2013
SER supported the Center for Fundamentals of Subsurface Flow in hosting Adolfo Puime Pires from the Universidade Estadual do Norte Fluminense, Macae/RJ-Brazil. Pires spoke on one-dimensional flow of compressible fluids in porous media. Approximately 30 researchers, academics and students attended.

April 19, 2013
Patrick O'Leary, assistant director of Scientific Computing for Kitware, Inc., presented "In Situ Analysis with ParaView Catalyst." Approximately 30 research scientists, students and professors attended.

April 26, 2013
Clayton Barrows (BS EE at UW, '05; PhD Energy & Mineral Engineering at Penn State, '13), postdoctoral researcher and member of the Energy Forecasting and Modeling Group in the Strategic Energy Analysis Center at the National Renewable Energy Laboratory (NREL), presented "Power System Optimization: Getting the Most Out of the Grid." Approximately 55 students, research scientists, faculty, staff and members of the public attended.

Collaborations

September 20-21, 2012
Laramie
SER sponsored the Wyoming Technology Business Center's annual conference, "Developing a Technology Business: Energy." Approximately 160 attended.

September 24, 2012
Laramie
SER sponsored the Rocky Mountain Rendezvous, one of five regional job fairs sponsored by the American Association of Petroleum Geologists and the Society of Exploration Geophysicists and hosted by UW's Department of Geology and Geophysics. The event, held at the UW Conference Center at the Hilton Garden Inn, attracted 350 geoscience students and 25 oil and gas companies.

March 3-5, 2013
Laramie
SER outreach supported the 2013 Wyoming State Science Fair at the University of Wyoming, coordinated by the Science and Math Teaching Center. 343 students attended from 16 public high schools, one private high school, 25 public middle and elementary schools, and nine private middle and elementary schools. SER Deputy Director of Research Diana Hulme introduced the event.

May 23-24, 2013
Four Saudi Aramco representatives visited UW and the School of Energy Resources. These guests and members of the Wyoming Governor's Energy, Engineering, and STEM Integration Task Force met for a day of meetings and laboratory tours in the College of Engineering and Applied Sciences and the Energy Innovation Center. Discussions of partnership opportunities in areas of petroleum engineering and geoscience, with specific research interests in porous flow media and student/faculty exchanges, continue.

Publications and Website
SER General Brochure was updated December.

A guide to the Energy Innovation Center was created in February.

The SER website is undergoing revisions to update content and provide information in a clear and easy to understand form.

A new monthly SER E-Newsletter began distribution in May.

SECTION 6 – STRATEGIC AREAS OF CONCENTRATION

The School of Energy Resources has been fortunate to secure support for a plan that sets priorities for accomplishment by energy programs at UW.

The plan continues to focus on three key areas:

- Exploring unconventional reservoirs that contain fossil energy resources that do not flow at economic rates or produce economic volumes of oil and natural gas without stimulation or other enhanced recovery processes
- Climbing the value chain by creating essential consumer products, such as liquid fuels and petrochemicals through conversion and other manufacturing activities that add value to and create new markets for energy resources that are now sold as commodities
- Developing wind and solar energy technologies that improve efficiency, mitigate the impacts of variable supply, and convert output to higher-value products

By the end of the second year of the five-year plan, $10.9 million in new commitments for private funding from six oil and gas companies had been secured against the $15 million in state matching funds. All of the external fundraising to date is directed toward the unconventional reservoirs area of concentration.

Discussions with private sector partners are maturing. Long-term collaborative research proposals are being finalized with two companies. UW faculty members are delivering short courses at industrial work sites. We have also significantly increased the internships with and recruiting by our private-sector partners. Additionally, the first modern data sets have been committed, and research projects are in early stages.

On the faculty front, we have one new hire, four searches in progress, and one is pending.

Progress has also been made in research and teaching assets. Phases II and III of the Hess Digital Rock Physics Lab are fully funded and are under development in the EIC. Level I design for the Energy Engineering High-bay Research Facility has begun in conjunction with the overall Engineering Complex redesign project.

SER's investment in strategic areas of concentration and the initiative to build a Tier 1 engineering program at UW are intimately linked. The High-bay Research Facility will contribute by housing the Center of Innovation for Flow in Porous Media (COIFPM), one of the College of Engineering and Applied Science niche areas that will grow from the Digital Rock Physics Lab. Several of the faculty being sought in the searches referenced above will join the engineering faculty as well as contribute to the development of unconventional reservoirs and climbing the value chain area of concentration. The director of SER is working closely with the interim dean of the College of Engineering and Applied Science to ensure this investment provides the maximum benefit to both initiatives.

SECTION 7 – ENERGY INNOVATION CENTER

The Energy Innovation Center (EIC) is a state-of-the-art research collaboration facility funded through more than $25 million in private donations and matching state funds. The center offers nearly 27,300 net square feet of highly technical research space, offices, classrooms and meeting rooms. Staff and faculty started moving into the EIC during December 2012, and completion work continued into 2013, including the installation of specialized scientific equipment.

These labs and facilities housed in the Energy Innovation Center:

Peabody Energy Advanced Coal Technology Laboratory

This lab is devoted to analyzing and researching coal conversion technologies. The conversion of low-value fossil resources into higher-value products – advanced conversion – is a key component of the School of Energy Resources strategic plan. The lab supports research in the conversion of natural gas and coal in manufactured products and liquid fuels.

Shell 3-D Visualization Research Laboratory

This is the first four-walled 3-D visualization laboratory in Wyoming. It complements the primary function of the center by enabling scientists and engineers to visualize and interact with highly complex data sets. This visual information technology combines high-resolution stereoscopic projections and 3-D computer graphics to create virtual environment where researchers can analyze, interpret and share a wide variety of spatially related data.

WPX Drilling Simulator

This teaching laboratory gives students and educators a fully interactive simulation experience of drilling rigs. They can explore, test, and interact with an extensive array of drilling components. The lab is used for petroleum engineering and geoscience courses and provides students and industry personnel the opportunity to obtain professional certificates.

Hess Digital Rock Physics Laboratory

This facility houses the Hess Nano-imaging Research Laboratory, the world's most modern lab for experimental investigation of multi-phase fluid flow through porous media. It encompasses the most advanced high-resolution 3-D X-ray microscope available. The custom-designed equipment enables researchers to obtain ultra-high resolution nano-images of porous media. The 3-D maps generated from that information can be used to more accurately characterize and model flow and fluid occupancy in reservoir rocks. This is the central research laboratory for the Center for the Fundamentals of Subsurface Flow.

The experimental research and complex data generated in this laboratory can be viewed and analyzed in the Shell 3-D Visualization Laboratory using the computational abilities of UW's Advanced Research Computing Center as well as the NCAR-Wyoming Supercomputing Center.

Enhanced Oil Recovery Research Laboratory

Research in this lab will help producers recover more resources from Wyoming fields, particularly mature fields, where more than half of the state's oil reserves remain stranded. A suite of state-of-the-art high-pressure, high-temperature equipment, such as phase behavior apparatus and gas chromatographs, which allow researchers to test and observe the feasibility and stability of various enhanced oil recovery methods with reservoir rocks and fluids.

The work planned for the laboratories and the simulator is being supported by other spaces throughout the Energy Innovation Center.

The **Cordillera Energy Partners Reception Area** serves as a sitting room, study area and gathering space for visitors, students and in-house professionals.

The **BP Collaboration Center**, which offers reconfigurable space that provides real-time research and knowledge exchange capabilities to connect UW researchers, academics and industry stakeholders to associates anywhere in the world.

The **Ultra Petroleum Corporation Student Area** offers students a space to study and interact within the EIC.

The **Encana Auditorium** can be lined in real time to all the EIC's technical laboratories so students can participate in research efforts conducted in areas of the EIC that are restricted. With its wide range of audio-visual equipment, the auditorium offers the ability to show images generated in the adjacent Shell 3-D Visualization lab.

The **Reservoir Characterization Suite** contains both the Marathon Oil Research Offices and the ConocoPhillips Collaboration Room. The offices give visiting professionals and researchers facilities for short-term and long-term stays, allowing them to work with UW faculty, students and other professionals.

The **Questar Conference Room** offers a conference and teleconferencing capabilities.