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These nuclear reactors fit on a flatbed truck. How safe are they?

The nuclear industry aims to miniaturize, looking to place hundreds of small power plants across the nation.

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By [Evan Halper](#)

The Golden Chest Mine in the far northern reaches of Idaho seems an unlikely staging ground for clean power innovation. It is a throwback to an earlier era, the last hard rock gold mine in Idaho, where heavy machinery bores deep into the earth.

But mine owner Idaho Strategic Resources plans to make the [operation](#) a showcase for a new energy source: [miniaturized nuclear power](#).

The company wants to power its mining machines with a nuclear reactor small enough to be packed in a shipping container and loaded on a truck. The project would put the company in the vanguard of microreactor development, which backers say could spur wider use of nuclear energy.

At least a half dozen companies are racing to develop tiny reactors, which bear no resemblance to the [hulking power projects](#) dotting riverbanks and coastlines across the United States, with their cooling towers and massive concrete containment structures.

The flatbed-size reactors are designed to generate as little as a single megawatt of power — roughly one-thousandth the amount of a large legacy unit. It's enough to power 1,000 homes, a single manufacturing plant or even a remote island owned by a billionaire (one company claims it has received such an inquiry).

They generally don't require water for coolant, instead using [helium gas](#), molten salt or air-cooled alkali metal pipes to carry heat away from the core. For fuel, they rely on a novel type of uranium pellet that the Energy Department has declared "meltdown-proof." It's an attractive prospect for remote energy customers seeking cheaper and cleaner alternatives to diesel generators and coal boilers.

Some scientists say industry and government claims of safety are [vastly overblown](#). They contend a radiological release could still be triggered by an explosion or technical malfunction that ruptures a small reactor. They also point out that the United States, after decades of futility and frustration, [has](#) yet to find a solution for permanently disposing of highly radioactive nuclear waste.

“The idea that we will start trucking these all over country, putting them in nooks and crannies in populated areas next to data centers and factories without any off-site emergency planning, is just madness,” said Ed Lyman, director of nuclear power safety at the Union of Concerned Scientists. “It is not justified by the science.”

But the Energy Department under both Republican and Democratic administrations has promoted the technology as a viable on-demand clean energy alternative. Now the government is pushing ahead with tests — at a fortified lab in Idaho — of multiple competing microreactor designs.

If one or more emerges as successful, it could be the first new commercial nuclear reactor design used in the U.S. since the early years of the Cold War. Developers of the technology hope to get the first of them running as soon as 2028 and envision installing them widely by the early 2030s.

“We do a lot of looking at what the mine of the future might be,” said Travis Swallow, Idaho Strategic director of business development. “We believe nuclear plays a key role.”

The mini nukes, associated turbines and switching machinery would arrive at a site like a life-size Erector Set. The entire plant footprint takes up as little as two acres.

“People hear ‘nuclear’ and they think Chernobyl,” said Jon Conrad, director of governmental affairs at Tata Chemicals, which hopes to replace dirty coal boilers with microreactors at a Wyoming factory that processes soda ash, a white powder used in toothpaste, laundry detergent and glass.

“They ask us how large this will be, and if we will have these huge cooling towers,” Conrad said. “It is nothing like that.”

The concept of a small, safe reactor that doesn’t have the financial and public health risks, engineering challenges, and environmental baggage of legacy models has intrigued the nuclear industry for decades. The Nuclear Regulatory Commission is looking to streamline approval of the microreactors, saying their “reduced risk profiles and enhanced safety features” may warrant expedited action. But community concerns will factor into its decisions.

Without a federal disposal plan, nuclear waste could linger at project sites for decades.

Another challenge is finding the uranium needed to power the new reactors, which has to be enriched to a much higher grade than the fuel used in existing commercial reactors. It is not currently manufactured in the U.S., and companies are reluctant to invest in facilities to make it until they are certain microreactors are viable and a substantial number of them will be deployed.

“We are going to soon find out what communities are willing to accept,” said Ted Nordhaus, co-founder of the Breakthrough Institute, which advocates for nuclear power and other technological solutions to environmental problems.

Idaho Strategic would purchase its reactors from a California start-up called Radiant. They would first be used at Golden Chest, which is connected to the power grid, so there is a backstop in the event of early glitches. But its hope is microreactors ultimately could replace diesel generators or the need to build power lines to remote, off-the-grid sites at costs of up to \$1 million per mile.

A mobile nuclear reactor that needs to be fueled only every five years is an attractive alternative, said Tori Shivanandan, chief operating officer of Radiant. Radiant plans to haul away the waste when it refuels client reactors and store it at a manufacturing site the company is seeking to build north of Casper, Wyoming.

The proposal to indefinitely store the waste of all Radiant clients in Wyoming is not warmly welcomed by locals.

“I’ve talked to all my neighbors,” Mitchell Groskopf, a Bar Nunn resident who lives near the proposed site, said at a recent public meeting. “Every single one of them is against it. I feel like it is moving way too fast.”

State Rep. Bill Allemand, a Republican who represents the area, warned county commissioners against approving Radiant’s plan to ultimately manufacture as many as 50 of the reactors each year in Bar Nunn, storing all the spent fuel cores on-site.

“When we look 30 years down the road, they have hundreds of these things coming in,” Allemand said. “The people of Bar Nunn do not want this.”

Radiant is undeterred. “We’re confident in the broad support from a majority of local elected officials and the community who want the hundreds of good-paying jobs we plan to bring to the area,” Ray Wert, a company vice president, said in an email.

In a U.S. nuclear industry that has a reputation for overpromising and underdelivering — the last commercial reactors to come online were nearly \$20 billion over budget and seven years behind schedule — the commercial microreactor had been dismissed as too expensive, impractical and dangerous to distribute widely. But soaring demand, driven in large part by the explosive needs of AI developers, is causing large-scale energy users to reconsider.

By next year, as many as three different microreactors will be installed in a domed, concrete-reinforced testing building at Idaho National Laboratory, a final stop for working out any kinks before the technology can be licensed and sold commercially. At least five companies vying to be the first to market are already inking deals with potential clients. They include Radiant, legacy nuclear manufacturer Westinghouse and military contractor BWXT in Virginia, which has partnered with Tata.

“Our customers are demanding a cleaner and more environmental product,” said Conrad of Tata Chemicals. “Coal is an oxymoron in that equation.”

The boom in commercial interest in microreactors is driven in large part by developments in what is

known as TRISO fuel, short for TRI-structural ISOTropic. According to the Energy Department, it seals uranium in poppyseed-size pellets coated with layers of heatproof material that keeps radiation from escaping to the outside in even the most extreme conditions, such as a fire or an earthquake.

“It keeps the bad stuff on the inside from getting out,” said Erik Nygaard, director of product development at BWXT’s new Lynchburg, Virginia, innovation campus. “You are creating the kind of containment that used to require big concrete structures and basically collapsing it into the head of a pin.”

Some scientists are less confident in the fuel, which they say has not been proved to withstand the extreme heat that can occur during a reactor malfunction.

At BWXT’s sprawling new campus in Lynchburg, there is an entire airplane-hangar-size section for Project Pele, the name of a Defense Department effort to build a tiny reactor for military bases. The unit is being assembled in preparation for delivery to the federal testing facility in Idaho. Engineers are putting components through an array of stress tests, examining them under industrial-scale CT scan machines to check for defects and subjecting them to scorching hydrogen-powered furnaces.

The company has long made the small reactors that power Navy vessels. But those run on highly enriched, weapons-grade fuel and are not safe for commercial use.

Down the hall from the Project Pele staging area at the BWXT campus is a cavernous section where the company is developing a microreactor that could be used for space exploration and satellite launches. Kate Kelly, president of BWXT Advanced Technologies, explains that it could also be used to “provide power on the surface of the moon to support human exploration or a commercial lunar economy.”

“Activity in space is increasing pretty significantly,” she said. “To support that, you need increased power.”

There are still numerous challenges to overcome before tiny nuclear reactors are deployed in space. A federal demonstration program called Project DRACO was canceled earlier this year amid concerns the technology cannot be manufactured cheaply enough to make it cost competitive.

At another mini-nuclear company called Nano Nuclear, CEO James Walker said potential clients include manufacturers and government officials in the Philippines and Indonesia looking for reliable power for remote islands.

Walker said a billionaire approached Nano inquiring whether the microreactor could be used to power a self-sustaining island community. “They asked if it was possible to have a project where this could power their own vertical farm and their own desalination plant on an island that is completely self-sufficient,” Walker said. “We communicated back that it is certainly possible.”

CORRECTION

A photo caption in a previous version of this article incorrectly asserted the Rössing Uranium mine in Namibia is now known as the Husab Mine. The Husab Mine is a separate mine near the Rössing mine and has a different operator.