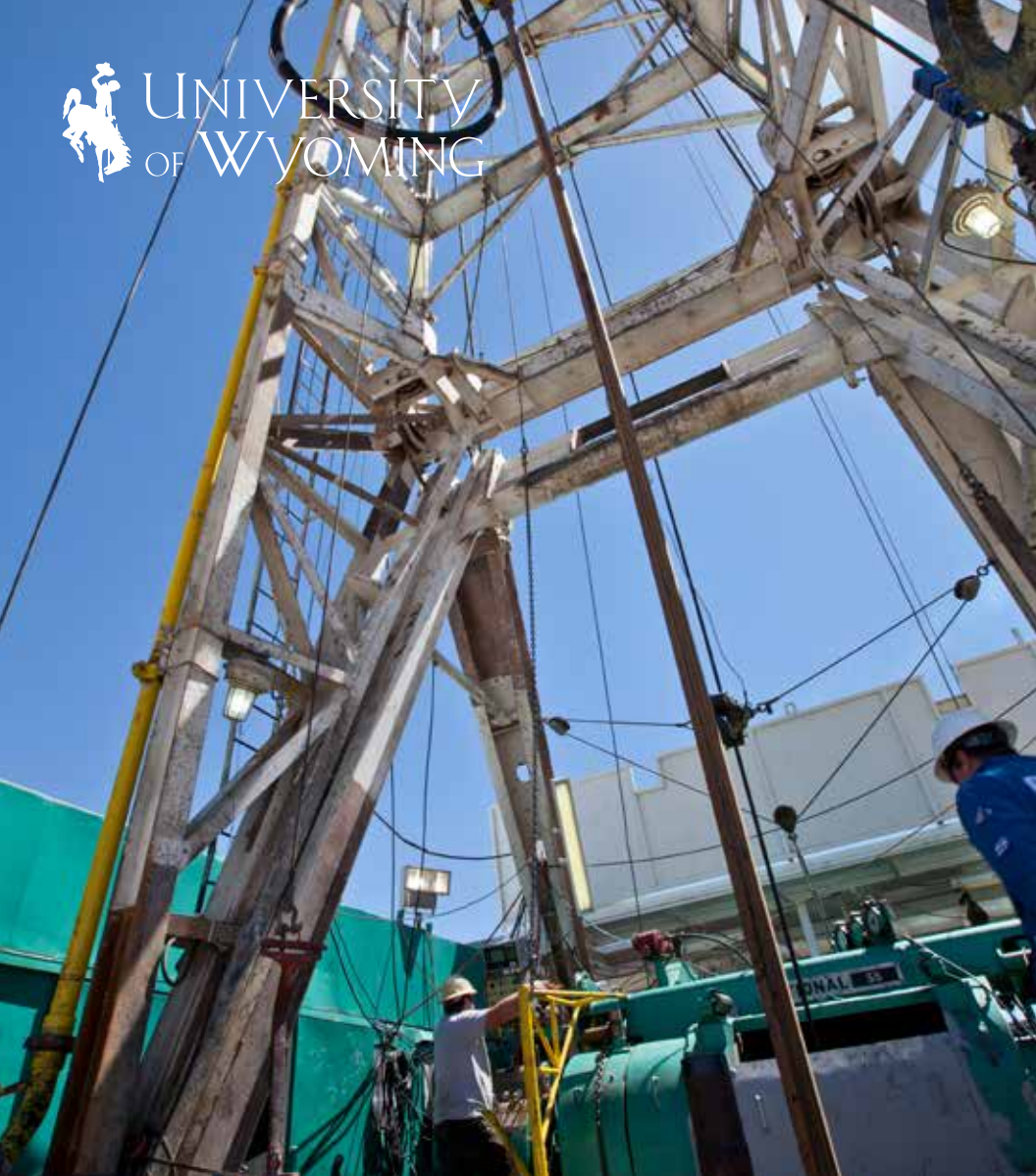




UNIVERSITY
OF WYOMING



Center of Excellence
for Economic Geology Research
SCHOOL OF ENERGY RESOURCES

AN APPLIED GEOLOGY, GEOPHYSICS, RESERVOIR
ENGINEERING, POLICY, AND ECONOMICS RESEARCH CENTER
SERVING WYOMING'S PEOPLE AND INDUSTRIES



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ABOUT THE **CENTER FOR ECONOMIC GEOLOGY RESEARCH (CEGR)**

The Center for Economic Geology Research (CEGR) at the University of Wyoming's (UW) School of Energy Resources is a group of research scientists who apply knowledge in geology, geophysics, reservoir engineering, policy, and economics to explore solutions to challenges in Wyoming's fossil fuel and mineral industries. Wyoming is a large producer of coal, oil, and natural gas, and continued use of these fossil fuels requires accelerated deployment of low-carbon emission solutions. CEGR is leading initiatives that will transform the global energy landscape.

CEGR research scientists actively collaborate with industry, the state of Wyoming, local governments, and national laboratories to:

- Characterize Wyoming's vast subsurface resources for carbon dioxide sequestration, oil and gas recovery, and mineral extraction;
- Develop forward-looking strategies to successfully transition Wyoming to a low-carbon fossil energy future;
- Find opportunities to diversify Wyoming's economy to use all geologic resources, including options for value-added resources in present industrial waste streams; and
- Screen and develop novel uses for Wyoming's distinctive geology, including energy storage and critical material development.

Through applied energy study, CEGR is taking a leading role in the energy transition.



CEGR collected over 600 feet of core for the Wyoming CarbonSAFE project. This core is housed at the Energy and Innovation Center at UW.

RESEARCH PROJECTS AT CEGR

Carbon Capture, Utilization, & Storage (CCUS)

CEGR is focused on economical and sustainable carbon capture and storage. CCUS involves capturing and separating CO₂ from emission sources (capture) and storing it safely and permanently in geologic reservoirs deep below the earth's surface (storage or sequestration). Utilization means the captured CO₂ is first used to increase oil production before being permanently stored underground. CEGR works to address all aspects of CO₂ sequestration, from initial site characterization to facility design and demonstration, legal and regulatory issues, education of the public about carbon management, and other challenges.

Wyoming CarbonSAFE: Wyoming CarbonSAFE (Carbon Storage Assurance and Facility Enterprise) is one of CEGR's carbon capture and storage (CCS) projects and is funded by the U.S. Department of Energy. The objective of the project is to characterize the geology of CO₂ storage reservoirs in proximity to a coal-fired power plant. Wyoming CarbonSAFE is located at Dry Fork Station, a coal-based electric generation power plant near Gillette, Wyoming. Under the supervision of CEGR, a deep characterization well was drilled to a depth of 9,873 feet below land surface to collect geologic core, fluid, and geophysical logs. The project team successfully collected 625 feet of core from 9 different geologic formations and fluid samples from 6 geologic formations. A 9 mile² 3D seismic survey will be collected.

CEGR is focused on economical and sustainable carbon capture and storage.

Core collected at Dry Fork Station near Gillette for Wyoming CarbonSAFE.



U.S.-China Clean Energy Research Center (CERC): CERC is a joint research effort between the U.S. and China. The U.S. membership consists of federal, private, and public sectors and is managed for the DOE by West Virginia University. CEGR has actively worked with CERC partners since 2010. The projects include a joint study to develop a commercial-scale integrated carbon capture utilization and storage demonstration project at Ordos Basin in China. The demonstration project will validate technologies on CO₂ storage and utilization with tight, unconventional reservoirs similar to the Muddy Sandstone in the Powder River Basin (PRB) in Wyoming.



CEGR research scientists examine coal core samples.

Critical Materials & Rare Earth Elements

CEGR conducts studies to evaluate the distribution and occurrence of critical materials in Wyoming and the mountain west. Critical materials are those considered crucial to the economic and national security of the United States or for which supply may be susceptible to disruption. Critical materials include rare earth elements that are essential for high performance electromagnetic sensors, lasers, and electric generators. Elements such as cobalt, manganese, and vanadium contribute desirable properties to speciality alloys and next-generation batteries. CEGR is evaluating several traditional and unconventional sources of these critical materials across Wyoming, with the greatest focus in rare earth elements feedstocks. The table below illustrates some of the rare earth elements and critical materials CEGR is investigating.

		Photovoltaic Films	Wind Turbines	Vehicles		Lighting
	Material	Coatings	Magnets	Magnets	Batteries	Phosphors
Rare Earth Elements	Lanthanum				•	•
	Cerium				•	•
	Praseodymium		•	•	•	
	Neodymium		•	•	•	
	Europium					•
	Terbium					•
	Dysprosium		•	•		
	Yttrium					•
	Indium	•				
	Gallium	•				
	Tellurium	•				
	Cobalt				•	
	Lithium				•	
	Manganese				•	
	Nickel				•	

U.S. DOE, 2011, Critical Materilas Strategy, December, 2011, accessed 12/23/2019 https://www.energy.gov/sites/prod/files/DOE_CMS2011_FINAL_Full.pdf



CEGR research scientists use field, laboratory, and modeling techniques to understand the geologic characteristics of the Powder River Basin, which is home to more than 40% of U.S. coal production. CEGR has collaborated with the National Energy Technology Laboratory (NETL) to quantify the region's potential for rare earth element production.

An unused rare earth elements resource in the PRB could improve coal economies without significantly altering current mining procedures.

Coal is analyzed with optical microscopy methods and other techniques.



Rare Earth Elements in Coal & Coal By-products: The Powder River Basin (PRB) is the largest supplier of thermal coal to the U.S. In an effort to expand coal production and diversify Wyoming's economy, CEGR is working to identify new value-added coal products. CEGR's previous work in this area found potential for the extraction of rare earth elements from coal and the coal fly-ash produced as a byproduct of coal combustion in power stations. CEGR has also characterized the occurrence and distribution of rare earth elements in the largest currently mined coal seams in the PRB and found an unused rare earth elements resource that could improve coal economies without significantly altering current mining procedures.

Rare Earth Elements Dissolved in Oil and Gas Produced Water and Geothermal Brines: CEGR completed a DOE-funded project, which showed that rare earth elements generally occur at low concentration in produced water and geothermal brines, but some basins have much higher concentrations. Continued investigation of rare earth elements in produced water and associated extraction technologies is occurring.

Rare Earth Elements in Unconventional Deposits: This ongoing research is focused on quantifying rare earth element concentration and distribution in sources such as residual igneous melts, uranium roll-front deposits, and the Phosphoria Formation.



CEGR researchers and collaborators at the Wyoming CarbonSAFE characterization well at Dry Fork Station near Gillette, WY.

Unconventional Oil & Gas Resources

Over the last decade, oil exploration in Wyoming has largely focused on unconventional reservoirs in the Powder River Basin. Scientists at CEGR lead and collaborate on research to better understand and develop Wyoming's unconventional reservoirs. All of these programs aim to help Wyoming producers by improving resource recovery.

Unconventional Enhanced Oil Recovery/Residual Oil Zones/Carbon Capture, Utilization, & Storage:

CEGR is collaborating on research that uses the latest operational techniques to target new production zones in some of Wyoming's oldest fields. In the western Powder River Basin, CEGR is working with UW's Enhanced Oil Recovery Institute to test the effectiveness of flooding residual oil zones in tight sandstone reservoirs with CO₂ in an effort to mobilize stranded hydrocarbons and to determine if these reservoirs could provide long-term/low-risk carbon storage.

Engineered Water & Gas Flooding for Improved Oil Recovery in Wyoming's Powder River Basin:

In collaboration with UW's Petroleum Engineering Department, CEGR is researching the response to hydrocarbon production in reservoirs to different injected fluids,



including engineered water, CO₂, low-BTU gases, surfactants, and high viscosity foams.

Mowry Shale: The Mowry Shale is one of the most prolific petroleum source rocks in Wyoming, but it can be hard to effectively recover due to its natural geologic complexity. CEGR is working on an unconventional hydrocarbon assessment of the Mowry Shale, an organic-rich source rock that has provided the oil to many of the oil fields in Wyoming. CEGR is taking a first order look at the Mowry Petroleum System to match geological attributes with production trends.

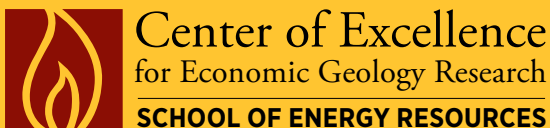
CEGR investigates solutions to challenges in Wyoming's fossil fuel and mineral industries. Research projects at CEGR explore opportunities to use Wyoming's distinctive geology for energy storage, critical materials development, carbon dioxide sequestration, oil and gas recovery, and more. CEGR is dedicated to developing these opportunities to diversify Wyoming's economy and to maintain competitiveness in a low-carbon fossil energy future.

About SER: The School of Energy Resources (SER) at the University of Wyoming was created in 2006 to enhance the university's energy-related education, research, and outreach. SER directs and integrates cutting edge energy research and academic programs at UW and bridges academics and industry through targeted outreach programs.



School of
Energy Resources





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CEGR is a Center of Excellence at the
University of Wyoming's School of Energy Resources.