

## Fracking Could Help Geothermal Become a Power Player

David Biello continues his reports for the Scientific American

Here's another use for fracking: expanding access to hot rocks deep beneath Earth's surface for energy production. In April Ormat Technologies hooked up the first such project—known in the lingo as an enhanced geothermal system, or EGS—to the nation's electric grid near Reno, Nev.

"The big prize is EGS," enthuses Douglas Hollett, director of the Geothermal Technologies Office at the U.S. Department of Energy (DoE). "The key is learning how to do it in a reliable way, in a responsible way."

By some estimates, the U.S. could tap as much as 2,000 times the nation's current annual energy use of roughly 100 exajoules (an exajoule equals a quintillion, or  $10^{18}$  joules) via enhanced geothermal technologies. With respect to electricity, the DoE concludes at least 500 gigawatts of electric capacity could be harvested from such EGS systems. Even better, hot rocks underlie every part of the country and the rest of the world. Australia's first enhanced geothermal system, spicily named Habanero, began producing power in May, and Europe has brought three such power plants online.

The idea is simple: pump water or other fluids down to the hot rocks beneath the surface. Heat from the rocks turns the water to steam. The steam rises and turns a turbine that spins a magnet to make electricity.

The technology is proved. For years people have turned naturally produced steam from hot springs and the like into electricity. A geothermal power plant in Larderello, Italy, has churned out electricity this way in Tuscany for more than a century, and big power plants can be built this way. The Geysers in California can produce 850 megawatts of electricity alone. But that's because the geothermal resource is close to the surface and obvious, thanks to hot steam rising into the sky.

Although similar natural bounty has turned Iceland into a geothermal powerhouse, there are only so many such sites around. That's where fracking, the controversial practice of pumping fluid underground to shatter shale and release oil or gas, can help. Fracking "enhances" geothermal by making cracks in hot rocks where none existed, allowing heat to be harvested from Earth's interior practically anywhere, although this reduces the total power produced because of the need to pump water through the system.

As an added benefit, however: geothermal power can run constantly—the hot rocks don't cool very fast—which makes it renewable and predictable.

"Geothermal is homegrown, reliable and clean," says Rohit Khanna, program manager at the World Bank for its Energy Sector Management Assistance Program. That is a big part of the reason it is being pursued in developing countries such as Chile, Indonesia, Kenya and the Philippines.

In the case of the Philippines geothermal power now produces nearly 2,000 megawatts, or nearly 20 percent of the country's electricity, thanks to investments

that were made in the 1990s. And Kenya, according to its ambassador to the U.S., Elkanah Odembo, would like to derive more than half its electricity from geothermal by 2030. The goal: a combination of geothermal and hydroelectric power that will make them entirely renewably powered. "The potential is there," Odembo promises. He says the Rift Valley contains an estimated 15 gigawatts of potential geothermal power. Nairobi has already become a boomtown for such development.

Yet, geothermal's abundant, renewable, clean potential for making electricity largely languishes, producing "less than 1 percent of global energy," according to a recent [perspective in Science](#). Indeed, only 6 percent of naturally occurring geothermal resources have been tapped to date, according to Bloomberg New Energy Finance (BNEF).

The reason is simple: money. In addition to the \$6-million to \$8-million risk of drilling a dry hole or a well that does not produce steam as it should there is the multimillion-dollar expense of building a power plant on top of those wells that do produce steam as they should. That adds up to a total cost for a geothermal power plant of roughly \$90 per megawatt-hour, which compares with \$67 per megawatt-hour for a natural gas-fired power plant or \$144 per megawatt-hour for photovoltaics, according to the DoE's [Energy Information Administration](#).

That number only partially includes the big expense of exploring the geothermal resource in the first place. Gradient holes have to be drilled to explore a particular area. Explosions need to be set off at the surface to send seismic waves through the rock that allow for surveying the underground landscape—a technique familiar from the oil and gas industry. It can take years and millions of dollars to do this exploration with the prospect of earning that money back slowly via electricity sales—or all those funds could be lost. A project by Google and the University of Texas aims to help with that by using public information to develop [maps of geothermal potential](#) in the U.S.

BNEF puts the odds of successfully completing a geothermal well at 67 percent, which means one third of all geothermal projects fail. The analyst outfit has called for a "[global geothermal exploration drilling fund](#)" of some \$500 million provided by investment agencies like the World Bank. Another problem: some EGS projects have been associated with small earthquakes, much like oil and gas drilling and [wastewater disposal](#). That has caused some projects to be abandoned.

As a result, there's a large role to play for supporting research and development to lower risks and improve the technology. The DoE, which [invested in Ormat's Nevada project](#), also has programs to explore how to expand geothermal's reach. For example, it may be possible to take advantage of lower temperatures from cooler rocks found throughout the subsurface. The hot water co-produced with oil and gas wells could also be used to produce electricity. Slimmer test wells might decrease costs of exploration. Of course, better drilling technology developed for geothermal energy production may find a use in the oil and gas industry first, such as the laser drilling being pioneered with the [help of ARPA-E](#) by Foro Energy. In fact, the oil and gas industry may find itself developing

technology that can be applied to enhanced geothermal. Their efforts to frack shales and free natural gas or oil require them to understand flow rates of fluid through the rock. "We know that has to tie into what we do," DoE's Hollett notes. In the end, [geothermal development](#) may be best summed up by a song title: "Nice Work If You Can Get It," says BNEF analyst Mark Taylor. "If you have a great resource, demand for power and secure access to land, it's great. Without any of those things, it's really tough to get geothermal done." Currently, the best place for enhanced geothermal systems in the U.S. is Nevada, particularly the northern part of the state, where there may well be more sheep than people and the government is a major landowner that favors renewable development. "Nevada in itself is having more projects than almost any country in the world," notes Benjamin Matek, an industry analyst for the [Geothermal Energy Association](#). Maybe that should change.