This Texas geothermal startup is storing energy in the ground

Sage Geosystems says its earthen "battery" system, now undergoing pilot tests in Texas, could be used to store energy to help balance power grids.

4 April 2023

Sage Geosystems CEO Cindy Taff, shown second from right, stands with her team at the Texas test site. (Sage Geosystems)

Maria Gallucci

Just south of San Isidro, a tiny Texas town near the U.S.-Mexico border, an abandoned gas

tapping the Earth itself.

Sage Geosystems, a three-year-old geothermal energy startup, is using the old well as a test bed. Last year, the company created a 3,200-foot vertical reservoir deep underground using its novel fracturing technology. For the last six weeks, Sage has been pumping and storing large volumes of water in the artificial reservoir, which sits in the rock formation at an average depth of 9,500 feet.

The reservoir's water pushes up against the rocks around it, building up mechanical pressure in the fracture. When the crew opens a wellhead valve at the top, the pressure releases, pushing out the water with such force that it can drive a turbine and generate electricity.

Cindy Taff, CEO of Sage Geosystems, likened the setup to an earthen battery. The idea is that, during times when wind farms or solar arrays produce more electricity than people need, the excess power can be used to pump water underground. When electricity demand is high, Sage can open up its floodgates and return power to the grid.

"What the tests showed is that this power is dispatchable, which is very important to the grid," she told Canary Media.

The mechanical storage system in Starr County produced enough electricity to power seven yellow shop fans. (Sage Geosystems)

The startup is also seeking to deploy the same approach in deeper and hotter geothermal wells – of temperatures exceeding 300 degrees Fahrenheit – where it believes the cost-effective combination of pressure and heat can deliver potentially two times more energy than pressure alone.

Sage is among the dozens of companies that are striving to make it easier and cheaper to access the vast amounts of heat beneath our feet – both for producing clean electricity in power plants and potentially for storing energy to keep the grid running smoothly. Many of the firms are led or funded by oil and gas industry veterans who are channeling their knowledge of drilling techniques and geosciences to harness heat instead of hydrocarbons – the leading culprit behind human-caused global warming.

Taff said she joined Sage in late 2020 to start a second career in renewables, after working for 35 years at the British oil and gas giant Shell. Sage's founders, Lance Cook and Lev Ring, worked for Shell and oil field services firm Weatherford, respectively, before pivoting to geothermal. The company is headquartered in Houston, a city known as the world's oil and gas capital that is also becoming the epicenter of the U.S. geothermal boom.

"This startup ecosystem is the fastest-growing in the world," said Jamie Beard, founder and executive director of Project InnerSpace, a nonprofit focused on expanding the use of geothermal energy.

The startup Sage Geosystems tests its advanced drilling techniques at an old gas exploration well in South Texas. (Sage Geosystems)

Beard, who previously ran the Geothermal Entrepreneurship Organization at the University of Texas at Austin, said she's helped advise and mentor several fledgling companies in recent years, including Sage's team. Now, more enterprises are emerging than she can keep tabs on, with firms working on everything from rock-vaporizing drills and subsurface radiator systems to digital mapping tools and business models for residential-scale installations.

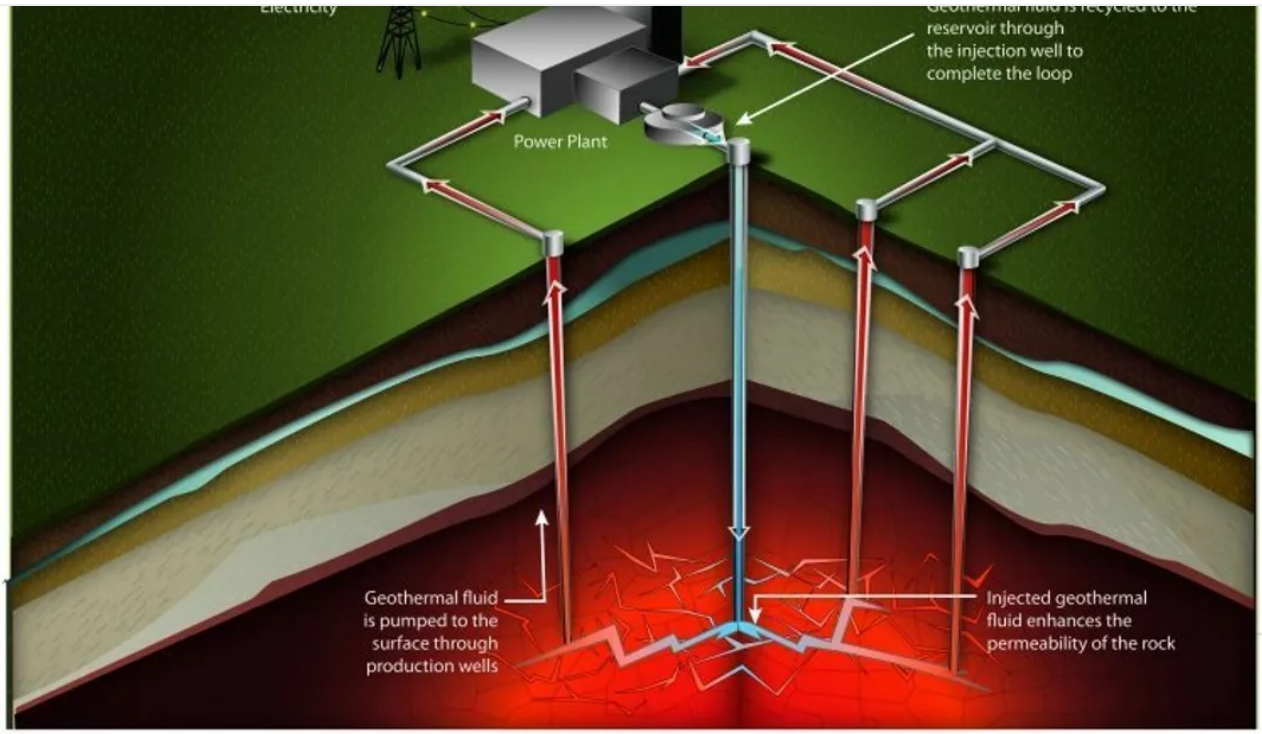
"Everybody claims to have a little bit of a different approach," Beard said. "Some startups are riding the coattails of others that have been successful. But there are quite a few that have come up with some pretty cool new stuff."

the burgeoning geothermal sector is primarily focused on figuring out how to harness Earth's heat to produce around-the-clock "baseload" electricity in more locations.

Today, a typical geothermal well reaches down thousands of feet into rocks or naturally occurring reservoirs. Hot water or steam is piped to the surface to drive turbines and generate 24/7 electricity. Most geothermal projects are located near relatively easy-to-access heat sources, such as hot springs, geysers and volcanoes. In the United States, such natural features occur in just a handful of places.

As a result, only about 0.4 percent of annual U.S. electricity generation comes from geothermal power plants, the bulk of which are located in California and Nevada. Wind and solar projects, by contrast, account for 10.2 percent and 3.4 percent, respectively, and are more widely distributed across the country.

Companies and research institutions are developing new approaches to access geothermal resources that are otherwise too expensive or technically complex for existing technologies to reach.



An illustration shows enhanced geothermal systems paired with a power plant. (U.S. Department of Energy)

In Utah, the U.S. Department of Energy is sponsoring an ongoing project to develop "enhanced geothermal systems," an initiative that involves drilling two 8,000-foot wells and creating fractures in the solid rock, allowing hot water to circulate in a closed-loop system. Fervo Energy, another Houston-based startup, is using the same horizontal drilling techniques and fiber-optic sensing tools as the oil and gas industry to develop lower-cost geothermal power. Its first commercial plant, a 5-megawatt facility, is now under construction in Nevada.

XGS Energy is creating thermally conductive materials that it says can transfer more heat from surrounding rocks to the water or working fluid in a closed-loop system. In early March, the Palo Alto, California-based company raised $19 million to build an aboveground prototype system that mimics the extremely hot granite formations – of roughly 480 degrees Fahrenheit or hotter – that the company plans to drill into.

recently announced a $74 million funding opportunity for up to seven pilot projects that will test and scale enhanced geothermal systems nationwide.

The Frontier Observatory for Research in Geothermal Energy (FORGE) project is underway in Beaver County, Utah. (U.S. Department of Energy)

Storing excess renewable power underground

Sage, for its part, is also interested in using its advanced drilling techniques to supply heat for geothermal power plants. But Taff said the company is increasingly focused on using its drilling technology to enable energy storage – a concept that is also gaining traction within the larger geothermal industry.

In February, Sage returned to the ranch in Texas to test its mechanical storage system.

The startup installed a ground-level storage facility that holds some 30,000 barrels (1.26

gathered during testing to simulate how much electricity the site could discharge, like a battery, over certain periods of time.

“The results are so much more than we anticipated,” Taff said by phone last week.

Early tests suggest that, by pumping 5,000 barrels of water into the well, the site could produce 200 kilowatts of electricity during a 5-hour stretch. With 10,000 barrels, the site could produce the same amount of power for 9 hours. A later round of testing indicated that pumping some 20,000 barrels of water could generate 650 kilowatts of electricity for 2 hours.

Water drives a pair of turbines at the Starr County test site. (Sage Geosystems)

Sage has plenty more work to do before it can turn the simulations into a real-world storage system. Its pilot tests are powered by diesel generators, but future projects will

Other entities are also making progress on underground energy storage. Fervo Energy is experimenting with storing energy beneath the desert floor of northern Nevada, as *MIT Technology Review* described in detail. Researchers at the National Renewable Energy Laboratory (NREL) are working to identify inactive oil and gas wells that could be repurposed for harboring electricity from concentrated solar power plants.

Depleted oil and gas reservoirs are a potentially good place for storing energy for a couple of reasons, said Dayo Akindipe, an NREL scientist working on the lab's new reservoir thermal energy storage project. Reservoirs are found mainly in porous, sedimentary basins that are easier to fracture than granitic rocks. Often, ample data is already available about a site's geology and subsurface characteristics.

Such information is key to understanding a site's potential risk for seismic activity, he said. In recent years, geothermal energy projects using different types of drilling technologies were shut down in Switzerland, South Korea and France after triggering earthquakes and rattling surrounding cities.

"There's always a risk of induced seismicity," Akindipe said. "But the risk is usually based off of whether you have done good reservoir characterization or not."

Taff said that Sage installed four induced-seismicity monitoring stations around the Texas ranch, which have been gathering readings since September 2021, before any testing began. The data is uploaded to a public portal called TexNet, which is run by the Bureau of Economic Geology at the University of Texas at Austin. So far, the stations haven't detected any earthquakes or tremors, she said.

Late last week, Sage's crew began dismantling the equipment at the site. The startup is now preparing to return later in the year with higher-pressure turbines to replicate its tests at a bigger scale and demonstrate commercial-scale electricity generation.

"The results that we're getting are so good that we're wanting to quickly move to a full commercial demonstration," Taff explained.

Maria Gallucci is a clean energy reporter at Canary Media, where she covers hard-to-decarbonize sectors and efforts to make the energy transition more affordable and equitable.

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