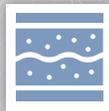




SCHOOL OF ENERGY RESOURCES



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Annual Report - FY 2015

OCTOBER 1, 2015



UNIVERSITY OF WYOMING

THE UNIVERSITY OF WYOMING
SCHOOL OF ENERGY RESOURCES
ANNUAL REPORT FY 15

October 1, 2015

Presented to:

Joint Minerals, Business and Economic Development Interim Committee,

Joint Appropriations Interim Committee,

Joint Education Interim Committee

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EXECUTIVE SUMMARY

In the nine years since the University of Wyoming School of Energy Resources (SER) was created, it has achieved a great deal. This year is no different and marks the completion of funding for the **High Bay Research Facility**, which is integral to the success of UW's slate of energy programs and serves as a platform for future growth, housing state-of-the-art facilities to undertake groundbreaking research into the understanding and recovery of hydrocarbons from unconventional reservoirs. This new facility will house the Center of Innovation for Flow in Porous Media and contain laboratories focusing upon improved oil recovery, geomechanics, petrology and structural engineering. The university community celebrated the groundbreaking for the High Bay Research Facility (HBRF) in March, with construction of the \$56 million facility expected to take just over a year.

The **academic program** thrives even while the energy industry continues to be stressed. Student enrollment in SER academic programs is growing and graduates are quickly employed upon graduation, many into well-paying jobs. Enrollment for the Energy Resource Management and Development (EMRD) program reached an all-time high of ninety-one. Interest also continues in the energy MBA programs offered by the UW College of Business. Outreach – including social media coverage and direct contact with Wyoming students in grades kindergarten through 12 continues to reap reward.

In FY15, **UW joined the Center for Advanced Energy Studies**, (CAES), a collaborative energy-focused organization composed of the University of Idaho, Idaho State University, Boise State University, and the DOE Idaho National Lab. This collaboration will leverage available expertise and resources and enhance UW's capability in the energy sector. Don Roth has been appointed associate director for CAES.

The Centers of Excellence (Centers) continued to conduct sophisticated applied research and analyses with their respective and often cross-cutting disciplines while seeking funding to attain self-sufficiency. During the year, seven Centers were active. Three of the Centers have new directors - the Carbon Management Institute, the Center for Energy Economics and Public Policy, and the Enhanced Oil Recovery Institute. A new position, Deputy Director for Emerging Technology and Special Projects, has been appointed and will immediately focus on a new carbon engineering initiative, which will seek to develop new opportunities for coal utilization. The Shell 3-D Visualization laboratory is expanding its client base, engaging with entities throughout the UW campus.

SER's research program supports University of Wyoming faculty and students by assisting with leveraging external funds and providing the facilities and administration needed to conduct cutting edge energy research. In FY2015, two SER Centers of Excellence released requests for proposals, funding 9 proposals and

providing a total of \$820,000 to UW faculty and students. On behalf of the Energy Resources Council and the Advanced Conversion Technology Task Force, SER continues to administer several research programs and projects funded by the Wyoming State Legislature, including the Advanced Conversion Technologies (ACT) program, the In-Situ Recovery of Uranium (ISRU) research program, the Rare Earth Elements (REE) research program, and an Integrated Test Center (ITC) project. Of 47 projects funded for \$41 million through the ACT program, 41 have reached completion. The seven research projects funded through the ISRU program for \$1,405,408 have reached completion; all were presented at a research symposium held in April 2015 at UW.

SER's **Outreach Program** continued a high level of activity. The Distinguished Speaker Series welcomed 32 top industry and academic professionals from around the world, and three conferences in Laramie welcomed over 500 attendees. SER continues to seek opportunities to collaborate on and sponsor other energy-related activities. Notable new sponsorships this year include SER's support for the UW Center for Global Studies, the Vail Global Energy Forum, and the Energy Law UW Summer Roadshow. SER also hosted high-level delegations from Shaanxi Province and Shanxi Province in China, and a Delegation from Vietnam – all of whom wish collaborative exchange with UW and Wyoming.

SER continues to focus on advances in three **Strategic Areas of Concentration**: unconventional reservoirs, advanced conversion, and certain aspects of renewable energy. Progress in the first two of these areas was impressive in 2015, with new research underway and \$8 million in research grants with the private sector. SER also drafted a roadmap for a new Carbon Engineering program that aims to promote the use of Wyoming coal as a feedstock to make high-value carbon products in the state. Both of these areas are strong collaborative links between SER and the College of Engineering and Applied Science Tier 1 Initiative.

SER is advised by the **Energy Resources Council (ERC)**, eleven members that include State legislative officials, senior executives from industry and *ex officio* members from UW. This year Sen. Eli Bebout joined the council. The ERC continues to be a most influencing body, discussing priority issues and research and technology imperatives for the State of Wyoming energy sector. Their insight guides the focus of SER leadership.



SECTION 1 – ADMINISTRATION

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

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

Administration and Organization:

The Energy Resources Council self-selects its chairman and vice chairman. The council meets generally once a quarter, including an annual November meeting with the UW Board of Trustees. The ERC is supported by the SER director and staff and is represented by the UW General Counsel.

The members of the Energy Resources Council are:

Paul Lang, Chairman

President and Chief Operating Officer, Arch Coal, Inc.

Tom Lockhart, Vice Chairman

Wyoming State Representative, Chairman, House Minerals, Business and Economic Development Committee

Carl Bauer

President, C.O. Bauer Consulting, Inc.

Eli Bebout

Wyoming State Senator

Thomas Botts

Retired Executive Vice President, Royal Dutch Shell

Cindy Crane

President and Chief Executive Officer, Rocky Mountain Power

David R. Emery

Chairman, President and Chief Executive Officer, Black Hills Corporation

Jeane Hull

Retired Executive Vice President and Chief Technical Officer, Peabody Energy

Rob Wallace

Managing partner, Rob Wallace Group

Richard McGinity

President, University of Wyoming (ex officio)

Indy Burke

Wyoming Excellence Chair, UW professor and director of Haub School of Environment and Natural Resources (ex officio)

Dave True

University of Wyoming Board of Trustees (ex officio)

In the last year, Wyoming Sen. Jim Anderson retired from the council, and Wyoming Sen. Eli Bebout was named to the council.

The Energy Resources Council met on the following dates

- August 22, 2014
- November 14, 2014, joint meeting with the UW Board of Trustees
- March 27, 2015

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



SECTION 2 – FINANCIAL SUMMARY

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. At the beginning of the biennium, SER planned that approximately equal amounts would be spent in each fiscal year of the biennium.

Expenditures for the 2015 Fiscal Year totaled \$8,721,146. Of that total, SER spent:

- \$3,762,639 for salaries and benefits for SER staff and 11 faculty
- \$191,920 for start-up commitments made to SER faculty
- \$1,257,370 to support research activities of six Centers of Excellence
- \$408,378 for the Matching Grants Fund
- \$286,084 for Outreach events
- \$675,543 for Tier 1 Engineering Initiative
- \$2,139,212 for remaining expenses that include graduate assistantships, recruiting, travel, publications, Energy Summer Institute, office support, etc.

Fiscal year 2015 expenditures fell short of the plan by nearly \$1.3 million. Over the past nine years, expenditures in the first year of the biennium frequently fall short of expectations for a variety of reasons. This year, the primary factors contributing to underspending were open positions that resulted from resignations (2 faculty and the director of EORI), delays in grant awards for the Matching Grant Funds, and lower than anticipated activity in the College of Engineering and Applied Science Tier 1 Initiative programs. It is anticipated that activity will increase in all of these areas such that the biennial budget will be utilized as planned.

Fiscal Year Financial Report (Actual) FY 2015

Academics	Fiscal Year 2015
Salary/Fringe	\$ 1,921,737
Startup	\$ 191,120
Other Support & Programs	\$ <u>1,320,908</u>
Subtotal Academics	\$ 3,433,766
Research	
Salary/Fringe	\$ 916,319
Matching Grant Funds	\$ 408,378
Center Support	\$ 1,257,370
Other Support & Programs	\$ <u>1,054,275</u>
Subtotal Research	\$ 3,636,342
Outreach	
Salary/Fringe	\$ 312,923
Other Support & Programs	\$ <u>320,459</u>
Subtotal Outreach	\$ 633,382
Administration	
Salary/Fringe	\$ 815,249
Other Support & Programs	\$ <u>202,407</u>
Subtotal Administration	\$ <u>1,017,656</u>
Totals	\$ <u>8,721,146</u>

Private Sector Funding

New donations and research contracts from the private sector in FY2015 totaled \$16.5 million; \$16 million of the new funding has been matched by state funds appropriated for either facilities or research match. The addition of \$16.5 million brings the overall total private sector funding since the inception of SER to just over \$62 million, of which \$57 million was matched.

The application of private sector funds acquired to date break down as follows:

- \$38.9 million for facilities and research instrumentation
- \$14.9 million for sponsored research
- \$8.2 million for endowments



SECTION 3 – ACADEMICS

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.

K12 Energy Education

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

The SER K12 energy program in partnership with the Science Posse (initiated in 2006, www.scienceposse.org) is focused on four major objectives:

- Engage and motivate K12 students to increase learning in energy science and build the workforce pipeline
- Increase societal energy literacy
- Provide professional development to in-service teachers targeting innovative pedagogy and energy content
- Provide graduate students with novel experiences to translate research to diverse audiences

Leading UW's statewide STEM outreach since program inception, the Science Posse/SER K12 programs have reached more than 131 schools/programs in 34 of Wyoming's 48 school districts and a total of 26,821 students and 162 teachers. Summer enrichment activities such as summer camps and workshops that have engaged 253 students and 128 teachers extend these opportunities.

The Science Posse/SER K12 Energy program has partnered with the UW College of Engineering and Applied Science, NASA Space Grant Consortium, Women in Mathematics, the Science and Math Teaching Center (Wyoming State Science Fair), UW Geology Museum, Wyoming Geographic Alliance, and the Wyoming Art

Museum to support interdisciplinary studies and focus on collective impact.

Partnerships extend throughout the state, with Greater Wyoming Big Brothers/Big Sisters, the Wyoming Department of Education, STARBASE, the Wyoming Afterschool Alliance, and the Teton Science Schools. In addition, the K12 energy program has partnered with Idaho National Laboratory's nationally recognized i-STEM and Center for Advanced Energy Studies (CAES).

Websites (www.scienceposse.org, <http://www.uwyo.edu/wystem/>; and <http://www.uwyo.edu/ser/energy-literacy/>) are resources for Wyoming teachers and students and include comprehensive lesson plans, an up-to-date listing of STEM-related opportunities, and two iBooks (available for free download). Teachers may link to virtual visits using cyber-based tools (Blackboard Collaborate and Skype) that connect the Posse with teachers and students across Wyoming.

The Science Posse has both a Twitter account (@SciencePosse) and a Facebook page that highlight Posse/SER K12 outreach events, recruit students and teachers for school year and summer programs, and to disseminate information about other STEM programs and opportunities.

News Articles

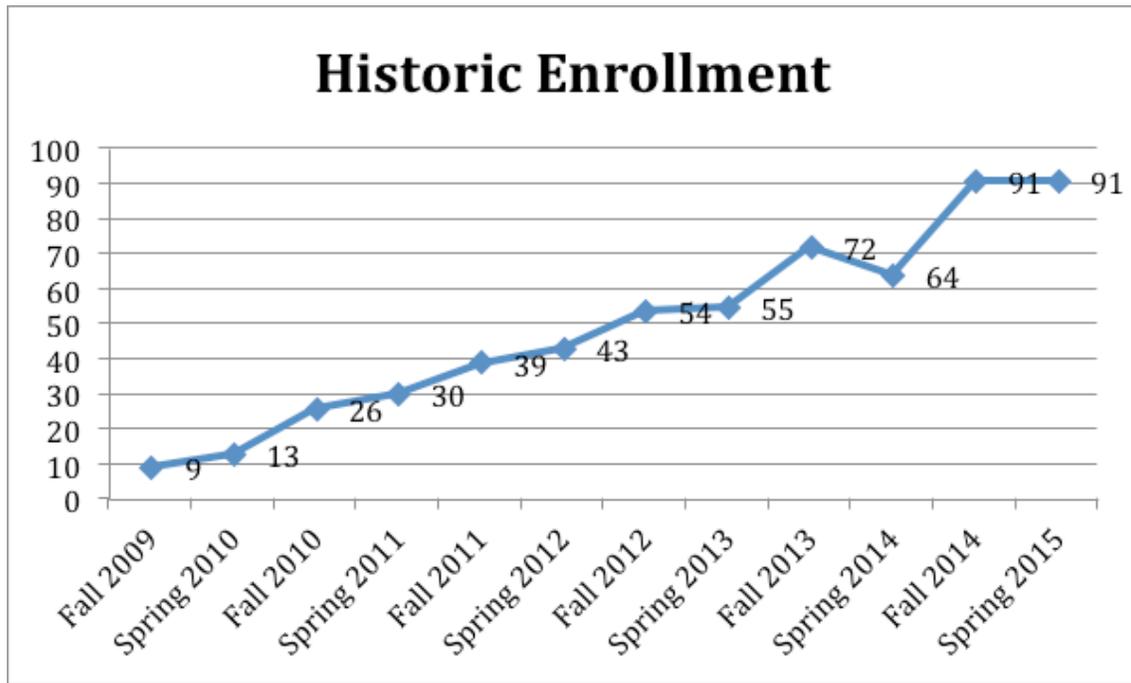
The Science Posse/SER K12 Outreach has been featured in a variety of news articles and broadcasts, in the Wyoming Business Report, The Oil City News (Casper), the Powell Tribune, KCWY (Casper) the Wyoming Tribune Eagle (Cheyenne), Scotts Bluff Star Herald (Nebraska), Deseret News (Utah), Laramie Boomerang, Rawlins Daily Times, and County 10 News (Fremont County), as well in various UW publications and news feed.

Undergraduate Education

The Energy Resource Management and Development program (ERM&D) is an interdisciplinary Bachelor of Science degree program that integrates training in engineering, geology, policy, economics, business, law, and natural resources. The degree connects energy sector problem-solving experiences with classroom learning to prepare students for workforce needs in the energy-sector. The program has four concentrations: Fossil Fuels; Renewable Energy; Energy Air, Land and Water Management; and Professional Land Management (PLM), which is one of nine accredited programs in North America.

As noted below, enrollment for the ERM&D BS degree has increased since its inception in 2009.

Figure 1. Historic Enrollment



Demographics

Demographic information for the last four semesters includes class standing, gender, concentration and residence.

Class Standing	Fall 2013	Spring 2014	Fall 2014	Spring 2015
Freshmen	22	16	33	19
Sophomores	17	11	14	25
Juniors	12	16	18	13
Seniors/Second Bachelors	20	23	23	34
Total	72	67	95	91

Gender	Fall 2013	Spring 2014	Fall 2014	Spring 2015
Males	61	57	73	75
Females	11	10	18	16
Total	72	67	91	91

Concentration	Fall 2013	Spring 2014	Fall 2014	Spring 2015
Original Program	9	6	3	2
Undeclared	17	9	7	7
Professional Land Management	19	22	35	35
Fossil Fuels	13	13	15	15
Energy Air/Land/Water	8	9	20	22
Renewable Energy	6	8	11	10
Total	72	67	91	91

Residence	Fall 2013	Spring 2014	Fall 2014	Spring 2015
Wyoming	46	40	48	54
Colorado	12	12	26	20
Other States	8	10	13	13
International	6	5	4	4
Total	72	67	91	91

Honor Roll recipients

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

Semester	President	Dean	Freshman	Provost	Total	% ERM&D Students
Spring 2015	5	14	4	4	27	29.6%
Fall 2014	3	6	6		15	16.4%
Spring 2014		15	3	1	19	28.4%
Fall 2013	3	8	4		15	21.7%
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%
Spring 2009			1		1	50.0%
Fall 2009	1	1	1		3	33.3%
Total	18	84	27	8	137	

Note: 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.

Curriculum Development

The ERM&D program was modified to meet the new University Studies Program (USP) general education requirements. Minor modifications were made to the concentration curriculums.

Tara Righetti, SER assistant professor with the College of Law used her private sector experience in a comprehensive capstone course to provide students with real-life decision-making responsibilities related to exploration and production scenarios. Motivating interdisciplinary problems required student team interaction, analysis, and communication. She invited industry speakers to interact with students and present summaries of their work-force leadership demands. The course is being modified to meet new requirements in the USP program.

Dr. Robert Fields, Department of Atmospheric Science, developed and taught a new Air Quality Management course developed for Spring 2015 to meet industry needs and to train students in air quality assessment.

To improve student ability to effectively communicate to diverse audiences, Ryan Oberhelman, in the UW Creative Writing program, developed and taught a new class titled Communication Across Topics in Energy. Students gain significant experience in technical writing and communication, but this course, which also meets the USP Communication 2 requirements, focuses on more creative writing and speaking experiences in non-technical communication.

Richard Hines, vice president of iLandman, provided training and certification for the energy land management software program during the Professional Land Management Seminar class. The workshop provided students with certification in the leading land management program used in industry. Five external speakers visited the class.

The Energy and Society course was modified to meet the new First Year Seminar requirements under the USP program.

The special calculus sequence in energy science is being eliminated; on review, the standard calculus sequence meets student needs.

A new non-math intensive course on Principles of Petroleum Engineering and Geology is under development. It is designed to provide a detailed overview of petroleum engineering and geology for non-majors including students in the Professional Land Management, energy business and energy law programs.

Dual degree programs are being finalized to allow Professional Land Management students to obtain degrees also in Finance or Supply Chain Management. Plans are to introduce the programs to the ERM&D students during the fall semester.

Development of an exchange program with Idaho State University's BS degree in nuclear engineering and University of Wyoming's BS degree in petroleum engineering has begun. A 2+2 or 3+1 program is envisioned with distance delivery for some courses.

Student Ambassadors

The new Student Ambassador program provides opportunities to develop communication and people skills while involved with recruiting activities and demonstrating the CAVE technology in the Shell 3D Visualization Center. Four ERM&D students were hired and are involved with campus student recruiting events including Campus Pass, Discovery Day and Showcase Saturday.

Department of Energy Internship Program

Qualified students were invited to an informal informational dinner about the U.S. Department of Energy's (DOE) Student Undergraduate Laboratory Internship (SULI) program on October 21, 2014. Dr. Bruce Parkinson discussed his work with the National Renewable Energy Laboratory. An overview was presented on each DOE laboratory and the application process was reviewed. A second meeting was held Nov. 7, 2014 to discuss writing essays for the application.

ERM&D student, John Brouwer, was chosen for an internship through the Department of Energy's SULI program; he will spend 10 weeks at the Idaho National Lab conducting research supporting its mission. He currently works in UW's Enhanced Oil Recovery Institute with senior research scientist Nick Jones on data compilation of petroleum reservoirs and fields, including mapping and analysis.

Summer Bridge Program

A new Summer Bridge Program helps incoming students get a jump on their college career by enrolling in two summer classes preparing them for college-level math classes in the fall semester. SER participated by offering a \$1,000 scholarship to ERM&D students who pass both summer classes.

Employer and Professional Relations

Representatives from the School of Energy Resources, the Center for Advising and Career Services, and the UW Foundation met with Halliburton professionals to discuss recruiting programs on August 18, 2014.

Anadarko Petroleum hosted an information session about its land internship program on September 24, 2014.

Erin Nelson with the Denver Association of Petroleum Landmen met with students on October 23, 2014 to discuss opportunities in land administration and the land management profession. She also talked to the Professional Land Management seminar class in April 2015.

Pam Henderson met with recruiters during the job fairs to discuss opportunities with potential employers.

Don Roth, Pam Henderson and two Professional Land Management students attended Rockies NAPE, the oil and gas industry's marketplace for buying, selling and trading prospects and producing properties in Denver, CO on December 11-13, 2014.

Nalco Champion hosted an information session about internship and job opportunities with its organization on February 18, 2015.

Loenbro representatives met with SER and Career Services to discuss its new recruiting program at UW on March 6, 2015.

Wyoming Conservation Corps hosted an information session on March 25, 2015 about crewmember opportunities.

Don Roth met with representatives from Shell to discuss internships, career development and recognition of SER as a top recruiting site.

Field Trips

Students are encouraged to attend field trips to learn more about their chosen career and to interact with industry professionals. The following field trips were completed:

- American Wind Energy Association Forum in Denver, CO on October 1, 2014.
- National Renewable Energy Laboratory in Boulder, CO on October 2, 2014.
- Wyoming Infrastructure Authority meeting in Cheyenne, WY on February 3, 2015.
- Bureau of Land Management Oil and Gas auction in Cheyenne, WY on February 3, 2015.
- Halliburton in Casper, WY on February 25, 2015

Career Services

SER worked with the Center for Advising and Career Services in delivering career services activities including resume reviews and interviewing techniques.

- Career Boot Camp – September 30, 2014
- Business, Government and Non-Profit Job Fair – October 6, 2014 and February 17, 2015
- Engineering, Science and Technology Job Fair – October 7, 2014 and February 18, 2015
- Just In Time Job Fair – April 15, 2015

Fellowships, scholarships and external gifts

Energy Resource Management and Development students received \$337,258 in awarded scholarships. The Nielson Energy Scholarships were added to promote recruitment and retention of highly talented students planning a career in the energy sector.

- Nielson Energy Scholarship for Women and Minorities - \$3,000
- Nielson Summer Bridge Scholarship - \$1,000
- Nielson Scholars Award - \$1,000
- James C. Nielson Transfer Student Scholarship - \$2,000
- Nielson Professional Land Management Scholarship – Pays the different in undergraduate and College of Law tuition up to 16 credit hours during the student’s senior year
- Nielson Summer Internship - \$2,000
- Nielson Experiential Learning Travel Support – Up to \$1,000

Awarded Scholarships	Total Amount	# Awarded
Hathaway Scholarships	\$78,374	36
Rocky Mountain Scholars	\$43,500	9
Nielson Scholarships and Fellowships	\$36,048	22
Trustees Scholars Award	\$35,154	3
Wyoming Association of Professional Landmen	\$9,000	3
American Association of Professional Landmen	\$5,000	2
Wyoming Scholars	\$4,000	4
York Future of Energy	\$1,250	1
Denver Association of Petroleum Landmen	\$1,000	1
Other Scholarships	\$123,932	31
Total	\$337,258	112

Anadarko Fellowships for Excellence in Energy Scholarship are competitively awarded to recognize and advance excellence in energy scholarship. The fellowships promote innovative and entrepreneurial research in areas aligning with Anadarko’s energy portfolio. Recipients for the 2014-2015 academic year are:

- Anadarko Fellowship for Excellence in Energy Scholarship – Faculty
 - Dr. Saman Aryana, Assistant Professor, Department of Chemical and Petroleum Engineering
 - Dr. Dario Grana, SER Assistant Professor, Department of Geology and Geophysics and Department of Chemical and Petroleum Engineering

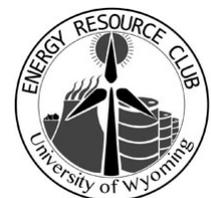
- Anadarko Fellowship for Excellence in Energy Scholarship – Graduate Students
 - Suman Chitrakar, Department of Ecosystem Science and Management
 - Beth Fitzpatrick, Department of Ecosystem Science and Management
 - Mitchell Helling, Department of Chemistry
 - Tao Li, Department of Geology and Geophysics
 - Josiane Pafeng, Department of Geology and Geophysics
- Anadarko Fellowship for Excellence in Energy Scholarship – Undergraduates
 - Evan Egenolf, Petroleum Engineering
 - Wilarachchige Gunatilleke, Chemical Engineering
 - Kirby Lawrence, Economics and Statistics
 - Thomas Peel, Civil Engineering

Nielson Excellence Fellowship in Energy Studies. The fellowship, which recognizes superior performance and future potential in sophomore and junior students enrolled in energy-related programs, provides students a unique experience to work directly with faculty mentors, graduate students, and energy companies on relevant, authentic research and development projects. Four ERM&D students were awarded the fellowship for the 2014-2015 academic year conducting research in photovoltaic, air quality, and land disturbance.

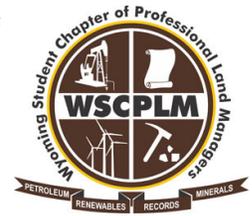
Internship and research experiences. Students are strongly encouraged to complete internships and undergraduate research projects. Placement opportunities expand yearly to accommodate all student requests. Below are academic year 2015 placements.

Internship Placement	Title	No.
Anadarko Petroleum	Land Intern	1
Anadarko Petroleum	Land Administration Intern	1
Cheyenne Light Fuel & Power	Engineering Intern	1
City of Laramie	Public Works Intern	1
Encana Corporation	Land Intern	1
Idaho National Laboratory	SULI Intern	1
InterTech Environmental & Engineering	Vegetation Monitoring	1
Legacy	AutoCad Intern	1
Loenbro	Pipeline	1
Peabody Energy	Land Intern	1
Siemens	Field Technician	1
University of Wyoming – Dr. Paddington Hodza	UW 3D Campus Project	1
University of Wyoming Physical Plant	Engineering Intern	1
Wyoming Conservation Corp	Crew Member	4
	Total	17

Energy Resource Club. A formally recognized UW club focused on energy has been established that SER supervises and funds. Approximately 51 students were involved with the club in AY 2015. Activities included a demonstration of the Shell 3-D Visualization Center, establishing a Facebook page and community service. A new logo was designed by a member.



Wyoming Student Chapter of Professional Land Managers Thirty-five students in the Professional Land Management Recognized Student Organization hosted an etiquette dinner, volunteered with the Laramie Soup Kitchen, and co-hosted a Homecoming tailgate event with the Wyoming Association of Professional Landmen. A new Facebook page was established and a logo was designed to promote the group's activities.



Graduates and First Destinations

Thirty SER students have graduated as of May 2015.

First Destination

Semester	Employed Full-Time	Continue Education	Continue Job Search	Unemployed by Choice	Total
Spring 2015	6	1	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		2			2
Totals	23	4	2	1	30
% Total	76.6%	10.0%	6.7%	3.3%	100%

Graduates who continued their studies are pursuing master's degrees or an additional bachelor's degree at the South Dakota School of Mines, the University of Edinburgh and the University of Wyoming.

First Destination Employers

Graduates have accepted positions in Wyoming, Colorado, North Dakota, Montana, California and Texas at the following companies:

- Anadarko Petroleum
- Atlas Carbon
- Calfrac Well Services
- DCP Midstream
- Encana Corporation
- Halliburton
- Infinity Power and Controls
- InterTech Environmental and Engineering
- Jonah Energy
- Loenbro
- Marathon Oil Corporation
- Nalco Champion

- Nomac Services
- PacifiCorp
- TIC Kiewit
- Wood Group PSN

First Destination Job Titles

- Associate Supervisor Wind Operations
- Cement Field Engineer
- Engineer MWD
- Environmental Compliance Coordinator
- Environmental Engineer
- Environment Health and Safety Analyst
- Environmental Professional
- Environmental Services Technician
- Field Engineer
- Field Geologist
- Production Enhancement Engineer
- Project Engineer
- Pumper
- Regulatory Analyst
- Sales Technician
- Surface Landman
- Wireline and Perforating Engineer

First Destination Locations

Location	Number
Wyoming	10
Colorado	6
North Dakota	4
California	1
Montana	1
Texas	1
Total	23

Salary Range

For 2015 graduating class the salary range was \$50,000 to \$69,000.

Second Destination Employers

Graduates report changing positions and/or employers. Two graduates have started their own businesses.

- Belle Fourche Pipeline
- Cudd Energy Services
- Encana Corporation
- Entrepreneur
- Halliburton
- Mair Energy
- Trihydro
- Wyoming Oil and Gas Conservation Commission

Second Destination Job Titles

- Associate Technical Professional-Geophysics
- Consulting Manager
- Data Analyst
- DOT Compliance Coordinator
- Engineer II
- Environmental Chemist
- Regulatory Analyst
- Stimulation Field Engineer

Graduate Education

Graduate assistantships SER competitively allocated four new graduate assistantships (GAs) for energy education and research for the 2015 academic year to faculty in the departments of Geology and Geophysics (1), Physics and Astronomy (1), Chemical and Petroleum Engineering (1), and Molecular Biology (1). Since 2007, SER has awarded 118 graduate assistantships.

MBA in Energy The College of Business in collaboration with SER Academics offers an MBA program focused on energy (see <http://www.uwyo.edu/mba/energy-management/>). Two tracks are available: MBA in Energy Management and MBA with an energy emphasis. Enrollment for AY2014-15 was 13 students in the Energy Management MBA and six students in the Energy concentration.

Energy Law The College of Law, with SER support, established a new center (Center for Law and Energy Resources in the Rockies) to promote energy law, regulation and policy. Tara Righetti, SER assistant professor of energy law, has been extremely active in developing associations with energy firms, and delivering energy law workshops, including a multi-city workshop for attorneys in Wyoming.

Faculty Updates

- Dr. Jay Sitaraman, SER Associate Professor in Mechanical Engineering, resigned.
- Brian Russell, vice president of Hampson-Russell, is a new adjunct faculty member. Hampson-Russell is a subsidiary of CGG.

- Philippe Doyen, vice president of research with CGG, is the York Visiting Professor. His two-month visit to UW is focused on developing long-term interactions with faculty, graduate and undergraduate students, delivering technical workshops, and collaborating with the Center for Advanced Energy Studies.
- Energy Law CLE traveling show -- Tara Righetti and Temple Stoellinger
- Norm Augustine (retired CEO, President, Chairman Lockheed Martin, NAE member, etc.) visit-4/6-8: UW and INL.
- Don Roth -- invited participant: DOE Nuclear Strategy Conference, 3/4-6; re: development of national strategies to promote nuclear energy R&D.
- Don Roth -- invited speaker. Advanced Nuclear Manufacturing & Supply Chain Conference, Pocatello, ID 4/20. Title: Workforce development & education imperatives for the 21st century.
- Don Roth-- appointed to Idaho LINE commission (Leadership in Nuclear Energy)- subcommittee on workforce development and education.
- Don Roth -- appointed Associate Director of the Center for Advanced Energy Studies (see below).

SER Faculty Top 3 Accomplishments for 2014:

Dr. Po Chen, SER Associate Professor, Department of Geology and Geophysics

- Full 3-D tomography for crustal structure in Southern California based on the scattering-integral and the adjoint-wavefield methods. Lee, En-Jui*, **Po Chen (corresponding author)**, Thomas H. Jordan, Phillip B. Maechling, Marine AM Denolle, and Gregory C. Beroza, 2014. *Journal of Geophysical Research: Solid Earth* 119, no. 8 (2014): 6421-6451
- Testing waveform predictions of 3-D velocity models against two recent Los Angeles earthquakes. Lee, En-Jui*, **Po Chen**, and Thomas H. Jordan, 2014. *Seismological Research Letters* 85.6 (2014): 1275-1284.
- 3-D, Elastic, Full-waveform Tomography for Crustal Structure in Southern California Using Earthquake Seismograms and Ambient-Noise Green's Functions, **Po Chen**, June 24, 2014. SEG/AGU Summer Research Workshop, Hyatt Regency Vancouver, Vancouver, Canada.

Dr. Timothy Considine, SER Professor, Department of Economics and Finance

- 3 referred journal articles
- 3 grants awarded for a total of \$167,000
- 4 presentations

Dr. Craig Douglas, SER Professor, Department of Mathematics

- Developed a medium movement method through porous media that is at least an order of magnitude faster than the methods considered to be the state of the art today. Further, the method is more accurate and works in two cases in which the standard methods may fail.
- Developed a mathematical theory explaining why the fast method differs from the others methods.
- Developed a blending mathematical model so that results can be identical when the methods all work, but will guarantee a result when the standard methods will fail to produce a result or an accurate one.

Dr. Maohong Fan, SER Professor, Department of Chemical and Petroleum Engineering

- National Coal Council Committee member appointed by the current DOE Secretary, Dr. Ernest Moniz
- Annual citations for Dr. Fan's journal papers reach 1,193 and he won Elsevier's JES highest Citation Award
- Secured external research funding including DOE and NSF in the amount of \$1.75M

Dr. Dario Grana, SER Assistant Professor, Department of Geology and Geophysics and Department of Chemical and Petroleum Engineering

- Book: 2014 | Seismic reflection of rock properties, Dvorkin J., Gutierrez M., and **Grana D.**, Cambridge University Press
- Eni Award 2014 – New Frontiers of Hydrocarbon, Upstream Section (Mukerji T., Mavko G., Dvorkin J., Grana D.) for “pioneering innovations in theoretical and practical rock physics for seismic reservoir characterization”, 2014.
- Funding: 2014-2016 | Seismic-dynamic sequential Bayesian updating of reservoir models using production and time-lapse seismic data (sole PI), Society of Petroleum Engineers (SPE), \$100,000.00 (1 of the only 4 funded proposals in the world by SPE)

Dr. Kristina Hufford, SER Assistant Professor, Department of Ecosystem Science and Management

- Established and expanded a collaborative research program in restoration ecology with the Bureau of Land Management personnel
- Graduation of first student admitted to conduct graduate research in her lab
- Continued collaborative work with the Wyoming Reclamation and Restoration Center, including workshops offered to agency and industry personnel throughout Wyoming

Dr. John Kaszuba, SER Associate Professor, Department of Geology and Geophysics

- Grant: 2014-2017, Integrated characterization of CO₂ storage reservoirs on the Rock Springs Uplift combining geomechanics, geochemistry, and flow modeling, co-PIs Vladimir Alvarado, Erin Campbell-Stone, Dario Grana, and Kam Ng; U.S. Department of Energy-NETL, \$1,400,255 (\$1.1M from DOE, balance = cost share)
- Industry Consortium funded: UW Cretaceous Tight Oil Consortium Phase 2 (KTOC II), 2 companies, 2 years, \$100,000
- Industry Project funded: Interactions between Hydraulic Fracturing Fluid and Parkman Sandstone, 1 company, 2 years, \$100,000

Dr. Subhashis Mallick, SER Professor, Department of Geology and Geophysics

- Submission of a NSF proposal
- Initiation of the industry-funded research consortium
- Initiation of the research project in collaboration with RSI on joint seismic and EM inversion

Dr. Bruce Parkinson, SER Professor, Department of Chemistry

- Winning the Humboldt Research prize
- Inducted as a Fellow of the Electrochemical Society
- Published 14 papers in quality peer-reviewed journals and/or invited plenary speaker at three international meetings

Dr. Mohammad Piri, SER Associate Professor, Department of Chemical and Petroleum Engineering

- Continued to grow strong research relationships and financial support with the private sector in the area of flow through porous media. Dr. Piri raised approximately \$16 million for research and equipment, all matched by the state, from companies including Baker Hughes, Haliburton, Hess, Newfield Exploration and Saudi Aramco.
- Completed the design for the totally innovative Center of Innovation for Flow in Porous Media in the High Bay Research Facility which is under construction.
- Remained very active in research publications in peer-reviewed journals and as an invited speaker at international conferences.

Tara Righetti, SER Assistant Professor, College of Law

- Present a paper on flaring at University of Idaho College of Law and Center for Advanced Energy Studies (CAES) Idaho Symposium on Energy in the West from November 13-14, 2014 (Paper, "Avoidably Lost" forthcoming in Idaho Law Review)
- Moderate "Emerging Issues" panel at CLERR Landscape Discussion on Energy Law and Policy
- Received CPL designation from American Association of Professional Landmen

Center for Advanced Energy Studies (CAES)

In 2014, UW joined the Center for Advanced Energy Studies, a collaborative energy focused organization composed of the University of Idaho, Idaho State University, Boise State University, and the DOE Idaho National Lab. This collaboration is intended to leverage expertise and resources and enhance UW's capability in the energy sector. Don Roth is associate director for CAES.

1. **CAES visitors** - meetings with UW faculty, meet and greet presentations, etc.
 - UW Meet and Greet at INL – 9 UW faculty participated
 - 2/24 - Ann Gaffney (INL director of process science and technology division. Anne is an expert in catalysis with a keen interest in carbon conversion, among other areas.), Dan Ginosaur, Lucia Petrovic (INL researchers in Ann's division)
 - 5/7 Howard Grimes – INL/CAES Director for Innovation in Industry
 - 5/6 Richard Boardman (INL Manager, Energy Systems Integration), Yuhan Sun (Chinese Acad Sci & Shanghai Advanced Research), Weiyao Fan (Chairman, Shanghai Jientec Co.)
 - NuScale- discussion on possible funding for hybrid energy projects
 - 4/27-28 - David Solan and David Koehler – Energy Policy Institute

- 5/12 -Travis McLing (Energy Water and CCS Lead), Tom Wood (UI water specialist), Cal Christensen (INL Energy-Water)
 - Trihydro representatives and CAES to discuss unmanned aerial capabilities in monitoring environmental parameters in oil/gas applications
2. **Competitive GA RFP to enhance CAES-UW connections**- 5 proposals received; joint UW and INL staff (UW PIs: Nam Kg, Maohong Fan, David Bell, John Kaszuba, Dongmei Li); Funded: Nam Kg, John Kaszuba.
 3. **DOE Deep Borehole proposal** – UW/INL cooperative venture in response to RFP by DOE. Initial application submitted and accepted.
 4. **DOE FORGE** (Frontier Observatory for Research in Geothermal Energy) proposal –Consortium of DOE lab/university/industry for R&D on enhanced geothermal systems; 5 proposals funded Phase 1 (**including the project with UW with a total budget of \$400,000**); 3 projects at \$29M will be selected in Phase 2 next year; and the project in final phase 3 will be selected in year 3. Total budget =\$31M.
 5. **Funded GA for Rob Godby** to develop the Regional Energy Corridor Map to include CAVE simulations.
 6. **Rare Earth Initiative**- conference calls to coordinate Rare Elements Resources, UW, and INL to establish parameters for research gaps/needs
 7. **Coordinated UW faculty participation** at regional CAES workshops related top Big Data/Analytics, Energy Law and Regulation, and Energy Policy.



SECTION 4 – RESEARCH

State-of-the-art research is critical to preserving and increasing the value of Wyoming’s energy resources while protecting its natural wonders. The ability of UW faculty to obtain external research grant funding is greatly enhanced by SER’s commitment to provide competitively awarded funds through a variety of programs which include Matching Grant Funds program, the Advanced Conversion Technology Fund, and the seven research centers of excellence. These highly leveraged funds provide UW with opportunities and facilities to compete in a wide range of research across energy sectors important to Wyoming – natural gas, petroleum, coal, uranium, wind and solar. The centers foster interdisciplinary research in program areas critical to advancing energy technology.

Centers of Excellence

SER provides seed funding for centers of excellence to be established as mechanisms to bring together faculty and graduate students from multiple disciplines to develop important energy research programs. With seed funding from SER, Centers are expected to capture external funds and attain financial independence within a few years. The centers evolve with time; new groups may form to work on emerging challenges, while some centers may disband as their programs are completed. Seven centers were active in FY2015.

Carbon Management Institute – Kipp Coddington, Director, Shana Dahl, Deputy Director

Carbon Management Institute (CMI) at the University of Wyoming – through research and development – aims to keep Wyoming at the cutting edge for deployment of successful, safe geologic CO₂ storage that is essential to future carbon management efforts, both in Wyoming and elsewhere.

During the 2015 fiscal year, CMI:

- Continued to work with and establish collaboration in China with multiple agencies and multiple projects.
 - Organized multiple trips to China and Wyoming for field work and discussion
 - Worked with data and information for the Ordos Basin to complete numerical simulations for optimal CO₂-EOR scenarios for Ordos Basin
 - Began discussions and preparation of proposals for expansion of the project for an additional five years, culminating in a carbon capture, use and storage (CCUS) demonstration
 - Attended and presented at multiple international meetings to update the progress of the project
- Continued analysis and evaluation on the Rock Springs Uplift (RSU) for verification of 99 percent carbon containment and verification of ceiling formations

- Continued to improve calculation resolution of the confining layers at the Rock Springs Uplift
- Evaluated geologic isolation of RSU#1 waters in RSU
- Evaluated geochemical reactions associated with seal failure for the various sealing lithologies
- Continued analysis of potential wellbore corrosion and optimal scenarios
- Attended and presented at multiple meetings to update the progress of the project
- Utilized project understanding to date, to submit competitive proposals for the advancement of CCUS
- Prepared six new proposals for competitive projects
- Continued to strengthen industry and academic collaborative relationships

Under the direction of recently-hired (March 2015) Kipp Coddington, the center will build on a new vision statement of international prominence on matters pertaining to carbon management, and develop a five-year roadmap that capitalizes on existing expertise and identifies new areas of potential targeted growth -- in all instances supported by a financial marketing plan that considers potential sources of public and private sector support. Goals will be refined and expanded to anticipate -- for the benefit of the state and the University of Wyoming -- the changing needs of carbon management beyond CO₂ injection and storage in saline reservoirs. Opportunities will be pursued to expand collaboration across UW with colleges and schools, multilateral entities such as the World Bank, other academic entities, federal and state governments; national labs; and the private sector.

During the fiscal year, CMI accomplished the following:

- Welcomed a new director, Kipp Coddington
- Relocated to the Energy Innovation Center on UW's main campus
- Hosted Chinese delegations for continued collaboration and further partnership opportunities
- Presented talks, posters and papers regarding current research, results and future opportunities
- Furthered completion of collaborative CCUS project in Ordos Basin China
- Furthered completion of CCUS seals project in Rock Springs Uplift, Wyoming
- Received two projects for feasibility/CCUS/Extracted Water in Ordos Basin, China, totaling \$100,000

CMI has further developed relationships with Schlumberger Carbon Services, Energy and Environmental Research Center, Los Alamos National Laboratory, Lawrence Livermore National Laboratory, Idaho National Laboratory, Wyoming Reclamation and Restoration Center, UW Department of Geology & Geophysics, UW College of Engineering and Applied Science, Shaanxi Provincial Institute of Energy Resources and Chemical Engineering (SPIERCE), Northwest University, and Yanchang Oil Company, Institute of Rock and Soil Mechanics of Chinese Academy of Sciences

During the year, CMI attended workshops or symposia presented by

- American Association of Professional Geologists (AAPG)
- Carbon Capture Utilization and Storage (CCUS)
- U.S.-China Clean Energy Research Center – Advanced Conversion Technology (CERC-ACT)
- International Conference on Greenhouse Gas Technologies (GHGT12)
- Geological Society of America
- Carbon Storage R&D Project Review Meeting
- China-U.S. Climate Change Working Group Workshop
- China-U.S. CO₂ Emission Control Science and Technology Symposium
- Huaneng Clean Energy Research Institute Workshop
- Yanchang Petroleum Group, Shaanxi Provincial Institute of Energy Resources Workshop

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 reserves using indigenous microorganisms.

The Center hosted a team of scientists from the Vietnamese Ministry of Natural Resources and Environment. Talks between the six-member Vietnamese Delegation and representatives from the Center for Biogenic Natural Gas Research and Carbon Management Institute 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 and nearly coincided with meetings between Nguyen Phu Trong, the head of Vietnam's Communist Party, and President Obama marking the 20th anniversary of the normalization of relations between the two countries.

This center has achieved financial self-sufficiency.

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 CEEPP's goals are to:

- Evaluate the economic costs and benefits of developing state, regional and national energy resources and integrating them into society.
- Develop effective policy to maximize the economic welfare achieved from such activity, balancing economic, environmental, and social considerations.
- Build a research infrastructure to solve the economic challenges of energy development and policy-making in the state, region and nation.

During FY2015, CEEPP focused its efforts to capture external financial support on the following:

- Federal grant funds: three federal agency grant proposals were submitted in 2014-2015 by CEEPP-supported researchers (Godby, Coupal, van 't Veld and Alvarado). One was funded (described below) for \$5.2 million in conjunction with engineering personnel at UW.
- State-sponsored policy projects – CEEPP developed relationships with Wyoming state officials to respond to state needs and develop policy-relevant research. These resulted in more than \$125,000 in research support from state entities (described below).
- Developing quasi-state and private support for research – CEEPP devoted significant time to cultivating relationships and discussing energy policy and research needs with business, non-state and quasi-state entities to increase public awareness of the center and its abilities, which resulted in potential future funding opportunities.
- CEEPP continues to build and develop partnerships with private industry, the State of Wyoming and with other federal, state and quasi-governmental agencies. These outreach efforts have been successful and helped raise over \$125,000 in non-federal funding.
- A business plan to create a policy-research consulting group specializing in soliciting state/federal research funds, with revenues to be used to support the center outside of SER funding, is being developed.
- Cooperative efforts with other SER policy-research centers, such as the Carbon Management Institute, continue to be developed to maintain the ability to react to and develop a credible, reliable and responsive energy policy-research talent at UW willing to engage in state efforts and serve state needs.
- Efforts are also underway in conjunction with the UW Foundation to solicit gift to provide permanent funding support for graduate student talent to develop policy research expertise.
- CEEPP continues to offer its services and develop policy relevant research that is of the highest quality while also being of value to Wyoming, its taxpayers, UW and its students.

Because CEEPP is a policy-research center, and not developing a specific technology or business opportunity, it is likely ongoing funding from SER will be necessary to maintain research efforts and to maintain necessary personnel (particularly graduate student support) to conduct research. CEEPP has been actively engaged in developing permanent, non-traditional funding streams. Some multi-year funding has been acquired that will allow the center to reduce its funding needs and/or expand its research efforts through the federal three-year support.

During FY2015, CEEPP received several external grants made possible through either current match funds or by previous CEEPP-supported research.

- Atmosphere to Grid (A2G); U.S. Department of Energy, Grant CFDA #81.049; Total value: \$5.2 million, August 2014-August 2017. This grant was awarded to CEEPP personnel Robert Godby and Roger Coupal, and to affiliated researchers in the UW College of Engineering, and the UW Wind Energy Research Center, along with researchers at Montana Tech. The project considers (i) wind energy generation improvements, (ii) grid and transmission development and (iii) the evaluation both types of development (generation and transmission to grid) on the overall social value of such activity. The energy economics portion is one of three thrusts the project will examine. It was made possible by past funding from CEEPP for development of an operating economic dispatch model, and the development of computable energy economic and land use models to evaluate the relative social benefits of various types of energy system improvements.

- **The Impact of the Coal Economy on Wyoming:** Wyoming Infrastructure Authority, value \$71,246 (\$20,000 CEEPP match, and International Programs match of \$8,000). Researchers Robert Godby, Roger Coupal, David (Tex) Taylor, and Tim Considine evaluated potential impacts of market and regulatory risks on Wyoming coal production, and developed an economic impact model to estimate how such changes could affect the Wyoming economy. A model of state revenues was developed and the impact on state budget flows was estimated for specific cost, demand and regulatory shocks. Primary efforts were focused on the estimation of U.S. Environmental Protection Agency's greenhouse gas regulations on Wyoming coal production if proposed rules become law.
- **Estimating the Impact of Coal Revenues on School Facilities Department Resources;** State of Wyoming, School Facilities Department; value: \$49,914, July 15-November 30, 2015. Robert Godby, David Aadland, Roger Coupal and Anne Alexander evaluated the potential impact future changes in coal production in Wyoming could have on the Wyoming School Facilities Department (SFD) budget. The department is charged with financing K-12 school construction and facility maintenance in Wyoming. The project developed a forecast model of SFD funding needs through 2022 and estimated the anticipated funding gap changes in coal production and revenues will have on the budget gap the department faces. This was made possible by the work performed and supported by the Wyoming Infrastructure authority with SER/CEEPP matching funds.

CEEPP released a request for proposals in July/August 2014 and funded the following four projects:

- **A Legal and Economic Analysis of the External Regulatory Barriers That Will Hinder States Ability to Implement the New CO₂ Reduction Rule for Existing Power Plants:**
 Researchers: Temple Stoellinger (College of Law), Sam Kalen (College of Law), Anne Alexander (College of Agriculture and Natural Resources)
 Graduate Students funded: 2
- **Aesthetic, Financial, and Behavioral Barriers to Net-Zero Energy and Solar Home Demand**
 Researchers: Ben Gilbert (College of Business), Anthony Denzer (College of Engineering), Jon Gardzelewski, (College of Engineering), Liping Wang, (College of Engineering).
 Graduate Students: 1
- **Integrating Petroleum-Engineering Knowledge into Models of Oil Markets, with Application to Wyoming**
 Researchers: Klaas van't Veld (College of Business), Vladimir Alvarado, (College of Engineering), Charles Mason, (College of Business), Ben Cook, (College of Business)
 Graduate Students: 1

CEEPP developed partnerships with the Wyoming Infrastructure Authority, the Wyoming School Facilities Department, the U.S. Department of Energy, Boise State Energy Policy Institute, the Center for Advanced Energy Studies (CAES), Idaho National Labs, Black Hills Power (Cheyenne Power and Light), Rocky Mountain Power, Southeast Wyoming Economic Development District, Rocky Mountain Coal Mining Institute (RMCMI), the Western Area Power Administration, the American Council of Engineering Companies (ACEC) – Wyoming Chapter, and the Wyoming Construction Coalition

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 multiphase multicomponent media through porous media. Its mission is to expand knowledge in current state-of-the-art experimentation and modeling in multiphase flow to ensure access to subsurface energy resources now and in the future. The center integrates research groups in experimental science, mathematical modeling, and computational science from various UW departments and institutes. Scientists with expertise in distinct aspects of porous media flow and transport projects develop collaborative research projects with other universities/institutions and industry to address new challenges of practical and technological importance. Research will lead to the development of new insight into the physics of subsurface flow, new physically based models, computational algorithms, and analytical/numerical models for the study of complex multiscale multiphase flow physics in heterogeneous porous media and applications of these methods.

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. The center issued the first request for proposals on April 1, 2010 for Geologic Sequestration of Greenhouse Gases and Recovery of Unconventional Gas. The research was focused on fundamentals of multiphase flow in porous media in two topic areas:

- Sequestration of greenhouse gas and associated impurities (GGI) in geologic formations, e.g., deep saline aquifers and oil and gas reservoirs.
- Recovery of natural gas from unconventional reservoirs characterized by low permeability.

Between November 2014 and January 2015, the center released second RFP to support research projects focused on various aspects of hydrocarbon recovery from unconventional reservoirs. Six of the eight proposals were approved for funding after thorough, competitive review:

- Experimental, Analytical, and Numerical Analysis of Hydraulic Fracture Enhanced Hydrocarbon Recovery with Environmental Constraints – PI: Dr. Shunde Yin; UW Department of Chemical and Petroleum Engineering,
- Optimization of Hydraulic Fracturing and Oil Recovery in Unconventional Oil Reservoirs Using Nano-emulsions – PI: Dr. Lamia Goual; UW Department of Chemical and Petroleum Engineering
- Pore-space Alteration Induced by Mineral Dissolution and Precipitation under Flow Conditions – PI: Dr. Mengqiang Zhu; UW Department of Ecosystem Science and Management
- Unconventional Reservoir Characterization Utilizing Parallel Bayesian Markov Chain Monte Carlo – PI: Dr. Victor Ginting; UW Department of Mathematics
- An Experimental Investigation of Flow Dynamics in Shale Oil Reservoirs – PI: Dr. Saman Aryana; UW Department of Chemical and Petroleum Engineering
- Design and Fabrication of Core holder Apparatus to Measure the Influence of Chemical Oxidation on Shale Permeability – PI: Dr. Michael Urynowicz; UW Department of Civil and Architectural Engineering

The project plans will be executed over a period of approximately 18 months with completion date of June 30, 2016.

Furthermore, members of the center have been able to capture new grants from federal agencies and private-sector entities:

- John Kaszuba and his co-PIs were granted a Department of Energy (DOE) award
- Mohammad Piri established new funded projects with FEI, Newfield, and Baker Hughes
- Dario Grana was granted Anadarko Fellowship for Excellence in Energy Scholarship, Anadarko Petroleum Corp.
- Saman Aryana was granted Anadarko Fellowship for Excellence in Energy Scholarship, Anadarko Petroleum Corp.
- Saman Aryana was granted a research project on Reservoir Management Using Data Analytics, by Oxy, USA

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 resulting knowledge will help minimize energy losses and maximize yields in processes such as biomass conversion, photo-generated fuels production and conversion of Wyoming's fossil energy sources into cleaner fuels. CPAC targets research opportunities that support a long-term vision of a future based on clean energy. Because solar energy and biofuels are emerging fields, CPAC and its partners expect to make groundbreaking advances in using the planet's most abundant but underused renewable energy resources.

CPAC has been primarily research-based, and funding for basic research is largely from outside agencies such as NSF and DOE. CPAC supports seed-grant funding to help turn preliminary findings into full proposals, but the overhead from resulting externally funded research projects do not come to the center. Making the CPAC self-sufficient as an organization focused on basic research requires that overhead from grant income from CPAC members goes at least in part to CPAC. Without that arrangement, income from research grants for CPAC will be nonexistent. In the cases that CPAC encourages and supports preliminary research that leads to larger external research grants, some of the resulting overhead income should come to CPAC to continue supporting cutting-edge research.

CPAC has taken steps during FY2015 toward other sources of income. The photovoltaic research array to be installed on the roof of the EIC is intended, as its first demonstration, to provide solar-generated hydrogen that will be used to combine with coal-derived syngas to make methanol as a fuel. This and related projects will attract outside funding for projects that add value to raw resources such as coal and will decrease the carbon footprint of using such resources.

While continuing basic research, because so much is needed, the center has initiated study of the use of solar-generated hydrogen as a hydrogen source for coal gasification and coal-to-liquids processes, which has potential to attract industry interest and support.

Student groups have designed a solar hydrogen-to-methanol pilot plant during the academic year. CPAC purchased much of the needed equipment and made steps to install and build the reactor. As noted last year, this project is in keeping with the SER's interest in value-added processes for Wyoming energy, and supports a long-standing need to store solar energy chemically rather than in batteries. During the summer, it is expected the photovoltaic arrays will be installed and the research systems will be working. The main photovoltaic system will have live monitoring so visitors will be able to monitor the system output. Remote online monitoring is also anticipated.

Because of uncertainties in timing and amount of the installation project costs of the rooftop solar project, CPAC did not run seed grant or undergraduate research requests for proposals. When the photovoltaic project costs become more definite, CPAC will have a better idea of how much to dedicate to competitive research support.

CPAC continues to work in concert with the Materials Science and Engineering (MSE) initiative to support faculty involved in energy-related MSE. SER has supported salaries for technical staff and the purchase of some equipment for the MSE analytical facility, such as a field emission scanning electron microscope, analytical lab facilities, a transmission electron microscope, an X-ray photoelectron spectroscope. The availability of the MSE facility greatly enhances the attractiveness of UW for researchers needing these basic materials characterization techniques, and MSE-related research facilities.

During FY2015, CPAC was awarded the following grants:

- Carrick M. Eggleston (Geology and Geophysics) was awarded a Major Research Infrastructure grant by the National Science Foundation (\$483,530) to build a next-generation hydrothermal atomic force microscope capable of molecular-scale in-situ imaging of mineral surfaces under formation conditions. This was leveraged with a \$200,000 Matching Grant Fund award from SER.
- Bruce Parkinson was notified that his NSF proposal titled "Solar Energy Storage via Photoredox Chemistry at Single Crystal and Porous Semiconductor Electrodes" will be funded at a reduced budget. The award was also leveraged with \$150,000 SER Matching Grant Funds.
- The DOE EPSCoR Grant titled "Quantum Dot Sensitized Solar Cells Based on Ternary Oxide Nanowires" was renewed for principal investigators W. Wang, J. Tang, M. Balaz, Y. Dahnovsky, C. Eggleston and J. Pikal through September 2016 for \$3.9 million.
- The CPAC seed grant to Professor Katie Li in Chemical Engineering has generated a proposal submitted to the ACS Petroleum Research Fund.

CPAC supported two visiting scientists:

- Dr. Katarzyna Skorupska was a visiting scholar from April 2013 to July 2013. She stayed on a visiting scientist in the Parkinson Group during FY2015 and has now returned to Germany to work at the Fritz Haber Institute in Berlin.
- Dr. R. Arun Prasath visited UW from December 3, 2014 to June 1, 2015 to engage in research at UW and with CPAC personnel, with the support of a Raman Fellowship from his native India. Prasath is a professor in the School of Green Energy Technology at Pondicherry University, India. Carrick Eggleston was his fellowship host. Dr. Prasath worked on synthesis and characterization of carbon nitride thin films for photocatalytic applications. The result of the project is that carbon

nitride films were produced with photocurrent densities far higher than had previously been demonstrated in the literature.

CPAC personnel secured these provisional patents and patents:

Provisional patents:

- Fan, M., Tuwati, A., Assiri, M., Catalytic CO₂ Desorption for Ethanolamine Based CO₂ Capture Technologies, 62/017,761
- Fan, M., Popa, T., The Hydrogenation Reaction of Dimethyl Oxate to Ethylene Glycol, 62/017,696
- Monterrozo, R. A, Fan, M., Environmentally-Friendly Inexpensive Composite Iron-Sodium Catalyst on Coal Gasification, 62/018,425
- Fan, M., Jin, E., Diethyl Oxalate Catalysts (Intermediates for Ethylene Glycol Production) and Methods of Making and Using the Same, 62/018,471
- Monterrozo, R. A, Fan, M., Flue Gas Emission Control System via Real-time Produced Coal-derived Sorbent, 61/811,028

Patents:

- Peter A. Dowben, Jinke Tang, David Wisbey, Neutron Detection Using Gd-Loaded Oxide and Nitride Heterojunction Diodes (U.S. Patent No. 8,860,161 B2) October 14, 2014

Awards and recognitions of center members:

Center Director Bruce Parkinson was awarded a Humboldt Research Prize by the Humboldt Foundation. The prize awards €60,000 to cover expenses related to joint research projects with German scientists. Parkinson spent two months in Germany during his sabbatical semester doing solar energy conversion research in collaboration with scientists at the Technical University in Darmstadt, the University of Munich, Ruhr University in Bochum and the Helmholtz Centrum in Berlin. He plans to return to Germany during July and August, 2015, to continue these collaborations.

Unconventional Reservoirs – Subhashis Mallick, Director and Vladimir Alvarado, Associate Director

The center's mission is to develop software and interpretation workflows for characterizing the unconventional hydrocarbon reservoirs.

The center is working to launch an industry-funded research consortium. As a first step, a preliminary meeting was held at the 2014 Society of Exploration Geophysicists (SEG) conference in Denver, CO, which was attended by approximately 50 representatives from 20 oil and gas companies. The current slowdown in the oil and gas industry has prohibited investment by companies to fund a research consortium. The center anticipates it may be operational by early- to mid-2016. Additionally, the center has submitted a proposal to NSF and is planning to submit another proposal to the DOE Office of Sciences.

During the 2015 fiscal year, the center pursued a grant for multi-physics, multi-scale, and multi-component optimization and uncertainty quantification. Principal Investigator (PI) Subhashis Mallick, Co-Principal Investigator Dario Grana, Funding agency: DOE, Estimated requested amount: \$1.5 million.

The center also funded a project, Development of a Multi-Physics, Multi-Scale and Multi-Objective Geophysical Inversion Method for Reservoir Characterization.

- SER graduate assistant funding received in 2014. PI Subhashis Mallick, co-PI Dario Grana.
- A new graduate student will start working on this project in the 2015 fall semester.

The center developed a partnership with Schlumberger GeoSolutions to examine the use of prestack waveform inversion for an improved subsurface image in the areas of complex subsurface geology. As a result, during the 2015 fiscal year, four papers were published in various geophysics journals.

Enhanced Oil Recovery Institute – Rob Hurless, Interim Director

During the 2015 legislative session, state statutes were amended to expand and refine the scope and mission of the Enhanced Oil Recovery Institute (EORI) and the Enhanced Oil Recovery Commission as follows:

The mission of EORI is to facilitate a meaningful and measurable increase in recoverable reserves and production of oil and natural gas in Wyoming that may otherwise not be realized. Key to this is the effective transfer of relevant technology, information and knowledge to Wyoming producers. EORI believes that its mission is being met when producers consider EORI as a vital source of relevant technology, information, and expertise and knowledge for Wyoming fields.

In addition to refocusing its mission, EORI has hired a new director. Steve Carpenter was appointed in July 2015. EORI will relocate its administration, geoscience and engineering functions to Casper, but a few technical staff and applied research activities will remain on the UW campus in Laramie.

More details about this center can be found in the Enhanced Oil Recovery Institute annual report under separate cover, and at www.uwyo.edu/eori.

Wyoming Restoration and Reclamation Center – Pete Stahl, Director

The Wyoming Reclamation and Restoration Center (WRRC) is an interdisciplinary program housed within the College of Agriculture and Natural Resources and works closely with the School of Energy Resources.

The center educates students, professionals and the public on land reclamation and ecosystem restoration; facilitates research and disseminates information on effective technologies and best management practices for reclamation of disturbed lands in Wyoming; and provides help to clientele seeking practical solutions for restoring or reclaiming disturbed lands.

In the last year, the WRRC hosted two workshops. One was the Wyoming Sage Grouse Habitat Restoration Working in Casper in March, featuring 20 presentations on industry approaches and new research outcomes of sage grouse habitat restoration.

The second was the Pinedale Reclamation Best Management Practices (BMP) Workshop held in April in Pinedale, focusing on knowledge sharing of learned best-management practices between industry and WRRC faculty at the University of Wyoming.

Shell 3-D Visualization Laboratory – Emma Jane Alexander, Manager

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

Since the Shell 3-D Visualization Center opened, numerous groups from around Wyoming and the region have experienced demonstrations in the CAVE, including members of the Wyoming Legislature, corporate executives, faculty and administrators from other universities in the region and numerous K12 students from around Wyoming.

In addition to demonstrations, UW researchers are using the CAVE to visualize large and complicated data sets, allowing for more thorough data analysis. They include:

- The Department of Geology and Geophysics has visualized the structure contour of key geologic formations for all of Wyoming's major basins
- The Enhanced Oil Recovery Institute has visualized a modeled pore network from rock samples found in reservoirs
- The Department of Molecular Biology visualized protein analysis as a teaching aid
- The Department of Physics and Astronomy created a bespoke tool for the prototype visualization of quasars
- The College of Engineering and Applied Science has used the CAVE for collaborative design reviews for 55 students

Matching Grants Fund

From 2007-2013, SER's Matching Grant Fund (MGF) has provided significant leverage to energy-related research proposals from UW to improve the chance of capturing external funding. In the last couple years of the program, the number of proposals received by SER decreased, and due to budget constraints of federal granting agencies, fewer proposals have been funded.

Several projects that were funded in 2013 are concluding, but SER has not issued a request for proposals from the MGF program since that time. Starting in fiscal year 2017, SER plans to roll the MGF program into the Centers of Excellence and provide center faculty the opportunity to apply for these funds. Because the Centers of Excellence encourage faculty collaboration on grant proposals, and collaboration on grants is being favored more and more, it is anticipated that matching funds from SER will support proposals with a good chance at being funded.

Uranium Research Fund

In the 2009 General Session, the Wyoming State Legislature appropriated \$1.6 million to the School of Energy Resources for activities related to the in-situ recovery of uranium (ISRU) in Wyoming. The legislation specifies

these funds revert by June 30, 2013; however, in the 2012 budget session, the legislature extended the funds' reversion date to June 30, 2015 (House Enrolled Act 005) to allow more time to deploy the research funds.

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

- September 22, 2009 – Uranium Extraction Workshop, Cheyenne, Wyoming
- October 2009 – Research Priorities for In-Situ Uranium Recovery in Wyoming – report of findings
- *Public Opinion in Wyoming about In-Situ Uranium Recovery*, WYSAC. (2010). Wyoming Survey & Analysis Center, University of Wyoming
- August 4, 2010 – The Future of Uranium Production in Wyoming – A Public Forum on In-Situ Recovery, Laramie, Wyoming
- Analysis of Remediation Strategies for Radionuclide-Contaminated Soils in Uranium Mining – a graduate student research project

The remaining funds (\$1.4 million) were dedicated to funding research related to ISRU. Under the Energy Resources Council's direction and in consultation with the Wyoming mining industry, SER developed a request for proposals to deploy the remaining \$1.4 million for research focusing on optimizing economic recovery of the resource.

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

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

All research projects funded through this program have a completion date of no later than March 31, 2015. All projects are finished and results were presented at a daylong symposium held in Laramie on April 21, 2015. Approximately 100 people from industry, academia, and government organizations attended. All final project reports are due by July 3, 2015. With completion of the research projects and symposium, all requirements of the legislatively funded program have been met.

For more information on the activities of the In-Situ Recovery of Uranium Research Fund please see the final report submitted to the Joint Minerals, Business and Economic Development Interim Committee report found on the SER website: <http://www.uwyo.edu/ser/>

Advanced Conversion Technologies Research Account

Activities of the Advanced Conversion Technologies Research Account are submitted under separate cover to the Joint Minerals, Business and Economic Development Interim Committee. For more information, see the 2014 Report of the Advanced Conversion Technologies Task Force.

Joint U.S.-China Clean Energy Research Center, (CERC)

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), a joint project between the United States and China. The U.S. membership consists of federal, private, and public sectors as shown below:

- West Virginia, University Research Corporation, prime awardee
- University of Wyoming
- University of Kentucky
- Washington University at St. Louis
- Lawrence Livermore National Laboratory
- 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

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 the desire to use coal and increase the viability of the coal industry by looking to conversion technologies that add value to coal. Conducting joint research leverages research funds. In addition, it is likely that commercial-scale projects built in Wyoming will see financial and technical benefit from Chinese partnerships.

In the first five years of the CERC (Phase I), UW provided \$2.5 million in matching funds from SER's budget and the Clean Coal Technology Fund.

In CERC Phase I, SER took part in two identified work projects. The first was research on sequestration theory and simulation technology of CO₂ geological storage and large-scale storage strategy. The key features are site characterization, modeling, risk assessment, and brine treatment, reservoir characterization and ranking, and monitoring planning and design. The second is research on novel catalysts and processes for conversion of coal to higher value petrochemical intermediates and fuels. The key foci are reduced cost of catalysts, greater specificity of product yields, and reduced waste streams of CO₂.

UW has submitted new proposals for funding from CERC Phase II, which will be a continuation of projects funded in Phase I, but must have a component of demonstrating new technologies at a commercial scale. Under this proposal UW would be the lead on a CCUS demonstration project in the Ordos Basin of China as well as a project to demonstrate the capture of CO₂ from an industrial source at an economic cost. If funded by the U.S. Department of Energy, CERC Phase II would begin in October 2015.



SECTION 5 – OUTREACH

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

Distinguished Speaker Series

The University of Wyoming, School of Energy Resources’ 2014-2015 Distinguished Speaker Series hosted 32 top 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 in the EIC’s Encana Auditorium. Speakers’ PowerPoint presentations are on the SER website.

Sept. 19, 2014

Dr. Sally Benson, Stanford University, “Recent Advances in CO₂ Storage and Technology” Attendance: 80

Sept. 26, 2014

Dr. Greg Poulos, director V-Bar Consulting, “Wind Energy, Grid Parity and Strategic Links to Natural Gas” Attendance: 50

Oct. 3, 2014

Martha Wyrsh, executive vice president and general counsel, Sempra Energy, “The Anatomy of an LNG Project” Attendance: 70

Oct. 10, 2014

Dr. Holly Krutka, executive director, Cornerstone Journal, “The Imperative on Global Communication on Clean Energy” Attendance: 50

Oct. 15, 2014

Dr. Mario Ruscev, chief technology Officer, Baker Hughes Attendance: 97

Oct. 17, 2014

Thomas Lockhart, Jr., director, Air Force Materials & Manufacturing, “Old Planes, New Science: Air Force Sustainment Science and Technology” Attendance: 45

Oct. 21, 2014

Dr. George Hirasaki, professor, Rice University, “CO₂ Foam Mobility Control for Carbonate Formations” Attendance: 95

Oct. 23, 2014

Dr. Ren Xiangkum, vice president Sanju Environmental Protection and New Materials, “China’s Coal

Conversion Technologies and Suggestions for Commercial Scale Carbon Capture in Wyoming.” Attendance: 53

Oct. 24, 2014

Mike Robinson and Joe Meyer, U.S. Bureau of Land Management, “BLM Oil and Gas Development A-Z: Case Studies from Converse County, WY” Attendance: 47

Nov. 5, 2014

Dr. Cullen Buie, assistant professor of mechanical engineering, Massachusetts Institute of Technology, “Ultra-Low Cost Membraneless Electrochemical Energy Storage” Attendance: 35

Nov. 7, 2014

Dr. Darryl Butt, Center for Advanced Energy Studies (CAES) **Materials Science & Engineering, Boise State**, “Phase Transformations and Stability of Ion Transport Membranes for Syngas Production” Attendance: 50

Nov. 10, 2014

Dan Ingersoll, NuScale Power, “NuScale Power: Thinking Small in a Big Way” Attendance: 60

Nov. 13, 2014

Jeane Hull, executive vice president and chief technology officer, Peabody Energy, “Technical Talent Pipeline Development – Students to Future Leaders at Peabody Energy” Attendance: 35

Jan. 30, 2015

Ted Watson, professor of chemical and biological engineering and director, Rocky Mountain Magnetic Resonance, Colorado State University, “Determine Intrinsic Permeability with Magnetic Resonance Imaging (MRI)” Attendance: 35

Feb. 13, 2015

Dr. Maohong Fan, SER Professor of Chemical & Petroleum Engineering, “UW is Becoming a Leader in Advanced Fuel and Chemical Conversion Areas” Attendance: 60

Feb. 20, 2015

Dimitri Mavriplis, professor of Mechanical Engineering and Max Castagne Professorship, “High Performance Computational Fluid Dynamics for Multidisciplinary Aerodynamic Problems” Attendance: 60

Feb. 24, 2015

Anne Gaffney, Director of Process Science & Technology, Idaho National Lab, “Oxidative Dehydrogenation of Ethane to Ethylene” Attendance: 50

Feb. 26, 2015

Pete Stahl, Professor, Soil Ecology; Director, Wyoming Reclamation & Restoration Center “The Importance of Restoring Ecosystems Disturbed by Natural Resource Production” Attendance: 45

Feb. 27, 2015

Dario Grana, SER Assistant Professor of Geology & Geophysics and Petroleum Engineering, “Geostatistics-based decision making for reservoir engineering” Attendance: 45

March 6, 2015

Vladimir Alvarado, Associate professor of Chemical & Petroleum Engineering, “Complex Fluids and Interfaces: Unveiling Enhanced Oil Recovery Mechanisms through a Multidisciplinary Approach” Attendance: 50

March 13, 2015

Shawn Taylor, director, Wyoming Rural Electric Association, “Rural Electric Cooperatives -- Who we are, what we do, and why we do it” Attendance: 50

March 26, 2015

Cindy Crane, President and Chief Executive Officer, Rocky Mountain Power, “New Challenges & Opportunities in the Electric Power Industry” Attendance: 35

March 27, 2015

Shane Murphy, Assistant Professor, Atmospheric Science, “Reconciling Methane Leakage Estimates from Basin-Wide to Individual Well Pad Scales” Attendance: 60

April 2, 2015

Bryan Pivovar, Fuel Cell R&D Research Manager, National Renewable Energy Laboratory, “An Overview of Fuel Cell R&D at the National Renewable Energy Lab (NREL)” Attendance: 43

April 3, 2015

Rob Godby, Associate Professor of Finance & Economics, director, Center for Energy Economics and Public Policy, “*The Impact of the coal economy on Wyoming, and possible implications of future GHG regulations,*” Attendance: 60,

April 7, 2015

Norm Augustine, retired Chief Executive Officer and Chairman, Lockheed Martin, “Science & Technology: *Can America Compete?*” Attendance: 100

April 9, 2015

Michael Urynowicz, Professor, Civil & Architectural Engineering and Director of the Center for Biogenic Natural Gas, “*Biogas with Carbon Capture and Storage (BG-CCS): Bridging the Gap between Fossil Fuels and Renewable Energy,*” Attendance: 40

April 10, 2015

Indy Burke, Wyoming Excellence Chair and Director of the Haub School of Environment & Natural Resources, “*Carbon Management in Ecosystems: Understanding the Opportunities and Challenges in the Semi-Arid West,*” Attendance: 60

April 14, 2015

Eric Grunsky, 2015 Distinguished Lecturer, International Association of Mathematical Geosciences, “*The use of geochemical survey data for predictive geologic mapping at regional and continental scales*” Attendance: 31

April 23, 2015

Phil Cameron, Executive Director, Energy Conservation Works “*Local Partnerships to Advance Energy Innovation*” Attendance: 33

April 24, 2015

John W. Pierre, Professor, Electrical and Computer Engineering, “*University of Wyoming’s Role in Improving Reliability of the US Electric Power Grids,*” Attendance: 44

April 29, 2015

Tara Righetti, SER Assistant Professor of Law and Temple Stoellinger, Associate Director of the Center for Law and Energy Resources in the Rockies “*Split Estate Surface Access to Severed Federal Minerals & Policy and Legal Implications of Recent Federal Rulings*” Attendance: 48

June 28, 2015

Dr. Nguyen Van Thuan and Dr. Le Quoc Hung gave a talk titled, “Vietnam’s Hanoi Coal Basin in the Red River delta” Attendance: 55

Conferences and Events**Sept. 30, 2014**

Global Leadership from Wyoming Panel Discussion with Ann Pickard and Tom Botts Attendance: 45

Sept. 30, 2014

Women’s Global Leadership Forum with Ann Pickard, Rita Meyer and Elinor Burkett Attendance: 95

Oct. 30, 2014

Energy Law and Policy In the Rockies Conference, Laramie. Attendance: 259

Collaborations and Sponsorships**July 2014**

- SER Outreach, in collaboration with the UW American Heritage Center’s Alan K. Simpson Institute for Western Politics and Leadership, completed an overview video that explored the social, environmental, and economic impacts of the potential Niobrara Shale Formation.

July 2014

- The UW Center of Global Studies (CGS) and SER Outreach, under the James E. Nielson Excellence Fund for the School of Energy Resources, have formed a two-year partnership to support CGS projects focusing on internationally oriented research related to energy and sustainability of natural resources. Specifically, the partnership supports both student and faculty international research projects, conferences, fellowships and scholarships, and broadening the impact of outreach speakers and symposia in energy and natural resources.
- SER Outreach offers support to the Wyoming Conservation Corps (WCC), which gives UW students experience in working on restoration projects in conjunction with WCC partner companies in Wyoming.

Sept. 17-18, 2014

Wyoming Oil and Gas Fair in Jackson, WY. SER Outreach and Academics hosted a booth.

Sept. 19 -20, 2014

Energy Day Partners Reception at EIC with UW Foundation and UW Athletics

Attendance: 80

Energy Day Tailgate Party, SER table. Attendance: 200

Sept. 26-29, 2014

Rocky Mountain Rendezvous. Attendance: 400

Oct. 9, 2014

X-Prize Contest Planners – Meetings with UW faculty and administrators

Oct. 10, 2014

Minerals Committee Tour of Energy Innovation Center, UW campus in Laramie

Oct. 23 -24, 2014

Dr. Xiangkum Ren, vice president, Sanju Environmental Protection and New Materials – meetings

Oct. 27, 2014

U.S. Senator Mike Enzi tours Energy Innovation Center

Jan. 31, 2015

Legislator's Day – SER provided tours of the WPX Simulator and an update on SER activities to approximately 70 legislators.

Feb. 3, 2015

Carl Bauer, representing SER and the Carbon Management Institute, presented at the Wyoming Infrastructure Authority Meeting in Cheyenne.

February 2015

Milt Geiger, Energy Extension Coordinator, held the following community outreach events:

- Wyoming Extension's Strategically and Technologically Informative (WESTI) Ag Days – On Farm Energy Audits," Feb. 2, 2015, Worland
- "Small Hydropower in SE Wyoming: Exploring the potential at existing water infrastructure," Feb. 17, 2015, Torrington and Wheatland

March 13-15, 2015

Vail Global Energy Forum, Beaver Creek, CO

May 12-13, 2015

Wyoming Energy Summit, Casper – Richard Horner presented

May – June 2015

Energy Law CLE-UW Summer Roadshow

CLE-approved program focusing on emerging issues in oil and gas, and energy law, regulation and ethics held sessions in Rock Springs and Jackson, Wyoming May 26, 2015. Total attendance: 60

Symposia were held June 10-11 in Gillette (attendance 20), Casper (attendance 55) and Sheridan (attendance, 37); June 15 in Cheyenne (attendance, 25) and June 18 in Denver (attendance 30).

Total participation: 227

June 3

Shaanxi Province Vice Governor Wang Lixia visited Gov. Matt Mead. A dinner was hosted by Wyoming Secretary of State Ed Murray. A memorandum of understanding between SER and SPIECE was signed, as well as a sister-sister agreement between Wyoming and Shaanxi Province. Discussions were held on exchanges and cooperation in the fields of science and technology, agriculture, education tourism and natural resources to promote relations, commerce and economic cooperation.

June 17

Shanxi Gov. Li Xiaoping attended meetings and a luncheon at the Energy Innovation Center to review energy academic and research programs at UW. Meetings were also scheduled with Gov. Mead, Wyoming Senate President Phil Nicholas and Wyoming House Speaker Kermit Brown; both Sen. Nicholas and Rep. Brown attended the closing dinner.

June 28-30

A Vietnamese delegation from the General Department of Geology and Minerals of Vietnam visited UW to study the methodology of exploiting coal in very deep seamed coal mines, such as those found in the Powder River Basin. The visit highlighted the cooperation between UW and members of the Wyoming

business community. Welldog, the Colorado School of Mines, Advanced Environmental Technology, the UW Carbon Management Institute and Cloud Peak partnered to provide information and a tour of the coalmine. Michael Urynowicz, director of the UW Center for Biogenic Natural Gas, hosted the event.

Publications and Website

- SER Energy Innovation Center building brochure was updated May 2015.
- Advanced Coal Technology Research Video produced and completed May 2015.
- SER Quick Guide brochure was updated May 2015.
- SER Centers of Excellence brochures were updated September 2014.
- The SER website continually undergoes revisions to update content and provide information in a clear and easy-to-understand form.
- The SER e-newsletter continues distribution to approximately 2,500 people monthly.
- SER database of contacts was updated in May 2015.
- SER Outreach, in collaboration with the UW American Heritage Center's Alan K. Simpson Institute for Western Politics and Leadership, completed an overview video that explored the social, environmental, and economic impacts of the potential Niobrara Shale Formation.
- SER Outreach collaborated with the Wyoming State Historical Society to publish the following articles. These articles will also be used for community college outreach programs:
 - Coal Slurry: An Idea that Came and Went, by Dan Whipple
 - Wyoming's Uranium Drama: Risks, Rewards and Remorse, by Chamois Andersen and Lori Van Pelt
 - Pumping Water to Powering Homes: Harnessing Wyoming's Wind by Tom Mast
 - Rural Electrification Changed Farm Life Forever in Wyoming by Kerry Drake
 - Five Wyoming Oil Fields and the Transformation of an Economy by Rebecca Hein

Hosted and Sponsored Events

April 7, 2015

Norm Augustine lunch with College of Engineering Faculty and Dinner with UW leadership members in energy programs.

April 10

Canadian government delegation lunch with energy program Canadian students attending UW

April 18, 2015

Sponsored a table at the 120th UW Alumni Association dinner held, SER Alum and SER leadership attended.

April 27, 2015

Energy Policy Institute meeting with UW energy program faculty to discuss collaboration opportunities.
Attendance: 28



SECTION 6 – STRATEGIC AREAS OF CONCENTRATION

SER has been fortunate to secure support for a strategic plan that sets priorities for accomplishments by energy programs at UW, and additional support that provided matching funds to build a new High Bay Research Facility (HBRF) to house large-scale energy research as a part of the plan.

The plan focuses on key areas of concentration:

- Exploiting 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 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 inadequate transmission capacity, and convert output to higher-value products.

Progress in programs that address the first two of these areas has been impressive. Research programs, external support from the public and private sectors, and graduate student participation continue to go. Major new contributions and research contracts have been committed by Hess Corporation, Halliburton, Saudi Aramco, Baker Hughes and Newfield Exploration. Well-funded research and graduate student participation is also continuing in the area of coal conversion – primarily to liquids -- research, and private sector support seems imminent.

To advance the goal of climbing the value chain, a draft roadmap for Carbon Engineering has been prepared and circulated for general review. In the near term, the focus is to promote the use of Wyoming coal as a feedstock to make carbon products that attract price premiums higher than its BTU value of coal. The intent is to complete within three years the full techno-economic appraisal for building a coal refinery complex in Wyoming, attract possible investment for the services of a process engineering modeling consultant and initiate groundbreaking research projects. A short form contract for the services of a process engineering modeling consultant, who will undertake preliminary engineering configuration and manufactured product appraisal studies has been initiated.

Carbon Engineering is one of several important links between SER and the College of Engineering and Applied Science Tier 1 initiative. SER is working with the UW Department of Chemical and Petroleum Engineering to identify three positions to be funded initially by SER as part of the initiative. The positions seek to bolster strength in areas of reservoir engineering and carbon conversion processes. SER also continues to commit funding to support three of four research clusters authorized by the college and the Tier 1 task force. SER funds are designated as a match against the state appropriation for Tier 1 designation.



SECTION 7 – HIGH BAY RESEARCH FACILITY

The High Bay Research Facility is critical to elevate the groundbreaking energy research now being undertaken at UW. The facility will provide sufficient space, capacity and state-of-the-art equipment to grow various niche areas of research.

High bay space is referred to as a building designed to incorporate large, open vertical spaces. That kind of space accommodates installation and development of large equipment and the ability to conduct research using large pieces of equipment and materials.

The facility will be a resource shared primarily among SER, the College of Engineering and Applied Science and the Department of Geology and Geophysics. The building will contain about 90,000 square feet of traditional and high bay research laboratories, offices and meeting areas. Initially, the facility will support research by the Center for Innovation for Flow in Porous Media, improved oil recovery, geomechanics and structural engineering.

UW raised \$15 million for the facility and for instrumentation important to the functionality of the target research through corporate partnerships with \$15 million appropriated from the Wyoming State Legislature. In addition, \$10.5 million was set aside during the 2014 legislative session to match investments for additional technology and equipment needs. In August, that goal was met.

In the 2015 legislative session, additional funds were allocated to the construction of the facility:

- \$830,000 in new, non-recurring funds
- Redirection of prior WYCUSP appropriation; \$2.4 million redirected for HBRF construction, not new appropriation
- \$4 million moved from the Engineering Building as a result of shifting the Structures Lab to the High Bay Research Facility, not new appropriation
- \$4.57 million moved from the Engineering Building by the Joint Appropriations Committee to pay for increased costs, due to the higher than anticipated construction costs and additions to the exterior finish

The project budget is \$53.6 million; the construction cost is \$42.8 million, and the remainder of the cost – design services, furnishings, research equipment, contingency, etc. – is \$10.8 million.

UW broke ground on the facility in March. Below-ground work on utilities and foundation started in June, and construction documents were completed. Above-ground work is anticipated to begin in September, and move-in is anticipated in October 2016.