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'Deep Geothermal' Promises to Let Drillers Go Deeper, Faster and Hotter

New technologies would allow geothermal plants to be built in places where Earth's heat is farther from the surface

Current geothermal plants, like this one near Calipatria, Calif., operate mostly where subterranean heat is closer to the Earth's surface. Deep geothermal could tap more heat sources and be a game-changing alternative to fossil fuels.

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By Benoît Morenne Follow

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A group of startups and researchers are developing technologies to expand the output of geothermal energy.

Geothermal plants produce steam from underground reservoirs of hot, porous rocks saturated with water, and channel it into electricity-making turbines or pipes that heat buildings. Although the energy is virtually free of carbon emissions, its adoption has been limited because drilling gets more expensive and more difficult as it goes deeper.

As a result, geothermal plants mostly operate where subterranean heat is closer to the Earth's surface and more accessible, including parts of the U.S., the Philippines, Indonesia, Turkey and New Zealand, and the wells that feed them steam typically aren't more than 1 to 2 miles deep. These countries held about

70% of global geothermal capacity in 2021, according to the International Renewable Energy Agency.

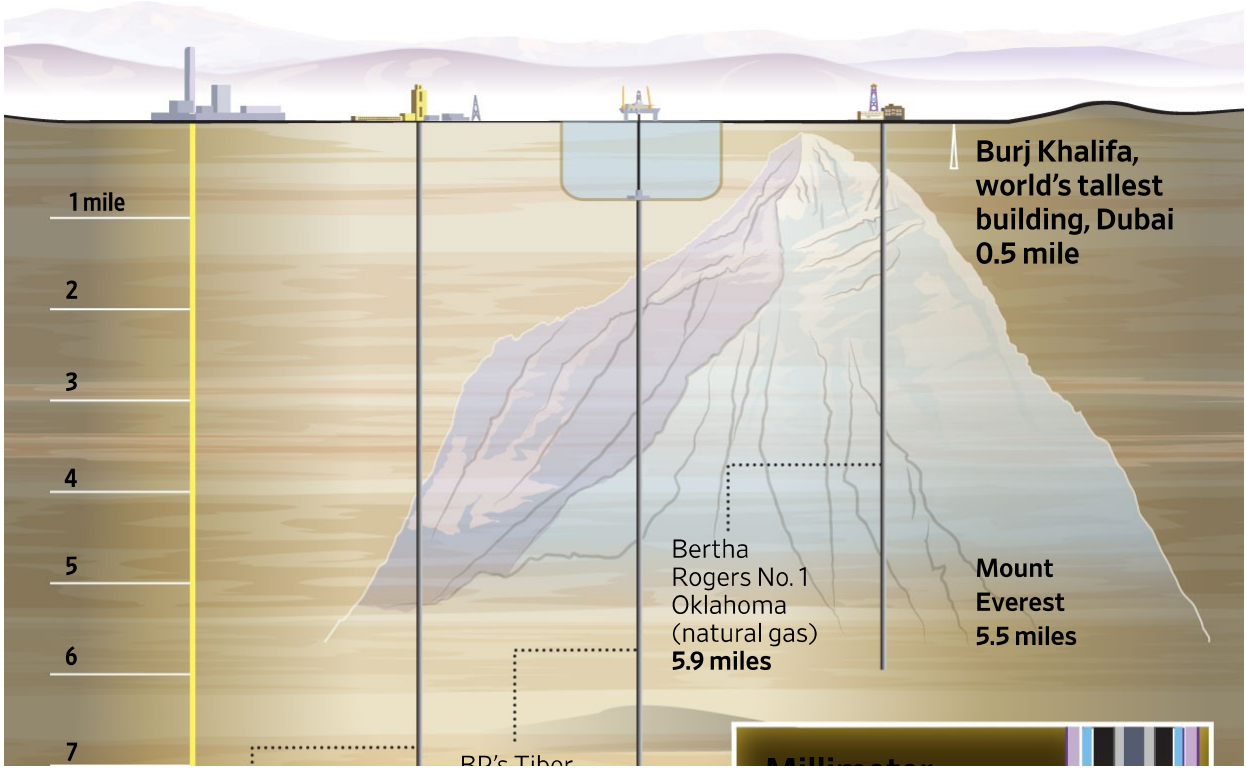
The new technologies being developed would enable deeper drilling, which would allow geothermal plants to be built in places where the Earth's heat is farther from the surface. Tapping into the hotter material at greater depths —which is known as deep geothermal—also has the benefit of capturing more of the Earth's energy. The goal is to reach depths where the temperature can exceed 900 degrees Fahrenheit.

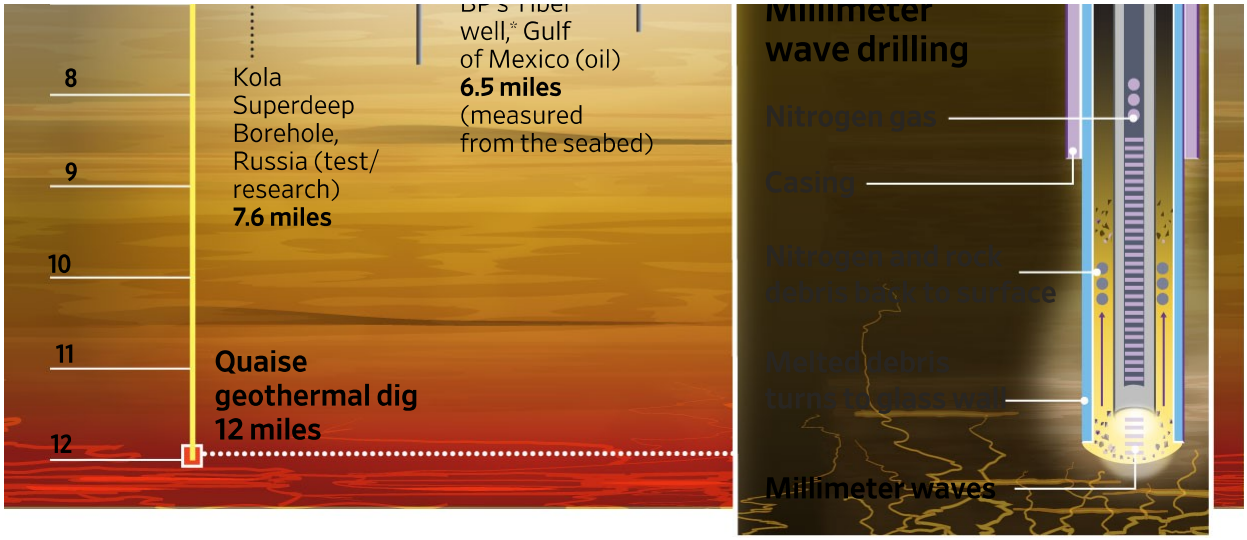
"Deep geothermal means hotter geothermal, and more consistently being able to distribute it around on the planet," says Dennis Whyte, the director of the Plasma Science and Fusion Center at the Massachusetts Institute of Technology.

Still, to be economically viable, deep geothermal will have to prove that long wells can be drilled faster than with traditional methods, and at comparable costs. If successful, these efforts could make geothermal a game-changing alternative to fossil fuels, scientists say.

Hot Resource

Deep geothermal energy aims to tap the intense heat deep in the Earth, where temperatures can top 900 degrees Fahrenheit. Here's the scale of the undertaking, with some comparisons, and a look at one technology.





Note: Surface buildings not to scale
*Offshore well
Sources: Quaise; WSJ reporting
Kevin Hand/THE WALL STREET JOURNAL

Repurposing coal plants

Quaise Energy, a spinoff from the Massachusetts Institute of Technology, has raised $75 million to develop technology it says can overcome the subterranean challenges of heat, pressure and sturdy rocks. It aims to use a drill bit to dig through sediments and, at a depth of around 3 miles, switch to a radio-wave-emitting device called a gyrotron.

Beaming the waves down the well will vaporize the rocks, allowing Quaise to drill at a rate of about 16 feet per hour, the company says. The company plans to dig wells of up to 12 miles deep, which could take about six months. The Kola Superdeep Borehole in Russia, currently the deepest man-made hole on Earth, extends about 7.6 miles below the surface.

Gyrotrons are already commercially available and in operation around the world in fusion-energy research laboratories, says Paul Woskov, a researcher at the MIT Plasma Science and Fusion Center who spent a decade researching the technology and whose work provided the basis for Quaise's project.

Quaise plans to join with power companies to feed steam to turbines in coal power plants, allowing these generators to be repurposed to create carbon-dioxide-free energy. Quaise estimates that digging wells and refurbishing a coal plant to produce 300 megawatts of clean electricity would cost about half a billion dollars, far cheaper than building new infrastructure. It aims to run in

billion dollars, far cheaper than building new infrastructure. It aims to run in-field tests in Texas or the Western U.S. in 2024 and start providing steam to a reconverted coal-fired plant in 2028.

Efforts in Europe

GA Drilling, a Slovakia-based startup, has invested about $75 million to develop a drilling method it says is compatible with drilling rigs used in the oil-and-gas industry. The company plans to dig underground using mechanical force until it reaches depths of about 3 miles. Then, it will lower a drill head shaped like a tank gun down into the well, and blast rocks with powerful bursts of water heated to the temperature of the sun's surface to crack and crumble them—a technology the company has dubbed Plasmabit.

This technology, which has been experimented with by some drilling companies, will be cheaper than conventional drilling at greater depths, says Igor Kocis, the company's founder and CEO. "Every kilometer drilled will be approximately similar as the previous one" in cost, he says. Drilling a roughly 6-mile-deep well will cost about $10 million, one-tenth of what it would cost using conventional means, he says.

In Europe, Orchyd, a group of five research institutions and a drilling company, received €4 million, equivalent to about $4 million, from the European Union to combine two drilling technologies already on the market: high-pressure water jets, which slice through rock, and percussive drilling, which pummels it two dozen times a second with a drill bit.

This method will allow engineers to soften hard rock and punch through it, say Laurent Gerbaud and Naveen Velmurugan, two scientists involved in the project, based at Center of Geosciences of Mines Paris/Armines, a research center in Paris. They say this approach will reduce drilling costs by about 65% compared with conventional drilling and offer a drilling rate up to four times as fast. The technology could be deployed in the field in 2025, Orchyd says.

Investment grows

Deep geothermal's promise of unlocking a constant, vast source of energy has also caught the eye of established drilling companies.

Houston-based Nabors Industries Ltd., NBR **2.85%** one of the largest providers of drilling services, has invested $12 million and $8 million in Quaise and GA Drilling respectively. Nabors hopes to become a leading driller of geothermal projects, says Guillermo Sierra, vice president of strategic initiatives. He acknowledges that the technologies presented scientific and engineering challenges, such as controlling the blasting of rock from miles away and ensuring electronics operate as designed in harsh conditions.

"We're just hoping that some of these things can start getting integrated within our rig," he says. These new techniques could also be used by oil-and-gas companies to extract hydrocarbons in a way that is more efficient and therefore less polluting, he says.

Beyond deep geothermal, companies developing digital solutions to map hydrothermal reservoirs, such as Zanskar, or developing ways to drill horizontally into geothermal reservoirs, like Fervo Energy, have also attracted millions of dollars in investments. PitchBook Data Inc. estimates that as of August more than $363 million in venture capital had been invested in geothermal in 2022, roughly double the total for all of last year.

Geothermal is also set to receive a boost from tax credits included in the Inflation Reduction Act, potentially totaling billions of dollars.

"Investment is back in geothermal," says Olivier Le Peuch, chief executive of SLB, the world's largest oil-field-services company, formerly known as Schlumberger.

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