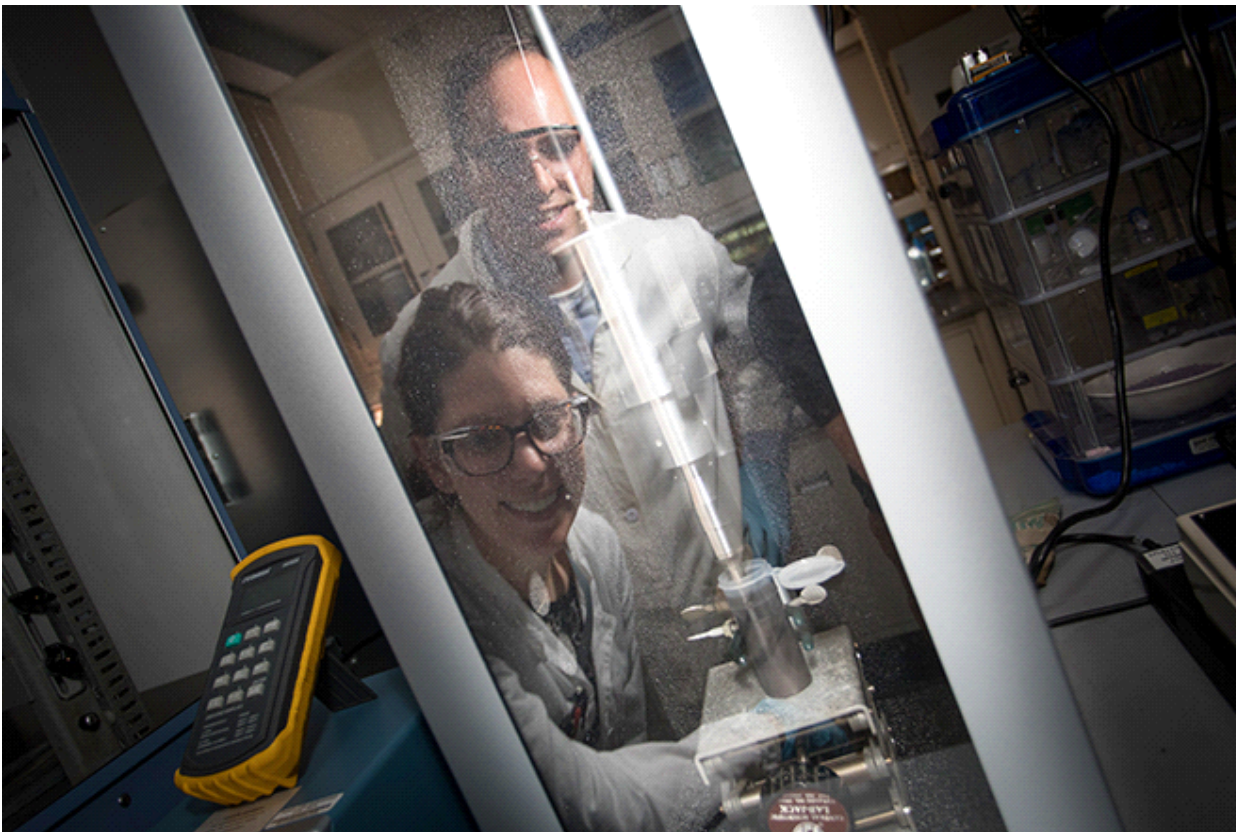


In Wyoming, rare earth elements could be the next coal

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By Taylor Kuykendall
Market Intelligence



National Energy Technology Laboratory researchers Elliot Roth and Megan Macala sonicate coal-based materials to enhance particle separation and the extraction of rare earth elements.

Source: US Department of Energy

Rare earth minerals could be the new coal for Wyoming, a state hoping to gain from the same energy transition that has imperiled its coal riches.

Coal mining companies are even getting in on the rare earths action, with at least one coal miner in the region looking to diversify its mining portfolio.

The rare earths comprise a slew of elements at the bottom of the periodic table that are used in electric vehicles, wind turbines and defense applications. Rare earths are expected to be a key input in electrifying the global economy and China dominates the rare earths supply chain. In the US, the Biden administration has poured money into the industry to help create domestic supply, with Wyoming appearing to be a major beneficiary.

"If we look 20 years down the road, I think that rare earths will be to Wyoming what coal has been," Mel Sanderson, president of Australian miner American Rare Earths Ltd., said in an interview. "It's the next big thing."

Probing for new energy industries

Wyoming's Powder River Basin surface mines are the largest in the country and the state has dominated US coal production for decades. However, the nation is turning away from using coal to generate power, and the fuel's share of US electricity generation has fallen rapidly. Coal generation comprised about 49% of the nation's power generation as recently as 2007, but that share decreased to 19.5% in 2022. This bodes ill for Wyoming, which hosts coal that does not meet the needs of the steel industry, a key global buyer of the black rock.

Weekly coal production from Wyoming



As of July 10, 2023.

Source: S&P Global Market Intelligence.

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With traditional coal customers rapidly disappearing, the state is exploring its options. The Wyoming Energy Authority, a nonprofit run by executives appointed by the governor, uses state money to fund energy projects around the state, from rare earths to coal to uranium.

"Wyoming is open for business," Rob Creager, executive director of the Wyoming Energy Authority, said in an interview. "Critical minerals and rare earths and the like — it's exciting. ... I think it's a huge opportunity for us. We embrace it."

Traditional coal mining and less conventional mining can be complementary businesses in a state very familiar with regulatory frameworks and permitting, Creager said.

"[Rare earths mining] is new-ish, but I think folks are certainly open to it," Creager said.

A federal boost

The discovery of rare earths in Wyoming's coal seams is partly due to a US Department of Energy effort looking at coal-related sediments for rare earths potential.

Researchers were first looking at the Powder River Basin due to its relatively simple geology, said Burt Thomas, technical portfolio lead for critical minerals at the DOE's National Energy Technology Laboratory.

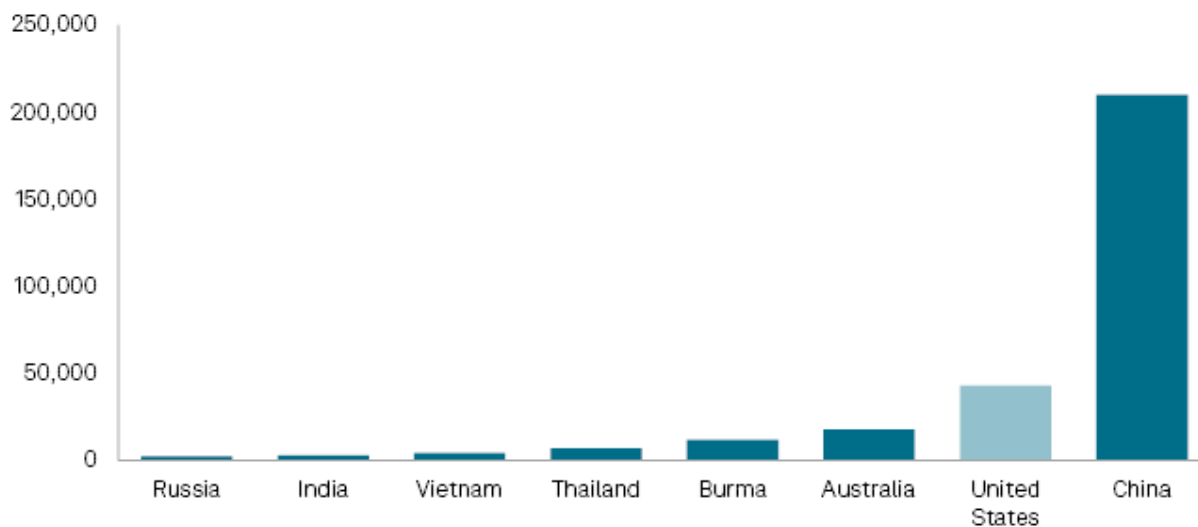
"Many coal seams have different enrichments at the edges of the seams," Thomas said in an interview. "This may be a

universally true thing in the Powder River Basin, or maybe not."

Researchers started analyzing publicly available data but soon realized they needed fresh samples. The DOE and Kentucky-based coal producer Ramaco Resources Inc. already had a research agreement, so they began analyzing samples from the company's Brook mine in Wyoming.

The DOE continues to research potential sources of rare earths while increasing understanding of the geology behind the co-occurrence of rare earths and coal. Researchers are also exploring in-situ extraction methods that would allow the material to be mined with minimal disturbance, Thomas said.

Estimated rare earth oxide equivalent production for select countries in 2022 (metric tons)



As of July 10, 2023.
Source: US Geological Survey.
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From coal to rare earths

The US was more than 95% reliant on foreign sources of rare earth oxides as of 2022, with China providing 74% of imports, according to US Geological Survey data released in early 2023. The US imported an estimated \$200 million worth of rare-earth compounds and metals in 2022, up 25% from \$160 million in 2021, according to the USGS.

The only operation actively digging up magnetic rare earth materials in the US is MP Materials Corp.'s 65%-owned Mountain Pass mine in California near the Mojave Desert.

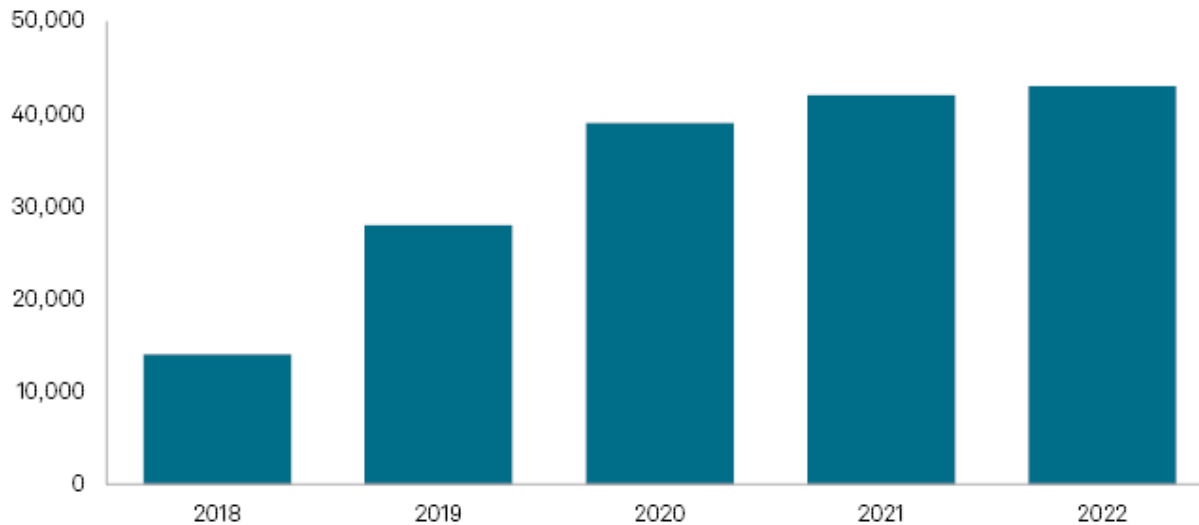
Ramaco Resources is embracing the global energy shift by searching for rare earths in the US. In early May, the company announced it had discovered what could be the "largest unconventional deposit" of rare earth elements in the US at its Brook mine, working in tandem with the US Department of Energy's National Energy Technology Laboratory and consultant Weir International Inc.

Testing including months of core drilling and chemical analysis suggests the deposit is particularly rich in magnetic rare earth elements such as terbium and dysprosium, and Weir recently updated its original resource estimate. The update outlined a range of 886,000 to 1.1 million short tons of rare earth oxides at the Brook property, including up to 260,000 short tons of magnetic rare earths.

Production of rare earth materials could begin as soon as early 2024, Ramaco Chairman and CEO Randall Atkins told Commodity Insights.

"We know we've got plenty of rare earths to satisfy market conditions," Atkins said. "What we don't know, right now, is the best way to process those to produce the concentrate chemically, and then from there, the oxide and ultimately, magnets."

Estimated US production of rare earth oxide equivalent (metric tons)



As of July 10, 2023.
Source: US Geological Survey.
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Atkins said the company is exploring how far down the supply chain it plans to be involved. Ramaco recently announced a new dual-class share structure that would allow investors direct exposure to either its metallurgical coal assets or its rare earth and coal-to-products efforts. The coal-to-products work focuses on manufacturing advanced carbon materials for applications such as creating lightweight automotive parts.

"Right now, we are clearly a met coal company with the tail of the dog being developing that rare earth potential," Atkins said. "At some point, if the rare earth [deposit] looks like it is commercially viable for us to develop, the tail might wag the dog, and we would be considered more of a critical mineral company."

Atkins pointed out that if there are rare earths to be found above and below the coal at the Brook mine site, it would be reasonable to think they exist around other coal seams in the Powder River Basin. Companies have also explored the extraction of rare earth elements from coal and coal waste in the eastern US.

"Fate loves irony," Atkins said. "Wouldn't it be something if you started to solve the rare earths problem that this country has by finding rare earths in coal, which is so much maligned?"

Also in Wyoming, American Rare Earths completed an initial resource estimate in late March for what it says may be one of the largest discoveries of rare earths in the world.

American Rare Earths says its Halleck Creek project hosts resources containing 4.73 million metric tons of total rare earth oxides. The company also recently announced a new method for extracting rare earth elements more sustainably. The project was a collaboration with Penn State University and the Lawrence Livermore National Laboratory and is expected to be deployed in Wyoming.

Meanwhile, US-based Rare Element Resources Ltd. has said its Bear Lodge project in northeastern Wyoming could become a major producer of rare earth elements. The company received \$4.4 million in funding from the Wyoming Energy Authority in November 2022, to advance a rare earths processing and separation demonstration plant.

Why Wyoming

Wyoming is a mining-friendly jurisdiction that does not come with heavy environmental and social baggage, American Rare Earths' Sanderson said.

"As those coal mines continue to shrink in size, there's this trained, professional mining workforce that just needs that little additional training and education to switch over to a rare earths mine like ours," Sanderson said.

Creager, a former senior policy advisor to Wyoming Governor Mark Gordon, said the state's long history of mining makes it a prime choice for new mining activity in response to the recent increase in demand for energy transition metals.

"This is a discussion that needs to take place in D.C. as well for folks that may have goals for EVs or something like that," Creager said. "They need to understand, if that is the case, it's going to require a lot of these minerals — and I think Wyoming and the United States as a whole is a good place for this, not only for jobs and the economic benefit, but the national security implications of making sure we have a domestic supply of rare elements and resources."

Sanderson noted Wyoming has solid transport infrastructure and will be able to easily get materials to the manufacturers building electric vehicles, renewable generation technology and more in the US West and Midwest.

"It will be a relatively short supply chain, and boy, you can't make it more secure than mined and made in America," Sanderson said.

Sanderson said she expects little backlash when it comes to bringing an industry typically associated with the energy transition to coal country.

"We have the smallest population of any state in America," said Sanderson, a Wyoming native. "We need those business taxes for quality of life. We need employment for those miners, and we need employment for those energy workers. So yes, Wyoming is very open to change. We don't have a conflict with that at all."

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