

ANNUAL REPORT



SCHOOL OF ENERGY RESOURCES



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SEPTEMBER 30, 2016



UNIVERSITY OF WYOMING



School of Energy Resources

**THE UNIVERSITY OF WYOMING SCHOOL OF ENERGY RESOURCES
ANNUAL REPORT FY 16**

SEPTEMBER 30, 2016

Presented to:

Joint Minerals, Business and Economic Development Interim Committee,

Joint Appropriations Interim Committee,

Joint Education Interim Committee



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The University of Wyoming (UW), School of Energy Resources (SER) was created in 2006 to enhance the university's energy-related education, research, and outreach. SER directs and integrates cutting-edge energy research and academic programs at UW and bridges academics and industry through targeted outreach programs. In the ten years that SER has existed, it has worked to maintain flexibility in its focus and structure to meet the changing needs of Wyoming's energy industries – which is now more critical than ever. This report will highlight SER's significant achievements from July 1, 2015, through June 30, 2016, in the areas of research, academics, outreach and newly emerging areas of focus to keep UW and Wyoming at the forefront of the energy sector.

Wyoming's economy has seen a significant change in the last year with decreasing revenues due to the drop in fossil fuel prices and production. With guidance from the Energy Resources Council (ERC), SER started re-focusing existing programs and added new ones meant to leverage Wyoming's natural resources to generate additional revenue opportunities for the state. This effort was assisted by a one-time appropriation from the Wyoming legislature in 2016 of \$2 million over two years for research targeted toward building industries in Wyoming centered around the conversion of coal to value-added products.

In addition to having to adapt to changes in Wyoming's energy sector, SER has experienced a change in staff losing two deputy directors to retirement, and two faculty and five staff members to other jobs. Going forward, SER is combining the research and outreach operations under one director and has established a program in emerging technologies to keep UW a leader in select energy-related technology and economics that are relevant to state, regional and national energy agendas. SER is also integrating the Carbon Management Institute (CMI) fully into SER and better using their expertise as a reliable source of energy policy and economic knowledge to decision-makers and the public. Lastly, the 3-D Visualization Center is working to make it a fee-for-service enterprise to generate revenue to cover the Center's expenses.

One of SER's goals is to provide seed funding to UW faculty to help them leverage external funding to grow their research programs in energy-related fields. In the



last year, SER provided over \$700,000 to five Centers of Excellence which resulted in an additional \$900,000 of external funding primarily in the field of carbon capture, use and storage (CCUS). In addition to the funds that SER contributed to energy research at UW, the Wyoming legislature appropriated \$316,000 of funding targeted toward applied research to improve rare earth element processing in Wyoming. The rare earth element research funded by the Wyoming Legislature has resulted in the award of two grants from the US Department of Energy (DOE) totaling \$1.4 million.

Energy-related research capability at UW will significantly increase in the coming year as construction of the High Bay Research Facility (HBRF) nears completion. The state-of-the-art HBRF will be integral to the success of UW's slate of energy programs and will allow growth of research targeting improved recovery of hydrocarbons from unconventional reservoirs. This new facility will house the Center of Innovation for Flow in Porous Media and contain laboratories focusing on improved oil recovery, geomechanics, petrology and structural engineering.

Instead of the historic annual increase seen over the last seven years, SER's academic program fall 2015 enrollment leveled-off as the energy industry continues to deal with multi-year low prices and subsequent employee lay-offs. Ten undergraduate students graduated in May 2016 – tied for the second-highest graduation rate in the program's history – and six of those students were able to find jobs upon graduation. This is a testament to the value of the Energy Resource Management and Development (EMRD) program given the current difficult job market in the energy sector. The SER academic program continues to promote K-12 energy education and renewed a partnership with the UW College of Education to promote energy literacy through teacher training and curriculum development.

SER's outreach program saw one of its busiest years by convening seven major conferences and hosting thirty speakers. Several of the conferences were international meetings with delegations from China and Vietnam to share technological information about advanced coal conversion and CCUS technologies.

SER appreciates the continuing generosity of the Wyoming legislature. In the face of tightening budgets, SER's activities show the commitment to providing funding support for energy education, research and outreach across multiple colleges at the University of Wyoming. In addition to funding from the State of Wyoming, SER's partnerships with UW faculty and industry representatives ensure the capability to be reactive and help keep energy a viable industry in Wyoming.



In the face of rapidly changing energy markets and implementation of new environmental regulatory requirements, SER must adapt its research priorities to meet new challenges facing the energy sector in Wyoming. SER has directed its research dollars to help UW faculty obtain external research grant funding through the seven research centers of excellence. The interdisciplinary research done by the centers and the funds they leverage provide UW with opportunities and facilities to compete in a wide range of research across traditional and emerging energy sectors in Wyoming.

Centers of Excellence

SER provides seed funding for the Centers of Excellence (COE) to be established as mechanisms to bring together faculty and graduate students from multiple disciplines to develop important energy research programs. With SER funding, the COE are expected to capture external funds and attain financial independence within a few years. COE evolve with time; new groups may form to work on emerging challenges, while some centers may disband as their programs are completed. Seven COE were active in FY2016:

- Carbon Management Institute
- Center for Energy Economics and Public Policy
- Center for Photoconversion and Catalysis
- Center for Fundamentals of Subsurface Flow
- Center for Biogenic Natural Gas
- Wyoming Restoration and Reclamation Center
- Enhanced Oil Recovery Institute

In addition to these seven COE, the concept for two new COE was developed over fiscal year 2016 - the Center of Excellence in Produced Water Management (CEPWM) and the Air Quality Center (AQC). The CEPWM will emphasize research and development for technologies and approaches for reducing the economic and environmental burdens of produced water management. Of particular interest is increasing revenue generation - adding new income streams or enhancing existing ones - from byproducts of oil/gas extraction, such as produced waters.



The AQC will receive seed funding from SER starting in fiscal year 2017 primarily to purchase equipment upgrades to their mobile laboratories. The vision of the AQC is to provide the knowledge needed to enable energy development while minimizing air quality impacts. The AQC's research into emission sources is designed to inform policies for compliance with existing and pending air regulations. The UW faculty leading the AQC have already established themselves nationally for their expertise in on-the-ground air quality monitoring of oil and gas fields. The establishment of the AQC will provide a platform for further development of the group's work that ties into both the mission of the University and the needs of the State of Wyoming, regarding energy development in Wyoming, environmental management, policy support, and education.

Carbon Management Institute - Kipp Coddington, Director

CMI supports the University of Wyoming's land-grant mission by: 1) providing the University with a balanced and experienced applied geologic and geophysics research branch focused on energy studies; 2) building upon the Institute's international expertise in the geologic storage of CO₂; 3) striving to become a world-class center of techno-economic and policy carbon management solutions, including CO₂ capture technologies; 4) assessing how carbon management laws and policies may be leveraged to the benefit of Wyoming's citizens and all of Wyoming's resources; and 5) providing the University's students with world-class education in energy and carbon management matters through teaching and collaborations with other University departments and programs.

To assist Wyoming energy producers generally and to help the Wyoming economy prepare for legal mandates related to reducing carbon dioxide (CO₂) emissions, CMI has been working on the following research efforts focused on applied CCUS:

- In December 2015, CMI completed an 18-month, \$1 million DOE research grant and published a technical report on, "Optimizing Accuracy of Determinations of CO₂ Storage Capacity and Permanence, and Designing More Efficient Storage Operations: An Example from the Rock Springs Uplift, Wyoming." This research focused on evaluating the uncertainty of sealing potential at the Rock Springs Uplift (RSU) for eventual CCUS, enhanced oil recovery, and groundwater recovery projects.



- Under a 9-month, \$1.9 million DOE grant, completed the first phase of pressure management/brine extraction & treatment research at the RSU and published a technical report in April 2016 on, “Field Demonstration of Active Reservoir Pressure Management through Fluid Injection and Displaced Fluid Extractions at the RSU, a Priority Geologic CO₂ Storage Site for Wyoming.” With this project, DOE asked for an expedited project end date. CMI met the requirements of the expedited end date but had to reduce the scope of work to do so. This meant that not all of the original project budget was spent. CMI requested a 6-month no-cost extension to the grant to complete the scope of work and use the remaining funding. In June 2016, DOE approved the no-cost extension for CMI until January 2017.
- Prepared and publicly released a suite of geophysical and petrophysical software tools. The tools are expected to particularly help small- and mid-sized Wyoming producers who lack in-house geophysical expertise.

In conjunction with technical research, CMI has published policy/legal/regulatory analyses of federal carbon management policies, including the US Environmental Protection Agency’s (EPA’s) new source performance standards for greenhouse gas (GHG) emissions from new fossil fuel-fired power plants (the 111(b) rules), the EPA’s Clean Power Plan for existing fossil fuel-fired power plants (the 111(d) rules), and the 2015 Paris Agreement. The UW College of Law and CMI published a critique of the federal government’s use of the Social Cost of Carbon (SCC) during energy development activities on federal lands (Stoellinger, T. et al., “Impact of Social Cost of Carbon Analyses in the Development of Energy Projects on Federal Land,” *The Electricity Journal* 29(1), January 2016).

Center for Biogenic Natural Gas Research – Michael Urynowicz, Director

The Center for Biogenic Natural Gas Research (CBNG) explores and develops novel methods for renewable, clean-burning natural gas production from depleted hydrocarbon reservoirs using indigenous microorganisms. This center has achieved financial self-sufficiency and no longer receives funding from SER.

In May 2016, CBNG hosted a team of scientists from the Vietnamese Ministry of Natural Resources and Environment. Talks between the 6-member Vietnamese delegation and representatives from CBNG and CMI focused on the exploitation of deep subbituminous coal deposits, such as those



found in Wyoming's Powder River Basin and the Hanoi Basin located in southern Vietnam, using technologies developed and patented at the University of Wyoming. Welldog, an energy-focused technical services company, headquartered in Laramie, also participated in the meeting which lasted for several days. The event culminated with a dinner and signing of a memorandum of understanding (MOU) between UW and the General Department of Geology and Minerals of Vietnam and Hanoi University of Science and Technology to advance CBM and coal biogasification research in Wyoming and Vietnam.

Center for Energy Economics and Public Policy – Robert Godby, Director

The Center for Energy Economics and Public Policy (CEEPP) provides objective information and analysis for energy policies at the local, state, national, and international levels. The goals of CEEPP are to evaluate the economic costs and benefits of developing state, regional and national energy resources and integrate them into society and build a research infrastructure to solve the economic challenges of energy development and policy-making in the state, region, and nation.

CEEPP used SER seed money to leverage external financial support for several projects. These included a Wyoming public opinion survey assessing attitudes towards funding and revenue choices given the state's current financial situation. The results were released in May 2015 and can be found at <http://www.uwyo.edu/newssupport/newshighres/documents/2016/06/pressrelease.pdf>.

CEEPP also engaged with the Rhodium Group to assist in updating the Wyoming Coal Impact study completed last year using simulations that reflect the most recent Clean Power Plan legislation and more current economic conditions reported in the Energy Information Administration's (EIA) Annual Energy Outlook (AEO) for 2015. This will be further updated using data from the EIA's AEO2016 report released in late June.

CEEPP and the UW Energy MBA Program was awarded a \$20,000 subcontract from the Southeast Wyoming Development District (SWEDD) in cooperation with TetraTech and USEConsulting. CEEPP contributed \$10,000 of its funding to the project. The grant will develop an economic development plan for large users of energy to help promote transmission location in southeast Wyoming, specifically Laramie, Albany, Platte, and Goshen counties. UW energy MBA students will evaluate energy demand by firm types, and inventory needs of such firms both existing and those in need of development.



Center for Fundamentals of Subsurface Flow - Mohammad Piri, Director

The Center for Fundamentals of Subsurface Flow (CFSF) is an interdisciplinary research center devoted to developing original and fundamental research in the area of multi-phase, multi-component flow through porous media. CFSF received funding from SER in this fiscal year to fund six UW faculty members to conduct research in hydrocarbon recovery from unconventional reservoirs. All six projects were completed by June 30, 2016.

CFSF researchers have been aggressively seeking funding for research through submission of grant proposals to state and federal agencies as well as private-sector entities. During the fiscal year, the center captured or leveraged numerous grants and industry funding worth more than \$15 million. As a result of the success in capturing external funding, CFSF is expected to be financially self-supporting in the next fiscal year.

Center for Photoconversion and Catalysis - Bruce Parkinson, Director and Carrick Eggleston, Associate Director

The Center for Photoconversion and Catalysis (CPAC) promotes collaboration and experimentation in the fields of solar energy conversion, energy storage, and catalyst optimization. The goal of CPAC is to help Wyoming and the world develop a more sustainable and efficient portfolio of both renewable and conventional energy resources. CPAC faculty and students work together to find new ways of generating and using energy, emphasizing conversion of light into both electrical and chemical energy, as well as the closely related catalytic chemistry needed to use new and conventional energy forms more cleanly and efficiently.

The CPAC issued a request for proposals (RFP) for undergraduate research to full-time University of Wyoming (UW) undergraduate students with a cumulative GPA of 2.5 or greater for the 2015-2016 academic year to conduct research related to solar energy, catalysis, and fuel cells. The students presented poster sessions of their projects at the Renewable Energy Conference held on the UW campus in June 2016.

CPAC was instrumental in constructing roof-top photovoltaic arrays on the Energy Innovation Center (EIC) building on the UW campus. The panels are providing more electricity to the EIC



than expected. A separate array of panels is being used as a demonstration project to electrolyze water into oxygen and hydrogen. The hydrogen is then used in a process to convert coal syngas into methanol which can be used as a feedstock for other products.

In the last year, the directors of CPAC have captured \$800,000 in external grants to be used over the next three years. They have also published ten peer-reviewed papers in the last six months.

Wyoming Restoration and Reclamation Center - Pete Stahl, Director

Outreach activities organized by the Wyoming Reclamation and Restoration Center (WRRC) this year included workshops on Reclamation Seeding of Wildlands in Cheyenne conducted in April and another on Latest Methods of Reclamation Monitoring which was presented in Buffalo, WY in June. Both workshops were well attended. A two-day symposium featuring speakers from across Wyoming and several other states on Sage Grouse Habitat Restoration was scheduled to be held at the Casper Events Center had to be postponed due to a snowstorm but has been rescheduled for September 8-9, 2016.

Research being conducted by WRRC continues to focus on sage grouse habitat restoration, development of digital disturbance and reclamation mapping tools, and best management practices in reclamation. Two new projects involving carbon management and engineering, one of which is funded by SER, have been initiated. The SER funded project, in the amount of \$234,000 over the next two years, is investigating uses of coal and coal residues as soil amendments. This study involves investigation of potential markets for coal as a soil amendment as well as effects of coal products on soil properties and plant growth. Initial phases of this study will be completed by the end of 2018. The other project examines impacts of ecosystem disturbance and reclamation associated with natural gas extraction on ecosystem carbon dynamics (additional funding is still being sought for this work).

Enhanced Oil Recovery Institute - Steve Carpenter, Director

The report for the Enhanced Oil Recovery Institute will be submitted under separate cover.



Shell 3-D Visualization Laboratory

The 3-D Visualization Center continues to work with colleges and departments across the UW campus on projects that integrate visualization technologies into their research. This includes the Department of Petroleum Engineering, Department of Computer Science, Department of Molecular Biology, Department of Psychology and the Enhanced Oil Recovery Institute. This diverse use demonstrates the benefit of the 3-D Visualization Center as a campus-wide research tool. Faculty are seeing the value of the 3-D Visualization Center to provide them a competitive advantage when seeking grant funding by including cutting-edge technology and letters of support from the Center in their grant applications.

In addition to providing research and teaching assistance to UW faculty, the 3-D Visualization Center is increasing outreach activities to connect the Center to other institutions. The manager of the 3-D Visualization Center is the founding chair of a new nonprofit with international membership. The group is called the CAAV – the Campus Alliance for Advanced Visualization and its mission is to promote the use of visualization technologies in higher education and at national labs. In June, the Center hosted visits and technology exploration sessions for the Energy Summer Institute (ninth and tenth grade students), City of Laramie Planners, the Engineering Summer Program and various K-12 groups of science teachers. Finally, the Center is in the process of hiring a new staff person to teach mid-career professional short courses in visualization for the private sector. It is anticipated that tuition for these courses will generate revenue that can be put back into the Center for technological upgrades.

The 3-D Visualization Center continues to stay on the forefront of new visualization technologies. The 3-D Visualization Center has also started a pilot project with Idaho National Laboratory-Center for Advanced Energy Studies (INL-CAES) to create the first CAVE-to-CAVE (Cave Automated Visualization Environment) connection to share data in two CAVEs simultaneously.



US China Clean Energy Research Consortium – Advanced Conversion Technology Center (CERC-ACTC)

The School of Energy Resources continues its work with the US - China Clean Energy Research Consortium – Advanced Conversion Technology Center (CERC-ACTC) a joint research effort between the United States and China. The US membership consists of federal, private, and public sectors and is managed for the DOE by West Virginia University. The first 5-year phase of the CERC-ACTC was completed in December 2015. A second 5-year, \$5.5 million contract to UW for two CERC Phase II projects has been executed, and work began on April 1, 2016. The Phase II projects are a CCUS demonstration project in the Ordos Basin of China and another on a novel CO₂ capture technology. In the first quarter of work, researchers began to evaluate existing data and set up testing equipment for their projects.

Rare Earth Element Research Program

In the 2015 general session, the Legislature of the State of Wyoming redirected \$316,764 of Abandoned Mine Land (AML) funds from two previously funded research efforts to the University of Wyoming for rare earth element (REE) research. In the same session, the Wyoming Legislature also appropriated \$250,000 from the general fund to SER that can only be expended if matched with an equal amount of non-state funds. Both the AML and general fund appropriations were intended to fund, “...applied research to promote processing developments that would improve the possibility that rare earth materials could be processed in Wyoming.” The REE research program legislation stipulated that the funds allocated for REE research would revert June 30, 2016.

On May 27, 2015, SER hosted a stakeholder meeting comprised of a member of the Wyoming House of Representatives; representatives from Rare Element Resources, a company proposing to mine rare earth elements in Wyoming; a representative from Idaho National Laboratory (INL); and several UW faculty and administrators. The objective of the meeting was to identify research topics of interest to stakeholders that satisfy the charge of the legislation.

Based on the outcomes of the stakeholder meeting, SER issued a request for proposals (RFP) on June 16, 2015, for research focused on REE with the intent of deploying at least the \$316,764 of redirected AML funds. RFP respondents were encouraged to include demonstration of non-state matching funds in the hopes of generating a minimum of \$250,000 in combined match that would



subsequently allow for deployment of the \$250,000 general fund appropriation. The RFP was open to all full-time UW faculty, academic professionals, research scientists, and post-doctoral research associates and specified that all projects were to be completed by the June 30, 2016, reversion date. Proposals were reviewed by SER in consultation with stakeholder representatives. The overriding criterion for proposal funding was demonstration of applied research with direct relevance to one or more of the research focus areas identified by the stakeholders and demonstration that the proposed work can be completed by June 15, 2016.

Three projects were funded through the 2015 RFP as follows:

1. “Unconventional Rare Earth Elements in Wyoming from Coal Fly Ash and Oil and Gas Production Water: A Technical and Economic Feasibility Study,” submitted by University of Wyoming Carbon Management Institute, Fred McLaughlin, Principal Investigator (PI). The total project budget is \$75,074. No matching funds were identified for this project.
2. “Rare Earth Element Recovery from Roll-Front Uranium Deposits in Wyoming: An Unconventional Source of Rare Earth Elements,” submitted by University of Wyoming Department of Geology and Geophysics, Susan Swapp, Principal Investigator. The total project budget is \$137,690, including matching funds of \$45,000 committed by the University of Manitoba.
3. “Electrochemical Conversion of Rare Earth Oxides to Metals/Alloys in Molten Salts,” submitted by Idaho National Laboratory, Eric Peterson, Principal Investigator. The total project cost is \$204,000 including matching funds of \$100,000 committed by the DOE Critical Materials Institute.

Overall, results of all three projects have been very positive and have resulted in additional external federal funding to continue the research. In the area of recovery of REEs from coal/coal by-products and produced water, UW received two DOE grants totaling \$1.4 million over two years. Other UW researchers funded through this program will continue to work with Wyoming uranium mining companies to recover REE’s as a by-product of in-situ recovery of uranium as it could result in an additional revenue stream for the company.



The REE program was completed with expenditure of the AML funds by June 30, 2016, as required by the legislation. The \$250,000 general fund appropriation was not used toward any REE research as an equivalent value of non-state matching funds was not acquired. Therefore, the funds reverted back to the state of Wyoming. A final summary report of the REE research program will be drafted by SER and submitted to Wyoming legislators and will be posted on the SER website.

SER Matching Grant Fund

SER's Matching Grant Fund (MGF) was established to provide additional leverage to selected UW grant proposals to improve the chance of capturing external funding. Requests for funding to the MGF program were taken during a set time each year. If a faculty member was successful in being awarded a matching grant from SER, those funds had to be set aside as a commitment for up to a year until it was known whether the proposal was funded. If a proposal was not funded by the external agency, SER would then have to reallocate those funds. Managing the matching fund commitments became an issue for SER as the timing of external funding of proposals often did not align with UW's biennial budget system. Because of this, SER is phasing out the MGF program and plans to provide matching funds to grant proposals through the Centers of Excellence on an on-going basis rather than one time a year.

Integrated Test Center (ITC)

Details on this program are covered in the 2016 Advanced Conversion Technology Task Force Annual Report.



SER's Academic mission is to develop innovative academic programs to meet the demands of the energy workforce and enhance societal literacy related to complex energy issues. Competitive success in the 21st-century energy sector requires deep foundational knowledge and enabling skills to adapt to rapidly changing technologies and an escalating knowledge base. Competency-based learning that integrates self-directed learning, problem-solving, critical analysis of uncertain and complex issues, and constant improvement in performance are overarching components of SER academic programs.

Energy Resource Management and Development Bachelor of Science

The Energy Resource Management and Development program (ERM&D) is an interdisciplinary BS degree program that integrates training in engineering, geology, policy, economics, business, law, and natural resources. This degree connects energy sector problem-solving experiences with classroom learning to prepare students for the workforce needs of the energy sector.

The program had four concentrations added in AY 2012:

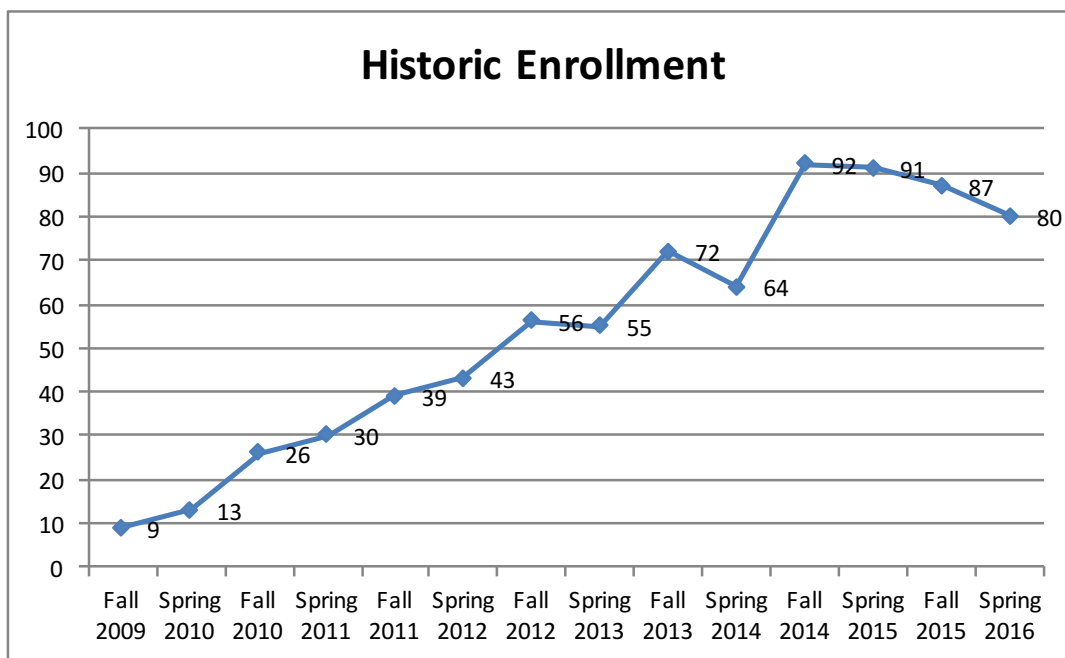
- Fossil Fuels
- Renewable Energy
- Energy Air, Land and Water Management
- Professional Land Management (PLM)

The PLM program is accredited in North America by the American Association of Professional Landmen.

The ERMD degree program started the fall 2015 semester with 91 enrolled students - the same number as last year including 13 new freshmen and 5 community college transfers. Detailed information on student enrollment data, demographics, graduation rates, and job placement for the 2015-2016 academic year is provided on page 14.



Awarded Scholarships – AY 2016	Total Amount	# Awarded
Nielson Scholarships and Fellowships	\$83,298	35
Hathaway Scholarships	\$54,890	24
Rocky Mountain Scholars	\$54,180	11
Trustees Scholars Award	\$35,433	3
Wyoming Association of Professional Landmen	\$7,500	4
American Association of Professional Landmen	\$5,000	2
York Future of Energy	\$5,000	2
Other Scholarships	\$95,095	29
Total	\$340,396	110



Enrollment by Class Standing						
Semester	Freshmen	Sophomores	Juniors	Seniors	2nd Bachelors	Total
Spring 2016	14	16	16	32	2	80
Fall 2015	22	20	12	31	2	87
Spring 2015	19	25	13	31	3	91
Fall 2014	33	14	18	24	3	92
Spring 2014	16	11	16	23	1	67
Fall 2013	22	17	12	20	1	72
Spring 2013	13	10	9	22	1	55
Fall 2012	16	8	15	17		56
Spring 2012	7	7	15	14		43
Fall 2011	10	9	9	11		39
Spring 2011	4	6	12	7	1	30
Fall 2010	6	7	8	5		26
Spring 2010	3	7	0	11		21
Fall 2009	1	5	2	1		9



Student Type					
Semester	New First				Total
	Time	Transfer	Returning	Current	
Spring 2016	1			80	81
Fall 2015	12	8	0	67	87
Spring 2015		2		89	91
Fall 2014	25	9		58	92
Spring 2014		9		62	71
Fall 2013	25	2	1	45	73
Summer 2013	16				16
Spring 2013	1			53	54
Fall 2012	2	10		38	50
Spring 2012	14	4		39	57
Fall 2011	1	3	1	23	28
Spring 2011		8	1	28	37
Fall 2010	7	1		17	25
Spring 2010				13	13
Fall 2009	3	6	1	4	14

Enrollment by Gender			
Semester	Female	Male	Total
Spring 2016	16	64	80
Fall 2015	18	69	87
Spring 2015	16	75	91
Fall 2014	18	74	92
Spring 2014	10	57	67
Fall 2013	11	61	72
Spring 2013	10	45	55
Fall 2012	9	47	56
Spring 2012	7	36	43
Fall 2011	7	32	39
Spring 2011	9	21	30
Fall 2010	10	16	26
Spring 2010	4	9	13
Fall 2009	4	5	9

Enrollment by Residence						
Semester	Resident	Out of State	Out of State Alumni	International		Total
				Resident	Int'l	
Spring 2016	41	30	5	1	3	80
Fall 2015	46	30	6	1	4	87
Spring 2015	52	31	4	1	3	91
Fall 2014	48	34	5	1	3	91
Spring 2014	38	21	3	1	4	67
Fall 2013	44	19	3	1	5	72
Spring 2013	34	17	2	1	1	55
Fall 2012	33	16	3	1	1	54
Spring 2012	31	11			1	43
Fall 2011	28	11				39
Spring 2011	21	9				30
Fall 2010	15	11				26
Spring 2010	10	3				13
Fall 2009	7	2				9

Enrollment by Concentration (Added Spring 2012)							
Semester	Professional					Original Program	Total
	Energy Air/Land/Water	Fossil Fuels	Land Management	Renewable Energy	Undecided		
Spring 2016	25	8	34	10	3		80
Fall 2015	23	10	34	12	8		87
Spring 2015	22	15	35	10	7	2	91
Fall 2014	20	15	35	11	8	3	92
Spring 2014	9	13	22	8	9	6	67
Fall 2013	8	13	19	6	17	9	72
Spring 2013	1	12	11	3	7	25	59
Fall 2012	1	8	6	2		37	54
Spring 2012	2	4		1		36	43



Concurrent Majors

Students may pursue a concurrent major in one or more colleges. Only one degree will be awarded from the college of the primary major.

Dual Degrees

Students may pursue degrees in one or more colleges by completing an additional 30 semesters hours from the University of Wyoming and meet all the college and major requirements of both majors. Multiple degrees and multiple diplomas will be awarded.

Concurrent and Dual Majors-Duplicated Headcounts					
Semester	Environment & Natural Resources				Total
	Natural Resources	Honors	Marketing	Finance	
Spring 2016	10	5	1	1	17
Fall 2015	13	7	1		21
Spring 2015	13	4	1		18
Fall 2014	13	4	1		18
Spring 2014	6	2	1		9
Fall 2013	5	2			7
Spring 2013	3	2			5
Fall 2012	7	4			11
Spring 2012	6	3			9
Fall 2011	5	3			8
Spring 2011	4	1			5
Fall 2010	1	1			2
Spring 2010	0	0			0
Fall 2009	0	0			0

Honor Rolls

Undergraduate students who achieve high scholastic grades are honored by being placed on one of the following honor rolls.

- ✓ **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

Semester	Honor Rolls				Total	% Students
	President	Dean	Freshman	Provost		
Spring 2016	5	17	5	1	28	35.0%
Fall 2015	4	15	4	1	24	27.6%
Spring 2015	5	14	4	4	27	29.7%
Fall 2014	3	6	6		15	16.3%
Spring 2014		15	3	1	19	29.7%
Fall 2013	3	8	4		15	20.8%
Spring 2013	2	8	1	1	12	21.8%
Fall 2012		13	3		16	28.6%
Spring 2012	3	4	2		9	20.9%
Fall 2011		9	1	2	12	30.8%
Spring 2011		2			2	6.7%
Fall 2010		2			2	7.7%
Spring 2010	1	2	1		4	30.8%
Fall 2009	1	1	1		3	33.3%



Graduation Statistics

Graduates by Gender			
Semester	Male	Female	Total
Spring 2016	9	1	10
Fall 2015	2		2
Spring 2015	8	1	9
Fall 2014	1		1
Spring 2014	3		3
Fall 2013	2	1	3
Summer 2013		1	1
Spring 2013	6	4	10
Summer 2012	1		1
Fall 2011	1	1	2
Totals	33	9	42

First Destination Locations	
Location	Number
Wyoming	11
Colorado	6
North Dakota	4
California	2
Montana	1
Texas	1
China	1
Total	26

Semester	Graduates - First Destination				Total
	Employed FT	Continue Education	Continue Job Search	Unemployed by Choice	
Spring 2016	6		4		10
Fall 2015	1			1	2
Spring 2015	7	2			9
Fall 2014	1				1
Spring 2014	3				3
Fall 2013	3				3
Summer 2013	1				1
Spring 2013	8	1		1	10
Summer 2012	1				1
Fall 2011	0	2			2
Total	31	5	4	2	42
%	73.8%	11.9%	9.5%	4.8%	

First Destination Employers

- ✓ Anadarko Petroleum
- ✓ Atlas Carbon
- ✓ Calfrac Well Services
- ✓ Campbell County Conservation District
- ✓ Chinese Society for Measurement
- ✓ DCP Midstream
- ✓ Encana Corporation
- ✓ Halliburton
- ✓ Infinity Power and Controls
- ✓ InterTech Environmental Engineering
- ✓ Jonah Energy
- ✓ Kearns and west
- ✓ Kinchen Ranch
- ✓ Loenbro
- ✓ Marathon Oil Corporation
- ✓ Nalco Champion
- ✓ Nomac Services
- ✓ Olie's Images
- ✓ On a String Horse Ranch
- ✓ PacifiCorp
- ✓ TIC Kiewit
- ✓ USAA
- ✓ Wood Group PSN



K-12 Energy Education

SER continues to grow innovative K-12 education programs to support Wyoming in meeting the demands of the energy workforce and enhancing societal understanding of complex energy issues. In November 2015, SER renewed a partnership with the College of Education to promote K-12 energy literacy through the promotion of pre-service and teacher training, curriculum development, and engagement of practicing classroom teachers. The Wyoming Energy Education Initiative (WEEI) seeks to:

- Provide a pathway to enhance teaching of Wyoming's energy-rich history and innovations behind energy use and resource development
- Encourage the critical understanding across curricular areas that support informed decisions related to Wyoming's energy, environment and economic future

As a lead partner of the UW's Wyoming Science, Technology, Engineering, and Math (WYSTEM) program supporting K-12 STEM education outreach, SER was instrumental in establishing campus-wide program collaborations and implementation of the first annual STEM Saturday event. STEM Saturday hosted one-hundred plus students and their parents from across Wyoming where they experienced hands-on STEM activities, met with faculty, and toured UW's world-class facilities. SER also continued strong collaborations with the College of Engineering and Applied Science (CEAS) co-organizing multiple student and teacher professional development events. The annual TEAMS (Tests of Engineering Aptitude, Mathematics, and Science) welcomed 11 teams to compete in a hands-on design challenge focused on fuel cells and an assessment targeting "Engineering Tools of Innovation." In addition, SER supported the CEAS first annual Engineer's Week in partnership with Wyoming Board of Professional Engineers. Engineer's Week reached 70 third grade classrooms across Wyoming, bringing practicing professional engineers into their local schools to guide a hands-on design challenge with students.

SER also delivered two successful summer programs including the Wyoming Energy Camp and the Energy Summer Institute. The Wyoming Energy Camp hosted twenty-two, middle-level students for a 5-day residential program targeting energy use in society, electrical generation and innovative thinking. The Energy Summer Institute served twenty ninth and tenth graders, welcoming them to UW for a 5-day residential program. Students toured diverse energy sites and participated in engaging hands-on energy-related activities led by graduate students and faculty.



Updates

Faculty News

- Tara Righetti, SER Assistant Professor in the College of Law, is the new director of the Professional Land Management concentration. She is a member of the American Association of Professional Landmen (AAPL) and is a Certified Professional Landman. Righetti completed the Energy Law CLE – UW Summer Roadshow with more than 200 attendees and gave an invited presentation at the Energy Exposition in Billings, MT on the topic of Business and Law of Oil and Gas Production.
- Dario Grana, SER Assistant Professor of Geology and Geophysics and Petroleum Engineering, was selected as an invited speaker at the 2016 Improved Oil Recovery (IOR) conference in Stavanger, Norway. He also gave a talk on “Seismic History Matching Using Ensemble-Based Methods and Model Order Reduction Techniques” at the SIAM conference at Stanford University.
- Related to the SER Strategic Plan, Maohong Fan, SER Professor of Chemical and Petroleum Engineering, was appointed to be the Conversion Committee Chair of National Coal Council.

Student News

- Two students graduated in December 2015 with the ERMD Degree. One graduated from the Fossil Fuels concentration and is working in China. The second graduate is from the PLM concentration and is considering applying to graduate or law school.
- Jay Quintanilla, a senior in the Energy Resource Management and Development program, was selected by the UW Campus Sustainability Committee as the student lead for the annual UW Greenhouse Gas Inventory.



- The 2016 Nielson Graduate Excellence Fellowship was awarded to Emily Beagle, from Sheridan, WY. Beagle is a mechanical engineering Ph.D. candidate. Beagle's Ph.D. dissertation project, titled "A Comparative Analysis between the EU and the United States of the Feasibility of Co-Firing Woody Biomass in Existing Coal-Fired Power Plants from a Technical, Economic and Policy Perspective," examines various ways to use biomass for energy applications.
- The Nielson Undergraduate Scholarship was awarded to Barbara Jean Bender from Lake Forest, CA. Bender is a senior in rangeland ecology and watershed management, and environment and natural resources. The Nielson Fellowship awards one \$10,000 graduate fellowship and one \$5,000 undergraduate scholarship for students whose coursework, research and career goals focus on developing human resources and the know-how required to solve critical energy and natural resource challenges faced by society.
- Qian Yang, current SER student, and Michael Grossett, a SER graduate, contributed to a publication accepted by the Journal of Physical Chemistry. Their research is based on work completed in Dr. Bruce Parkinson's lab. The title is "Photosensitization of Natural and Synesthetic SnO₂ Single Crystals with Dyes and Quantum Dots."



Energy Outreach supports SER's mission to be a global leader in building a secure and sustainable energy future.

Presenters and Distinguished Speakers

For FY 2015-2016, SER hosted industry and academic professionals from around the world, bringing together students, faculty, researchers and the public to learn about a wide range of advanced energy technologies and industry trends. All presentations were recorded and are available for viewing on the SER website at <http://www.uwyo.edu/ser/conferences/speaker-series-presentations.html>.

School of Energy Presentations and Distinguished Speaker Series

During FY 2015-16, SER hosted 15 UW Faculty presenters and 9 distinguished speakers, which brought in approximately 2,000 attendees.

College of Engineering Seminar Series

SER also partnered with the College of Engineering and helped co-host and sponsor the College of Engineering Seminar Series, which featured another 11 speakers and brought in 355 attendees.

Events

Through the efforts of Outreach, SER hosted and sponsored multiple events throughout the academic year to include over 20 major events such as the International Standards Organization (ISO) TC 265 Working Group and Plenary Meetings, which brought in 63 delegates from 11 countries. SER also hosted events that brought together the Vice Governor of Shaanxi, China and Wyoming's Governor Mead, as well as the Vietnamese delegation from the General Department of Geology and Minerals of Vietnam. For a list of all conferences and events, please visit the SER website at <http://www.uwyo.edu/ser/conferences/upcoming-events>.



Carbon engineering – transforming Wyoming coal into marketable non-combustible carbon-based products

Background

In the 2016 budget session, the Wyoming State Legislature provided a special \$2 million appropriation to fund research focusing specifically on creating new markets for coal. According to the May 2016 report from the US DOE Clean Energy Manufacturing Analysis Center, demand for carbon-based materials is growing globally at roughly 12%-20% annually – depending on the industry sector. Carbon fiber composite materials are seeing market growth in the aerospace, automotive and wind energy industries, and in the manufacturing of pressure vessels. Much of the increased demand is in Europe as they strive to meet renewable energy targets. SER's carbon engineering initiative seeks to develop a new coal-based manufacturing industry to produce carbon fiber and other non-energy carbon-based products.

Achievements and Progress

Prior to receiving the \$2 million from the Wyoming Legislature for the Carbon Engineering effort, SER provided \$1.4 million of funding to UW faculty to study conversion of Wyoming coal. A preliminary modelling exercise revealed what a coal refinery could look like and how it would differ from a conventional oil-based chemical manufacturing plant.

The \$2 million of funding from the Wyoming Legislature has been used to fund fourteen research projects to investigate conversion of coal into consumable high-value carbon products from Wyoming coal. The projects that have been funded to date are shown in the table on page 23.



Research Category	Project Title
Process Conversion Platforms	Wyoming Coal Characterization through various routes
	Carbide Products process routes from Coal
	Supercritical extraction of coal and biomass
	Carbon fiber from solvated coal tar pitch
Coal Based Intermediate Products	Spinning carbon fiber precursors from coal using ionic liquid approaches
	Magnetic Properties of Wyoming Coal residues and product possibilities
	Coal residue as a soil amendment
	Road paving and asphalt from coal
Coal Based Derivative Products	Green Building Materials from Coal
	Graphene Production from Wyoming Coal
	Diamantoid and advanced carbon products from coal
	Manufacture of Nitrogen Containing Graphitic Materials for Energy Applications
Gas Clean Up & Treatment	Manufacture of silicon carbides from coal
	CO ₂ + CH ₄ Dry Reforming Process Feasibility Evaluation using Cerium doped Ni catalyst



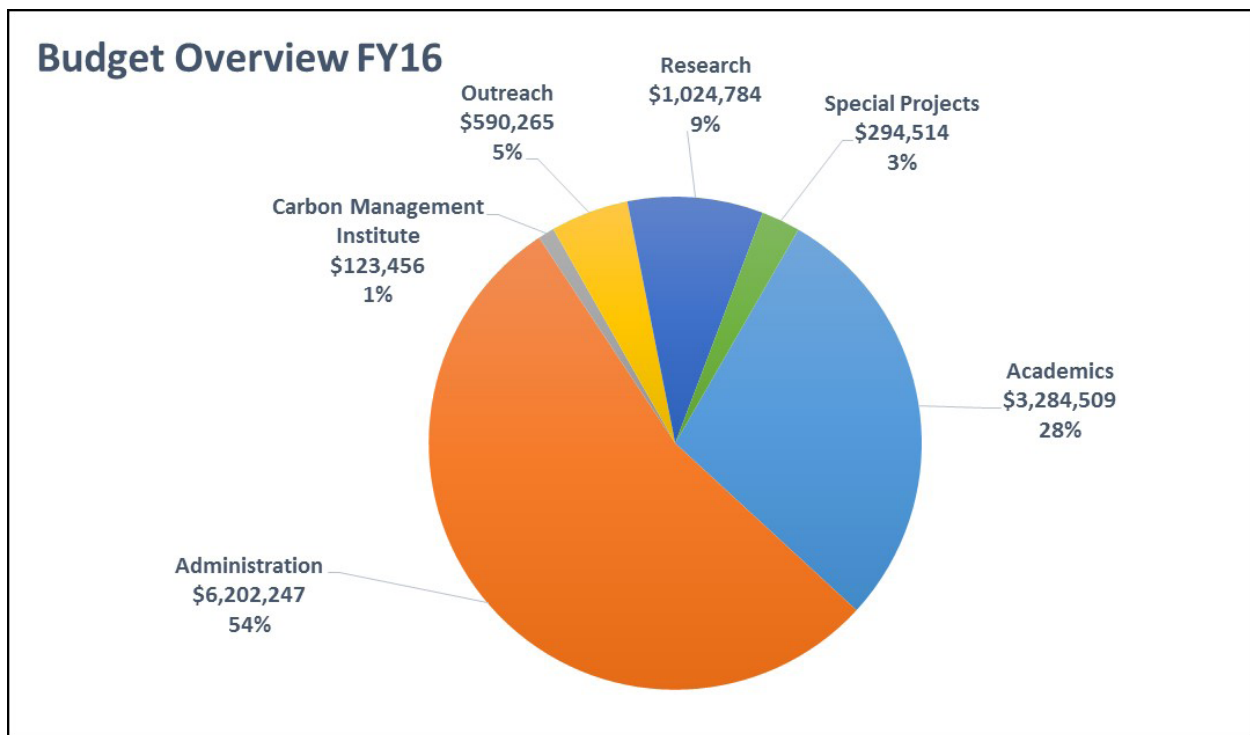
The Wyoming State Legislature provided funding for SER over the 2015-16 biennium in the 2014 Legislative Budget Session in the amount of \$20,240,921. In Fiscal Year 2015, \$8,721,146 was expended. The remaining \$11,519,775 was spent in Fiscal Year 2016.

Expenditures for the 2016 Fiscal Year totaled \$11,519,775. Of that total SER disbursed:

- \$3,586,764 for salaries and benefits for SER staff and faculty from Academics and Administration
- \$306,274 for Enhanced Oil Recovery salaries and benefits from Administration
- \$332,638 for Carbon Management salaries and benefits from Administration
- \$567,782 for faculty start-up commitments from Academics and Administration
- \$527,495 to support research activities of the Centers of Excellence from Research
- \$276,325 for Matching Grants Fund from Research
- \$459,094 for Outreach Events from Outreach
- \$1,474,055 in support for campus equipment and projects from Administration
- \$1,900,000 for the High Bay Research Facility overage from Administration
- \$2,089,348 in remaining expenses that include graduate assistantships, recruiting, travel, publications, Energy Summer Institute, office support, etc.



Account	Jul '15 - Jun 16	Original Budget	Revised Budget	\$ Remaining
Academics	\$3,284,509.00	\$3,827,481.00	\$3,284,509.00	\$0.00
Administration	\$6,202,247.00	\$2,336,891.00	\$6,202,247.00	\$0.00
Carbon Management Institute	\$123,456.00		\$123,456.00	\$0.00
Outreach	\$590,265.00	\$972,695.00	\$590,265.00	\$0.00
Research	\$1,024,784.00	\$3,089,765.00	\$1,024,784.00	\$0.00
Special Projects	\$294,514.00		\$294,514.00	\$0.00
Total	\$11,519,775.00	\$10,226,832.00	\$11,519,775.00	\$0.00





Over the course of the last fiscal year, the energy sector and the State of Wyoming experienced a marked decrease in production and therefore - revenue. As a result of changing energy markets, SER is transitioning its research focus to maximize the flexibility of coal and natural gas to create value-added products, managing carbon dioxide emissions and storage, developing appropriate alternative energy resources, and assessing energy policy impacts on Wyoming's economy. With respect to education, SER has an ongoing dialog with employers to maintain the relevance of energy education at UW. As SER moves into a new year, the commitment to prudent expenditure of state funding to ensure Wyoming fulfills its desire to be a global leader in energy will continue.

CONCLUSION