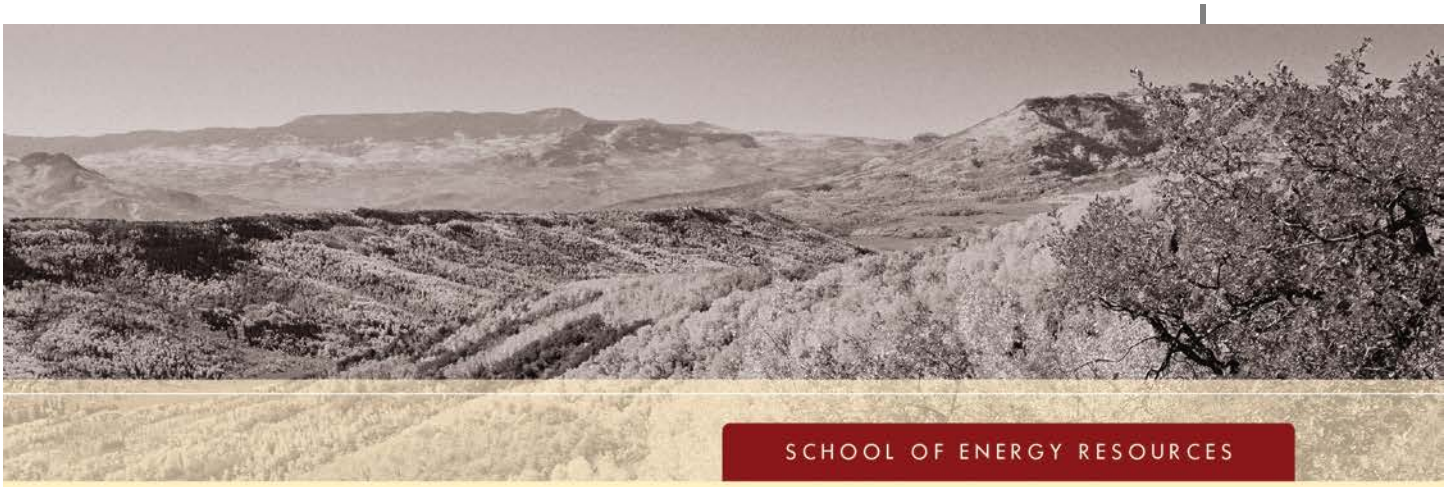

SCHOOL OF ENERGY RESOURCES

2012 Annual Report: The University of Wyoming School of Energy Resources

UNIVERSITY OF WYOMING

2012 ANNUAL REPORT OF THE UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES

1 October 2012

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

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Executive summary

The sixth year of the University of Wyoming, School of Energy Resources represented a new direction, defined by the strategic areas of concentration that were developed, approved and funded during the year. The result is investment in and the evolution of energy programs at the University of Wyoming.

The School of Energy Resources (SER) stepped up its international profile, co-sponsoring the International Advanced Coal Technologies Conference in Xian, Shaanxi Province, China, and hosting the international Secondary Biogenic Coal Bed Natural Gas International Conference in Laramie.

2011 was also a year of catching up and cleaning up in terms of spending, both in the amounts and sources of funds. The appropriation for the 2011-2012 biennium was $17.4 million; the Wyoming State Legislature approved a $2 million carryover from the previous biennium, so the total budget for the biennium was $19.4 million. In addition, SER had $4.6 million carried over from previous years. Total funding at the beginning of the year was $24 million. The biggest variance from the proposed budget was $5.3 million spent in the last quarter of FY12 for 12 pieces of major equipment for energy and materials science related to energy programs.

During the year, SER Academic Programs continued its work in academics and outreach to Wyoming K-12 students. The Energy Resource Management and Development undergraduate degree was put in place with four concentrations in fossil fuels, renewable energy, energy land and water management, and petroleum land management. Enrollment stands at 54 students. The Master of Business Administration in Energy was developed with the UW College of Business, creating a unique MBA focusing on energy management.

SER Research Programs continued to shift emphasis away from individual research projects to multidisciplinary research programs in the Centers of Excellence; eight centers are active. Several centers have captured outside awards in excess of $1 million.

SER Outreach Programs continued to deliver symposia, conferences and workshops of particular interest to Wyoming.

New funding ($10 million in Abandoned Mine Land funds for talent and research, and $15 million in AML matching funds for facilities and equipment) was received during the year to invest in SER's three areas of strategic concentration:

- Unconventional Reservoirs
- Climbing the Value Chain
- Renewables

Private sector partnerships continue to be important to SER's success. Four companies made significant new contributions; other companies are currently reviewing proposals.

The Energy Innovation Center is in the final stages of construction, with move-in expected by the end of November 2012 and a ribbon-cutting ceremony in January 2013.

SECTION 1 – Introduction

The University of Wyoming Energy Resources Council (ERC) was established by statute (W.S. 21-17-117 (e)) to provide direction to the School of Energy Resources regarding identifying and prioritizing issues that should be targeted for research and outreach. The ERC consists of 11 members, including:

- UW president and director of Ruckelshaus Institute (ex officio);
- One member each of the Wyoming Senate (appointed by the President of the Senate) and the House (appointed by the Speaker of the House);
- Seven members representing diverse components of Wyoming's energy industries appointed by the Governor at the consent of the Senate; these members serve three-year terms.
- During 2011, the ERC invited a member of the UW Board of Trustees to join the ERC as ex officio. This trustee appointment is at the invitation of the ERC and allows for greater communication between the two boards.

Administration and Organization

- The council self-selects a 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.

The members of the UW Energy Resources Council are:

Ron Harper – Council chairman
Retired CEO and general manager
Basin Electric and Basin Cooperative Services

Tom Lockhart – Council vice chairman
Wyoming State Representative
Chairman, House Minerals, Business and Economic Development Committee

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

James L. Bowzer
President, CEO and Director
Baytex Energy Corp.

Jeane Hull
Executive Vice President Technical Services
Peabody Energy

Kit Jennings
Wyoming State Senator

Paul Lang
Executive Vice President
Arch Coal, Inc.

Rob Wallace
Managing Partner
Rob Wallace Group

Martha B. Wyrsch
President
Vestas-American Wind Technology, Inc.

Thomas Buchanan – ex officio
President, University of Wyoming

David F. "Dave" Palmerlee – ex officio
University of Wyoming Board of Trustees

Indy Burke – ex officio
Wyoming Excellence Chair, UW professor and director
Haub School and Ruckleshaus Institute of Environment and Natural Resources

The Energy Resources Council met:

July 28, 2011
Special meeting
Teleconference

August 26, 2011
UW Conference Center at the Hilton Garden Inn
Laramie

November 18, 2011
UW Conference Center at the Hilton Garden Inn
Laramie

March 10, 2012
UW College of Business
Laramie

May 18, 2012
UW Conference Center at the Hilton Garden Inn
Laramie

SECTION 2 – Financial Summary

In the 2010 budget session, the Wyoming State Legislature provided funding for SER over the 2011-12 biennium in two parts. First, the legislature appropriated $17.4 million derived from the Abandoned Mine Land Fund and second, the legislature approved the carryover of up to $2 million from the 2008 budget session appropriation, for a total budget of $19.4 million. In addition, the carryover budget of the 2009-10 biennium appropriation was $4,479,759, resulting in a combined available budget of $24,023,567 to operate SER for the 2011-12 biennium. Total expenditures at the end of the biennium were $23,872,788 with a reversion of $150,779.

Table II-I.

Comparison of Original FY11 and FY12 SER Operational Budget to Actual Expenditures

	Fiscal Year 2011		Fiscal Year 2012			Total Expeditures
	Original Budget	Actual Expenditures	Original Budget	Revised Budget	Actual Expenditures	FY 11 & FY 12
Academics	$ 4,144,730	$ 3,178,287	$ 4,144,730	$ 4,005,723	$ 4,005,723	$ 7,184,010
Research	$ 3,742,719	$ 950,266	$ 3,742,719	$ 7,351,588	$ 7,351,588	$ 8,301,854
Outreach	$ 905,679	$ 682,611	$ 905,679	$ 811,099	$ 811,099	$ 1,493,710
Administration	$ 628,201	$ 533,682	$ 628,201	$ 1,879,774	$ 1,879,774	$ 2,413,456
Unallocated Funds				$ 9,329		
Total:	**$ 9,421,329**	**$ 5,344,846**	**$ 9,421,329**	**$ 14,057,513**	**$ 14,048,184**	**$ 19,393,030**
Unallocated Funds FY11:		$ 4,076,483				

Expenditures in the first year of the budget cycle are typically lower. When outside funding does not materialize or schedules are not met, funds must be rapidly repurposed; that often shifts the spending into the second year. The biggest variance from the proposed budget is $5.3 million, spent in the last quarter of FY12 to buy 12 pieces of major scientific equipment to upgrade UW's capabilities in energy and materials science.

Expenditures for the 2012 fiscal year, which covers the period of this report, totaled $16,865,200. Of that total, SER spent:

- $3.5 million for salaries and benefits for SER staff and faculty
- $679,000 for start-up commitments made to SER faculty
- $2.7 million in support to the Centers of Excellence
- $170,000 for the Matching Grants Fund
- $436,000 for Outreach events
- $1.24 million to the EIC
- $5.2 million repurposed for major scientific equipment to upgrade UW's capabilities in energy and materials sciences
- $2.9 million for remaining expenses that include graduate assistantships, recruiting, travel, publications, Energy Summer Institute, office support, etc.

Table II - II. School of Energy Resources 2011-2012 Expenditures

Academics	Fiscal Year 2011	Fiscal Year 2012	Total FY11/12
Salary/Fringe	$ 1,879,385	$ 1,946,669	$ 3,826,054
Startup	$ 609,650	$ 678,844	$ 1,288,494
Other support & Programs	$ 1,306,791	$ 1,380,139	$ 2,686,930
Subtotal Academics	$ 3,795,826	$ 4,005,652	$ 7,801,478
Research			
Salary/Fringe	$ 758,945	$ 756,207	$ 1,515,151
Matching Grant Funds	$ 85,000	$ 170,547	$ 255,547
Center Support	$ 1,130,244	$ 2,761,894	$ 3,892,138
Other support & Programs	$ 30,609	$ 6,480,026	$ 6,510,635
Subtotal Research	$ 2,004,798	$ 10,168,674	$ 12,173,472
Outreach			
Salary/Fringe	$ 314,529	$ 252,676	$ 567,206
Sponsorships	$ 51,779	$ 35,008	$ 86,786
Publications & Materials	$ 207,113	$ 122,483	$ 329,596
Distinguished Speakers	$ 2,383	$ -	$ 2,383
Workshops	$ 56,142	$ 272,545	$ 328,687
Other support & Programs	$ 50,665	$ 128,387	$ 179,052
Subtotal Outreach	$ 682,611	$ 811,099	$ 1,493,710
Administration			
Salary/Fringe	$ 431,436	$ 542,701	$ 974,137
Other support & Programs	$ 102,246	$ 1,337,073	$ 1,439,320
Subtotal Administration	$ 533,682	$ 1,879,774	$ 2,413,456
Total Expenditures for Fiscal Year	$ 7,016,917	$ 16,865,200	$ 23,882,117

SECTION 3 – Academic Programs

Overview

The 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 content knowledge and behaviors that allow adaptation to new areas of proficiency, rapidly changing technologies, and competencies. All SER academic initiatives are guided by 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 section summarizes 2012 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 from kindergarten through high school. 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 2011-2012 included:

- **Summer Energy Institute** – In conjunction with the UW Science Posse (see www.scienceposse.org), 19 high school sophomores and juniors attended the sixth annual Energy Summer Institute held June 17-22, 2012 at UW.
- **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.
- **Simulation development** – A 10th-12th grade focused computer simulation "game" was developed to deliver a virtual experience to understand and learn about interdisciplinary processes related to fluid flow in reservoirs.
- **Energy clubs** – SER is cooperating with the Gillette school system and a community coordinating committee to establish energy clubs in the middle and high schools.
- **Energy academies** – The Rock Springs school district has an established energy academy that SER is assisting through preparation and delivery of activities and coordinating UW field trips.

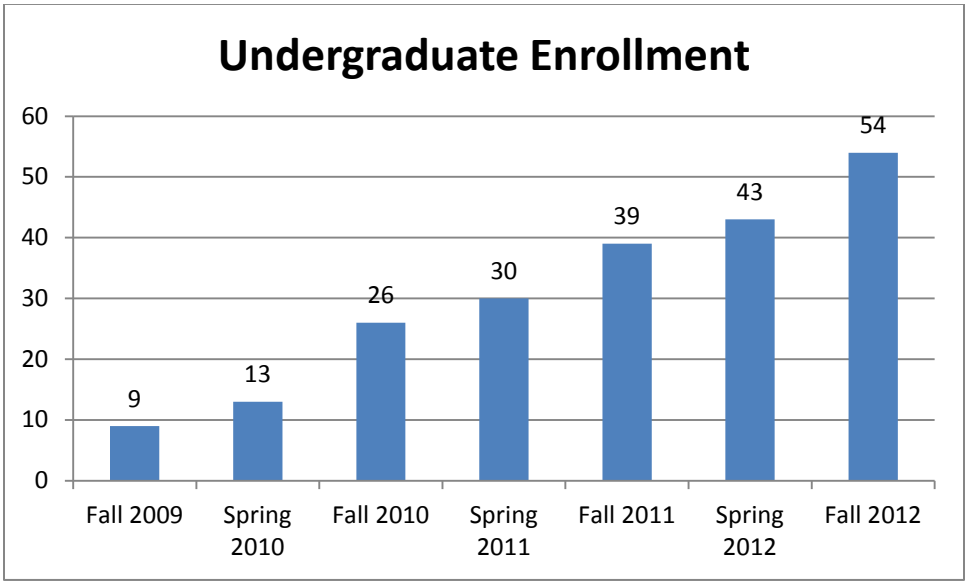
- **Involvement of graduate students in the 7th-12th grade classrooms**. Graduate students in energy fields (including those supported by SER) discuss, explain and showcase their research to teachers and students.

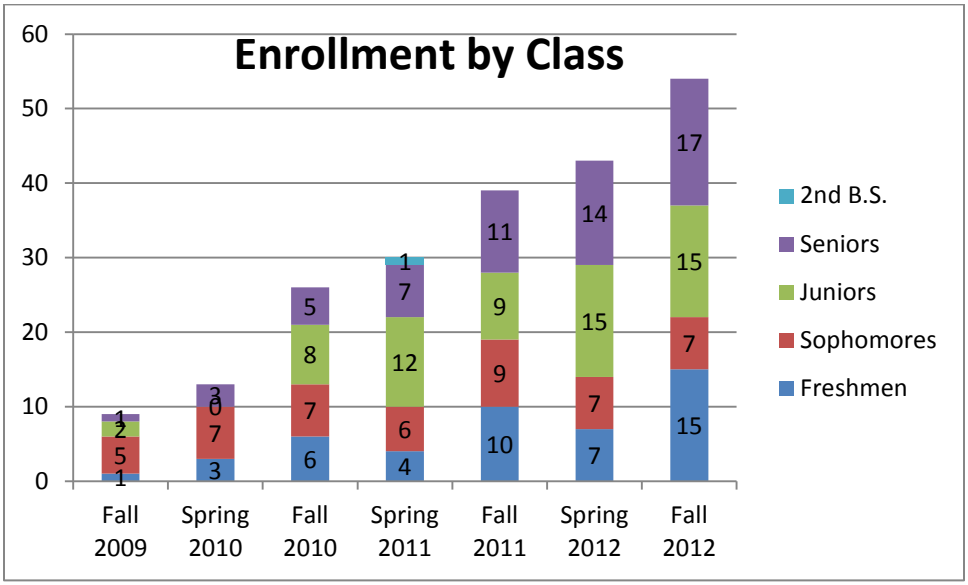
Undergraduate Education

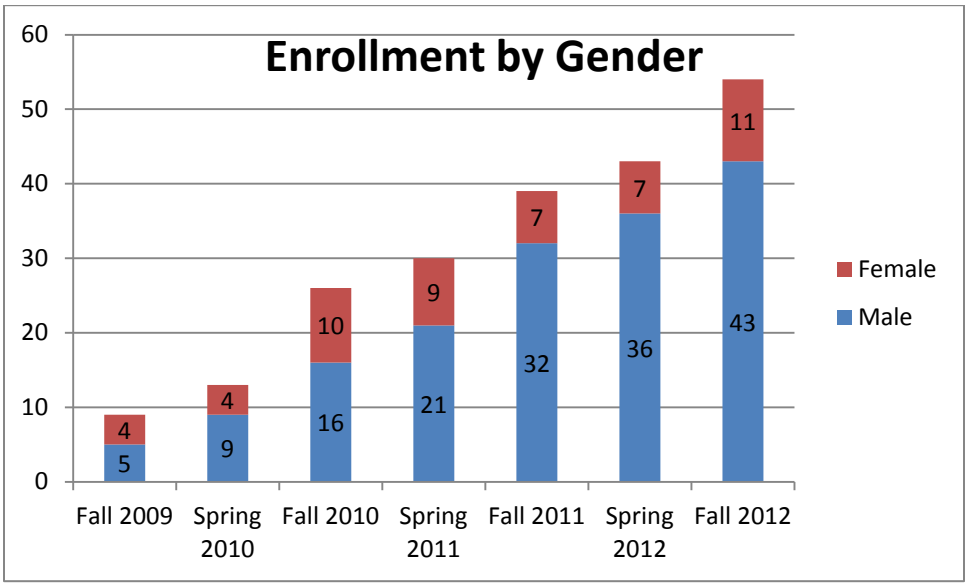
The Energy Resource Science degree program was substantially modified and renamed as Energy Resource Management and Development (ERMD), an interdisciplinary energy bachelor of science degree (B.S.) program that integrates training in engineering, geology, policy, economics, business, law, and natural resources content. The degree is workforce directed that connects energy sector solutions-based problem solving experiences with classroom learning.

- The program has three concentrations: Fossil Fuels, Renewable Energy and Energy Land and Water Management.
- A fourth concentration in Petroleum Land Management is undergoing accreditation by the American Association of Professional Landmen (AAPL) and is targeted for final certification in 2013.

Enrollment in the program since it started in 2009 has increased substantially, an indication of student demand (see below). We have placed all three graduates to date. The first two students graduated in Fall 2011 and a third student is scheduled to graduate in Summer 2012. The Fall 2011 graduates are pursuing their education in water quality and petroleum engineering. The Summer 2012 graduate is working for PacifiCorp as an associate wind operations supervisor.







Internship and research experiences Students are strongly encouraged to complete internships and undergraduate research projects. Below are academic year 2012 placements.

- 3 students with Intertech Environmental and Engineering LLC – Reclamation, Restoration and Plant Identification
- 2 students with Encana Natural Gas – Environmental Health and Safety
- 2 students with Enhanced Oil Recovery Institute – Reservoir Modeling and Geographic Information Systems
- 1 student with Dr. Carrick Eggleston, Department of Geology and Geophysics – Solar Cell Development
- 1 student with Dr. Jay Sitaraman, Department of Mechanical Engineering – Wind Turbine Blade Modeling

- 1 student with Anadarko Petroleum – Reclamation, Restoration and Plant Identification
- 1 student with Halliburton – Hydraulic Fracturing Crew
- 1 student with KC Harvey – Reclamation, Restoration and Plant Identification
- 1 student with QEP – Permitting and Reservoir Modeling

Energy Resource Club A formally recognized UW club focused on energy is supervised and funded by SER. Approximately 15 students were involved in AY2012. Activities included student presentations from internship experiences, an Energy Brown Bag Lunch Series, and a film festival on energy topics.

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

- The Anadarko Fellowships supported the research experiences of one undergraduate in civil engineering and two graduate fellowships in petroleum engineering and economics. The Junior Faculty fellowships were awarded to Dr. Vladimir Alvarado and Dr. Jonathan Brant.
- Six Nielson Fellowships were awarded to students in Mechanical Engineering and Energy Systems Engineering, Energy Resource Science, Geology (2), and Chemistry (2).

International programs

- Three SER students traveled to Xian, China to attend the International Advanced Coal Technologies Conference. They attended the conference presentations by invited speakers from China, the United States, and Australia, and toured coal-to-liquids facilities.
- As a result of agreements between UW and China (Northwest University and China University of Petroleum) 4 visiting scholars and 1 MS student are working on energy research projects with SER faculty at UW.
- Agreements to establish a 2+2 B.S. degree program between UW and China University of Petroleum and Northwest University, Xian, China were approved. The program allows students to attend the first two years at their home university and the following two years at the reciprocal institution.

Community college interactions Discussions with Wyoming community colleges established a foundation to develop an associate's degree in Energy Resource Management & Development and to enhance the pipeline from 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 2012 academic year to faculty in the departments of Chemistry (3), Geology and Geophysics (1), Mathematics (1), Physics and Astronomy (2), Chemical and Petroleum Engineering (2) and Computer Science (1). Since 2007, 92 graduate assistantships have been awarded.

Master of Business Administration 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).

Energy Law, Regulation and Policy Initiative the formation of a partnership between SER, the College of Law and the College of Business has been framed to promote Energy law, regulation and policy.

SER Faculty Performance Eleven SER faculty and five adjunct SER faculty published more than 50 research articles in nationally referred 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 news releases.

SECTION 4 – Research

Centers of Excellence

The Centers of Excellence are established with seed funding from the School of Energy Resources budget. 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 FY2012.

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

Center Mission:

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

FY2012 Achievements:

- On June 20-21, 2012 in Laramie, the center held an international conference on secondary biogenic natural gas. Details can be found in the Outreach section of this report. Attendees expressed a great deal of interest in convening future conferences, which may serve as a source of center revenue.

- In this fiscal year, the CBNG received a two-year grant from the Wyoming Department of Environmental Quality of $74,038 for a laboratory study to evaluate the energy value of coal following microbial conversion.

- CBNG members recently formed EnWyo, Inc., a UW technology spin-off company, which is the sole licensee of several technology patents developed through the center. Its focus is commercialization of these technologies. The latest is a provisional patent application number 61/470,351, regarding biomass-enhanced natural gas from coal formations.

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.

FY2012 Achievements:

- The center is collaborating on a major multi-institution proposal to the National Science Foundation titled, *The Sustainability of Nano-enabled Products.* The group includes researchers from the University of Illinois, Arizona State, Duke, M.I.T., Lafayette College, the Pacific Institute, North Carolina A&T, Resources for the Future, and Decision Process Inc. The proposal requests $17 million in funding, and if awarded the center will receive $600,000 over five years. The center will analyze the material and energy supply chain

economics of three nano-enabled products: carbon nano-tubes, titanium dioxides, and light emitting diodes. A funding decision will be announced in August 2012.

- The CEEPP funded the following three research projects awarded to UW faculty:
    - Economics of Natural Gas Transmission Networks
    - Economics of Carbon Sequestration
    - Optimal Economic Integration of Wind Power in Electricity Transmission Networks
- The CEEPP has been developing partnerships with these industry, agencies, or other academic institutions:
    - Manhattan Institute – in discussions to conduct an analysis of shale gas reserves.
    - American Enterprise Institute – discussing follow-up research to the economic, environmental, and fiscal impacts of renewable and fossil fuel energy development.
    - Lower Valley Energy and Jackson Hole Energy Sustainability Project – reinvigorated a lagging research effort that led to an invitation to submit a follow-up research proposal.
    - Marcellus Shale Coalition – continuing work.

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.

FY2012 Achievements:

- The CFSF submitted several proposals to fund further research relevant to carbon sequestration, gas shale formations and unconventional reservoirs, and hydrogeological modeling. Specifically, CFSF researchers submitted grant proposals to the following:
    - U.S. Department of Energy (DOE) for research on the geomechanics of geologic sequestration of CO_2. The amount requested from DOE is $2,936,871, and if approved, the project will begin in September 2012.
    - Research Partnership to Secure Energy for America (RPSEA) for an investigation of fundamental matrix/fracture interactions in gas shale formations. The amount requested from RPSEA is $3,976,367. If funded, the project will begin in October 2012.
    - U.S. DOE, National Science Foundation (NSF), and the Institute of Geophysics and Planetary Physics (IGPP) for uncertainty analysis regarding geological carbon sequestration. The funding requested is $179,795, $380,047, and $151,324, respectively. The proposal has been identified to receive matching grant funds from SER and is currently under review to obtain outside funding.
    - U.S. DOE for research on reducing conceptual model uncertainty in basin-scale hydrogeological modeling of heterogeneous aquifers. The funding requested from DOE is $539,000. The proposal is under review.
- The CFSF issued a request for proposals (RFP) on April 1, 2010 for geologic sequestration of greenhouse gases and recovery of unconventional gas. The CFSF reviewed projects awarded

funds under this RFP after one year and gave six projects a favorable review for continuing their work. They are:

- *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*

- CFSF Professors Drs. Ginting, Pereira, and Piri formed an international partnership with Dr. Leonardo Guimaraes, a professor at the Federal University of Pernambuco in Brazil. Guimaraes was able to contribute nearly $5 million in matching funds for a project currently under review under the 2012 Advanced Conversion Technologies Research Program RFP.
- The CFSF held a three-day workshop May 8-10, 2012 in Laramie, Wyoming focused on recovery of natural gas from unconventional reservoirs and sequestration of green house and associated impurities in geologic formations. More details about this workshop can be found in the Outreach section of this report.

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.

FY2012 Achievements:

- The Wyoming Carbon Underground Storage Project (WY-CUSP) researchers continue work analyzing and interpreting 3-D seismic data to provide a more detailed understanding of the sub-surface at the Rock Springs Uplift.
- WY-CUSP researchers continue fluid analyses including rock/chemical reactions.
- Two CMI researchers presented at the Clean Energy Research Center (CERC) conference in Beijing, China
- CMI researchers continue to collaborate with researchers from Northwest University, Xian, China
- Plans have been finalized for three Chinese students to come to Wyoming to work on project data, and preparations are being made for two Chinese delegations to visit Wyoming.

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.

FY2012 Achievements:

- CPAC researchers have obtained several grants in the past year (notably from the National Science Foundation), and have ongoing projects funded by major grants from DOE and NASA. The CPAC's total grant portfolio is nearly $3.5 million over three years.
- The center released two RFPs, and funded five seed grant proposals along with two undergraduate research projects during the 2011-2012 academic year.
- The CPAC signed a cooperative agreement with the Helmholtz Centrum (HZB) in Berlin, Germany's largest energy-related national laboratory. The agreement allows for exchange of one scientist between the HZB and the University of Wyoming.
- The CPAC is currently working on an agreement to collaborate with the Center for Revolutionary Solar Photoconversion in Colorado.
- The CPAC hosted a visiting lecture series by Professor Frank Willig from Germany's Fritz-Haber Institute of the Max-Planck Society.

Wyoming Reclamation and Restoration Center – Dr. Pete Stahl, director and Dr. Mark Balas, 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.

FY2012 Achievements:

- Outreach efforts of WRRC include a series of *Best Management Practices Bulletins* provided to the reclamation industry in Wyoming.
- Summer Laboratory and Field Work, 2011 – 18 projects including soil amendments, sage grouse habitat restoration, weed control, reclamation database construction and native seed production; many undergraduate and graduate students involved in internships
- Established reclamation demonstration plots at Vet Lab in Laramie and at Wyarno, seeded plots at the Vet Lab
- Summer Laboratory and Field work, 2012 – 20 projects; many undergraduate and graduate students involved in internships
- Seven students graduated with minors in reclamation science. Three graduate students graduated with certificates in reclamation science.
- Team of the Year Award, by the Wyoming Game and Fish Department for contributing to the Interagency Sage Grouse Core Area Strategy Implementation Team

- Initiated participation in Cameco Resources In-situ Uranium Mining aquifer restoration
- WRRC presentations and addresses during the year included:
    - Annual Wyoming Weed Management Association meeting
    - Wyoming Crop Improvement Association meeting to talk about native seed production
    - Presented Reclamation 101 Workshop in Vernal, Utah,
    - High Altitude Revegetation Conference, invited to join Organizing Committee
    - Native Seed Issues workshop for the Natrona County Extension Office
    - Two-day Southwest Regional Reclamation School in Rock Springs, filed and classroom work requiring the development of a reclamation plan by participants
    - Two-day Northwest Regional Reclamation School in Ucross
    - Organized Constraints to Successful Reclamation Round Table discussion

- Awarded grant by the BLM to inventory soil biotic crusts in undisturbed and disturbed sites in Wyoming
- WRRC funding by energy companies and State Match program initiated
- Published Reclamation Extension Bulletin #B-1231 *Reclamation on Salt and Sodium Affected Soil*

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.

FY2012 Achievements:

- Ongoing projects supported by a gift from BP continue to provide WERC faculty with the background and preliminary data needed to write competitive proposals. Projects currently funded by the WERC BP Gift Fund include:
    - Adaptive Control of Large Wind Turbines in Region 2 & 3 and Transitional Operation
    - Fatigue Model Development for Wind Turbine Composites
    - Unified URANS-LES Simulation of Wind Farm Flow Fields and Wind Turbine Loads
    - Winds and Turbulence at WERC Site
    - Swirling Wakes
    - Characterization and Control of Two-Dimensional Flat-Back Wind Turbine Blade Flows
    - Flow Physics of Two-Dimensional Wind Turbine Blades
    - Turbine Wind Inflow Modeling
    - Advanced Control Theory for Improved Pitch Control of Wind Turbines
    - Fine-Scale Wyoming Wind Resource Assessment and Forecasting
    - Wind-Load Response of Small Wind Turbine Towers
    - Intrinsic Distributed Strain Sensing for CFRP Wind-Turbine Rotor Blades

  - Adaptive/Distributed Control and Systems Health Management for Large Scale Wind Turbine Condition Monitoring and Efficiency Enhancement
  - Development and Application of Aerodynamic Prediction Tools for Wind Turbine Micro-siting
  - Bend-Twist Coupling for Aeroelastic Blade Design

- The center also obtained funding from external sources. External funders include the DOE, Lawrence Livermore National Laboratory, Walter Scott Foundation, and Wyoming Infrastructure Authority. Projects receiving external funding include:
  - Investigation of Dynamic Aerodynamics and Control of Wind Turbine Sections under Relevant Inflow/Blade Attitude Conditions
  - Fellowships for Students Pursuing Interdisciplinary MS with a Focus on Wind Energy
  - Bend/Twist Coupled Blades for Small Wind Turbine Applications
  - Multi-Scale Modeling of Wind Farms
  - Installation of a Meteorological Tower at the WERC field site
  - Wind Diversity

- The WERC has pursued partnerships with major wind energy companies in addition to submitting several proposals to federal agencies. WERC research has appeared in seven conference papers (two invited), one abstract and presentation, and one poster. Many are being rewritten for submission to archival journals.
- WERC participated in the DOE Complex Flow Workshop and the IEC Wakebench workshop, which recruit participation at the national and international level, respectively.
- Two WERC members serve on wind-related technical committees, and WERC is working with other institutions, such as Montana State University, to establish strong educational programs in wind.

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 FY2012, the commission included the following members:

- Governor Matt Mead, ex officio
- Tom Drean, State Geologist, ex officio
- Peter Wold, President, Wold Oil Properties
- State Senator Eli Bebout
- Bruce Williams, WY Oil and Gas Conservation Commissioner
- Betty Fear, University of Wyoming Trustee
- Bern Hinckley, Geologist, Hinckley Consulting
- Tom Fitzsimmons, Legacy Reserves Operating, 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 salary 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 Matching Grant Fund (MGF) provides significant additional leverage to strong UW proposals, thereby improving the chances of capturing external funding.

SER's sixth call for proposals for the FY2012 Matching Grant Fund was issued on February 1, 2012. Fourteen proposals were received and five were approved for funding commitments of $359,968.

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. For projects that have been funded since the start of the program, please visit our webpage at www.uwyo.edu/ser. From 2007 to 2011, 39 of the 98 proposals that received matching commitments from SER were awarded external grants. Since 2007, $3,276,346 in funds from the SER Matching Grant Fund program has leveraged $11,204,607 in external funds. For every dollar of research funds committed by SER, almost 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; and energy education.

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

In the first four years of program, 33 percent of proposals approved obtained outside funding. In the last two years, research fund availability 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 requires these funds to 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. Five 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. The deadline for proposal submission is August 13, 2012. Funding decisions for these awards are expected to be made by November 30, 2012.

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

Advanced Conversion Technologies Research Account (formerly the Clean Coal Research Account)

As of July 1, 2012, the Clean Coal Task Force and the Clean Coal Technology Research Account were renamed the Advanced Conversion Technologies Task Force and the Advanced Conversion Technologies Research Account, respectively, in accordance with original Senate File 15/Senate Enrolled Act 3 enacted by the Sixty-first Legislature of the State of Wyoming in the 2012 budget session.

The task force's composition will remain the same, consisting of the voting members of the University of Wyoming Energy Resources Council. The name change allows the task force's scope to be broadened from coal conversion to conversion of other mineral feedstocks to value-added fuels and products.

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 2012 Report of the Advanced Conversion Technologies Task Force.

Minerals to Value-added Products Feasibility Study

During the 2012 budget session, $500,000 was appropriated to the School of Energy Resources for providing grants to conduct one or more studies to determine the feasibility of constructing a commercial-scale minerals to value-added products facility in Wyoming. The study shall determine the economic viability of a commercial-scale minerals to value-added products facility, potential obstacles to the construction of such a facility, availability of infrastructure and resources and possible state incentives.

A request for proposals was issued by the School of Energy Resources on behalf of the Advanced Conversion Technologies Task Force on April 20, 2012 and 14 proposals were received by the May 25, 2012 deadline. On June 18, 2012, the task force convened a special meeting to recommend awards to the Joint Minerals, Business and Economic Development Committee. The following two proposals were selected:

1. Western Research Institute, Dr. Vijay Sethi, Principle Investigator, "Distributed Production of Fuels and Chemicals from Stranded Natural Gas," $162,000.
2. ARCTECH Inc., Dr. Daman Walia, Principle Investigator, "Techno Economic Analysis of MicGAS™ Coal Biorefinery Plants Deployment in Wyoming for Moving Wyoming Coal Up the Value Chain," $329,243.

Final reports of the feasibility studies are due to the Joint Minerals, Business and Economic Development Committee on or before September 1, 2012.

One-time Major Equipment Purchases for UW Faculty

On March 27, 2012, SER released a request for proposals for one-time major equipment purchases to conduct energy-related research at the University of Wyoming. Funding derived from the SER general budget funded by a regular appropriation from the Wyoming legislature. Only proposals requesting a minimum of $100,000 were considered, and funds were not to be used for computational equipment, software, laboratory construction or renovation costs, laboratory or field supplies, vehicles, extended warranties, or repairs or maintenance of existing equipment. Proposals were selected for funding based on the relevance of the equipment to energy research and the number of users and collaborators across the university that would benefit from the equipment. SER received 26 proposals, and eight received funding in the amount of $2,848,470.

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 utilize 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.

This year, Nadia Kaliszewski joined the Outreach staff as an outreach coordinator; her duties include coordinating conferences and related activities and contributing to outreach strategy support.

Outreach launched a twice yearly newsletter in January, which promotes the activities of the School of Energy Resources, its staff, researchers and students. It's available both in printed form and electronically.

SER collateral materials were updated.

This year, Energy Outreach implemented an event sponsorship policy for organizations seeking SER funding and support. To qualify, events must address issues that add to the solution of critical energy challenges faced by Wyoming, the nation and the world. The policy outlines criteria which must be met, including providing a statement of how the event will add value to energy issues and stakeholders in Wyoming.

2011-2012 conferences and events

Clean Coal Technology Fund Symposium
August 27, 2011
With Clean Coal Task Force – presentations of completed projects
Laramie
100 attendees

Oil and Gas Industry Workshop
September 14, 2011
Jackson

Hydraulic Fracturing: A Wyoming Energy Forum
September 26-27, 2011
Co-hosted with the UW Ruckelshaus Institute of Environment and Natural Resources
Laramie
400 attendees

Sustainable Management: Strategies and Tools for Energy and Extractive Industries
March 6-7, 2012
With the UW College of Business
Laramie

Third Workshop on Porous Media Flows: Expermentation, Multi-scale Modeling and Simulation
May 8-10, 2012
With the Center for Fundamentals of Subsurface Flow
Laramie

International Advanced Coal Technologies Conference
June 3-8, 2012
Co-sponsored by the UW School of Energy Resources and the Shaanxi Provincial Institute of Energy Resources and Chemical Engineering
Xian, Shaanxi, China

Secondary Biogenic Coal Bed Natural Gas International Conference
June 20-21, 2012
Laramie
132 attendees

Other collaborations:
State Science Fair
Oral History of the Niobrara Development Experience
Annual Conference with the Enhanced Oil Recovery Institute
In-reach programs at UW
Energy Speaker Series
Wyoming Conservation Corps

SECTION 6 – Areas of Strategic Concentration

The School of Energy Resources has charted its path for the next five years with its strategic plan, endorsed by the Energy Resources Council, approved by the University of Wyoming Trustees and partially funded by appropriations from the 2012 legislative session.
With goals to create balance and distinction, the School of Energy Resources is focusing investment in three key areas over the next five years to accomplish these objectives:

- 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

This plan will deliver broad and significant benefits for Wyoming, the University of Wyoming and the energy industry. Chief among them are:

- Growth in energy-based revenue streams for Wyoming
- Improved performance in production and profitability for Wyoming's most valuable energy assets
- A hedge against boom and bust economic cycles
- Enhanced competitiveness at UW for student and faculty recruiting, corporate partnerships and funding
- Mutual gain for UW and industry from collaborative partnerships

The Wyoming State Legislature acted on a number of funding proposals during the 2012 legislative budget session that advance SER's strategic plan.

They are:

- $10 million in Abandoned Mine Land funds to put SER's strategic areas of concentration in place
- $15 million in Abandoned Mine Land funds to be matched by non-state funds for the Energy Partnership Matching Funds program

The overall five-year investment is envisioned to be a $70 million program, so prioritization is necessary. The first priority in the strategic areas of concentration is unconventional reservoirs due to the potential immediate impact on the state's economy. The second priority, with a longer time for implementation, is climbing the value chain. Developing renewables is third priority. The School of Energy Resources was quite active in FY 12 in laying the foundation for implementing the strategic areas of concentration. Fundraising in the private sector has derived $4.25 million in firm commitments against state matching funds, with more than $10 million in proposals in various stages of consideration.

SER directors worked with deans and department heads at the University of Wyoming to identify talent needs and began initial recruiting to fill those needs. At the time of this report, five experienced faculty positions in areas of geomechanics, petrophysics, drilling, petroleum systems, and reaction engineering have been defined and will soon be advertised.
In conjunction with engineering complex redesign, an energy engineering research facility – a high bay facility for large-scale research – is being planned. Private sector funding and the state match raised under this program will be dedicated to that facility to support the three key areas.

SECTION 7 – Energy Innovation Center

The Energy Innovation Center (EIC) is a state-of-the-art research and collaboration facility funded through private donations and state matching funds. The EIC houses about 30,000 square feet of space, highlighted by 12,000 square feet of rapidly reconfigurable laboratory space to help the university and the School of Energy Resources ensure Wyoming is global leader in building a secure and sustainable energy future.

Current Building Schedule

Due to the need for some mechanical and electrical system redesign to the laboratory on the third floor (Digital Rock Physics Lab), the date for 100 percent building completion has been delayed. Completion of EIC will be phased to accommodate additional work required by the third floor lab redesign.

The current plan is to start moving furniture into the finished spaces (offices, lobbies, conference rooms) of the building by November, 2012. Employees can take occupancy of the finished spaces by late November. The third floor lab work will continue into March 2013.

EIC Budget

Below is a summary of the budget for the EIC. The initial budget includes architectural and engineering fees, administrative costs, furniture, technology and construction contingency.

Other building costs have not been finalized. These include redesign of the third floor laboratory mechanical and electrical systems, design and support for the -D visualization system, and installation of the audio/visualization system.

Budget Summary

Starting Budget	$ 25,400,000
AV equipment and scope change supplement	$ 1,240,000
Construction contract to date	$ 20,291,774

3-D Visualization Lab

The hardware and software costs, $2.9 million for the lab were raised separately from private sources and matched with state funds.

The center will be comprised of three separate visual platforms:

- Four-wall cave
- Four-by-four flat screen array
- Single flat screen portable visualization system

The three different levels of equipment will enable a range of resolutions and functions for visualizing complex data sets. The cost of hardware and software for these three systems will be approximately $2.5 million.

Drilling simulator lab

The drilling simulator lab will also be housed in the EIC. It will be owned and operated by the College of Engineering and Applied Science. Its initial use will be primarily for students in the petroleum engineering undergraduate program. Additional opportunities for professional training will be explored. Between a partner donation of $500,000 and state match of $500,000 this lab is completely funded at $1 million.