

**GEOTHERMAL**

## Geothermal Potential Runs Hot in Texas

Geothermal energy is bidding to emerge from its dark horse status in Texas and become a possible solution of choice for some renewable applications.

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A Nabors rig on location for Sage Geosystems in Starr County, Texas. *Source: sagegeosystems.com.*

When it comes to oil and gas production in the US, Texas is king. In 2022, the Lone Star state pumped out 1.83 billion bbl of crude in total—that's over three times the next state on the list, New Mexico. Over the same period, Texas set a record with 11.2 Tcf of natural gas production, more than 3.5 Tcf higher than second place Pennsylvania.

With renewables, Texas can hang its hat on being the number one wind energy producer in the US, generating about 93 TWh of electricity from wind in 2020, according to the US Energy Information Administration (EIA)—almost triple that of second-place Iowa. Texas is number two on the list when it

With leadership positions in most commercial power-generation endeavors, Texas is behind the curve when it comes to exploiting geothermal energy. In fact, most of the nation has yet to embrace geothermal power, beyond some projects in California.

According to the EIA, in 2020, consumption of renewable energy in the US grew for the fifth year in a row, reaching a record high of 11.6 quadrillion British thermal units (Btu), or 12% of total US energy consumption. While wind led the way with 26% of the total, only 2% was geothermal.

All of this, however, could be changing.

A recent report about the future of geothermal energy in Texas—a year-long multidisciplinary, cross-collaborative effort from researchers at five Texas universities, the [University Lands Office](#), and the International Energy Agency—found the state’s geology presents a large and promising opportunity to develop geothermal resources. The 400-page report showed the amount of heat below state lands is many thousands of times larger than what would be needed to power not only Texas, but the world. The report was funded and supported by the Cynthia and George Mitchell Foundation, The Educational Foundation of America, and [Project InnerSpace](#), a nonprofit organization focused on expanding the use of geothermal energy globally.

The heat beneath Texas varies with the geography, but most of the population is at or near good temperature environments, particularly in the eastern, coastal, and far west regions. However, all areas are hot enough if you drill deep enough. It becomes a matter of continually improving economics of drilling to deeper depths. In general, the hotter the better, but a good minimum rule of thumb is about 150°C (or 300°F) as a target temperature **(Fig. 1)**.

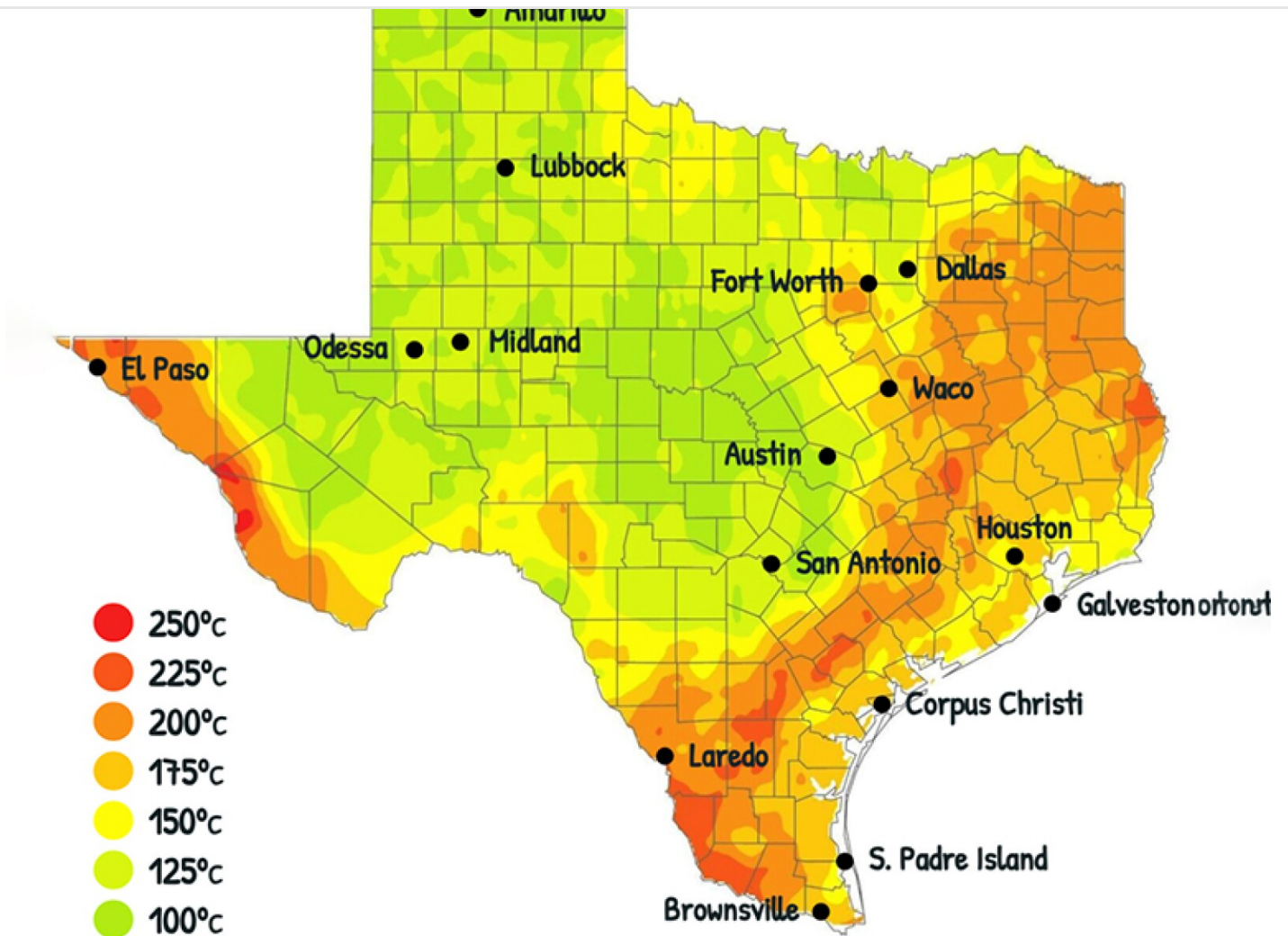


Fig. 1—Temperature of Texas geothermal resources at 6.5 km depth. As mapped, much of the state is at or near conventional minimum viable temperatures for geothermal power generation. *Source: The Future of Geothermal in Texas, 2023. Adapted from SMU Geothermal Laboratory.*

Houston’s subsurface temperatures in that ballpark, for instance, can be found around 4.5 km to 5.0 km deep (2.5 to 3.0 miles). Under Austin, Texas, which is more centrally located in the state, those temperatures lurk deeper—6.0 to 9.0 km (3.5 to 5.5 miles).

“Rock is a great heat battery and the upper 10 km, or 6 miles, of the earth’s crust as a battery of heat holds an estimated 1000s of years’ worth of our energy needs in the form of accessible heat energy,” said Ken Wisian, associate director of the Bureau of Economic Geology at University of Texas at Austin. “That’s an immense resource to tap and one that gets us all excited.”

Additional oilfield drilling has helped better define the temperatures of the rock below the state. In a recent preliminary update of the assessment of temperatures below Texas, it was found that temperatures are generally 10 to 15% hotter than were previously thought. This is compared to studies conducted over a decade ago and marks a significant improvement in the area’s geothermal potential.



Sage Geosystems installing a new wellhead on a reclaimed Shell well in Starr County, Texas. *Source: sagegeosystems.com.*

## Report Finds Acute Oil Industry Role

Geothermal energy is a hot constant. Unlike solar and wind energy that are intermittent renewables, geothermal is always on. With the right infrastructure, this differentiator allows it to play the same role in energy production as natural gas or coal. Of all the competing energy sources, geothermal has the lowest lifecycle carbon emissions, smallest land footprint, and lower water contamination. The report puts it ahead of solar, wind, nuclear, fossil fuels, and battery storage. It is also more resilient versus weather or attack because much of its operational footprint is located underground.

The oil and gas industry knows a thing or two about the subsurface. Over the past 2 decades, advances made in directional drilling and hydraulic fracturing have allowed the nation to move from a net importer of oil to the world's largest producer. These new technologies and methodologies have yet to be fully applied in the geothermal energy space.

"If the right technology roadmap elements are in place to make that transfer happen, and to expand the resource base for geothermal, we found that there is a potential for around a 20 to 43% cost savings directly from oil and gas industry transfer and also growing the economies of scale," said Rebecca Schultz, energy and investment consultant at the International Energy Agency and founding member of [SPE's Geothermal Technical Section](#). "It's not just the technology side only that was critical to drive forward the opportunities, we found that the standards and regulations play a big role in opening up the market for geothermal and helping to establish a common way to communicate to exchange information to move assets and learnings around across Texas and beyond. These were viewed as important signals to the investment community and to the oil and gas industry to take more confident steps into trialing and deploying geothermal."

The study identified four major pathways for the oil and gas industry's role in the expansion of geothermal energy. First, was the early adoption of oil and gas industry practices, some of which is already occurring in current trials in Utah and south Texas. Second, is the reduction of exploration risk in sedimentary basins, and that is a large driver of cost and uncertainty in geothermal itself. Third, was that providing the funding, the resources, assets, and data are a way to help move geothermal deployment further, much more quickly. Lastly, providing a role model for industry standards and best practices and ways to be able to not just create them, but to put them out there and expand on them quickly.

circulated, then a second well produces those fluids to the surface, which is connected to turbines to generate electricity (Fig. 2).

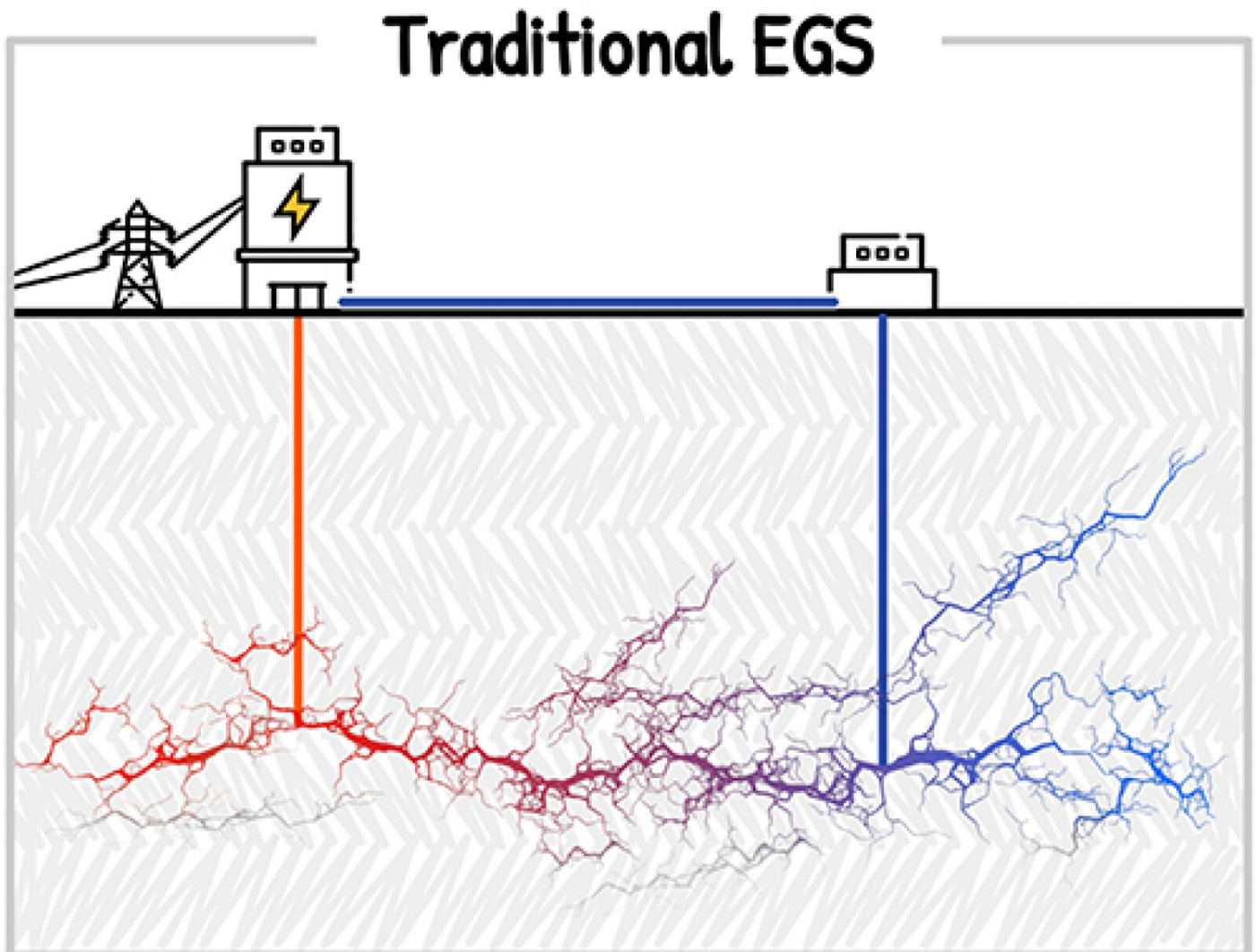


Fig. 2—Schematic of a traditional EGS approach, featuring two vertically drilled wells, with a fracture network connecting them in the subsurface. *Source: The Future of Geothermal in Texas, 2023.*

The closed-loop systems, also referred to as advanced geothermal systems (AGS), operate with no fluid exchange and no hydraulic fracturing. A single well is drilled into the heated formation and a concentric pipe-in-pipe system is used to both inject and recover fluids. Closed-loop systems typically carry additional technological challenges and costs.

Lastly, multisystem hybrids can couple traditional and closed-loop systems into one geothermal system.

Oil industry participation in the growth of geothermal doesn't come down to a simple technology transfer. It comes with consequences that, in some eyes, could create a slippery slope toward extinction. The geothermal study postulates that if 4 years of the current level of drilling for oil and gas were applied to tapping geothermal energy, the results could yield a zero-carbon grid for Texas. Where does that result leave the state's robust oil and gas industry?

"Because you can decarbonize Texas doesn't mean you wouldn't export oil and gas or oil and gas products to other states and other countries," said Michael Weber, professor of energy resources at University of Texas at Austin. "We're not imagining that Texas would make it illegal to do oil and gas production all of a sudden. It would just change the situation where we prefer to sell our gas to other people, because it would make more money. It'd be cheaper to use geothermal in Texas, rather than burning the fuel because we can sell it for a higher value to Japan or Europe or other locations or use it for industrial activities like chemicals and that kind of thing. So, this doesn't assume that oil and gas must die or that it's outlawed."



Sage Geosystems wellsite in Starr County, Texas. *Source: sagegeosystems.com.*

## Current Trials

A joint venture between Sage Geosystems—a private energy company funded by Virya, led by Chris Anderson of TED Talks fame, and oilfield contract driller Nabors Industries—and the Bureau of Economic Geology at the Jackson School of Geosciences at University of Texas at Austin, is conducting a geothermal test project in south Texas based on a US Air Force-funded initial feasibility study. Sage is testing new



The process calls for drilling four laterals around 350 ft apart, then fracturing those from the top down to create connectivity that will act as a sort of chimney for heat for the deeper formations. The trial is targeting bottom well temperatures as low as 100°C (212°F) and up to 250°C (482°F), which are present at depths of 1.9 to 3.7 miles (3 to 6 km), making them accessible using traditional drilling techniques and equipment. Sage is measuring temperature, pressure, and flow rate of fluid in the well to simulate how much energy or electricity could be generated through the combined laterals vs. a single wellbore.

If successful, Sage is expected to build the first prototype geothermal project at the Ellington Field Joint Reserve Base just south of Houston. The Ellington project envisions a surface generator which will sit almost directly on top of a well. The power produced will feed into a microgrid connected to systems that need power at all times. It will connect to a commercial power grid off base.

The base is located at the edge of a geopressure zone, an area abundant in underground heat, water, and permeability—key ingredients of geothermal, according to the US Department of Energy (DOE).

“The US Air Force has funded an initial project in Texas that looked at designing a 3-MW plant to go on the south side of Houston and at Ellington Field, Joint Reserve Base,” said Wisian. “Now, the secretary of the Air Force’s Office of Energy Assurance has driven, along with the US Army, a recent call for prototype geothermal projects at four bases around the country, including Joint Base San Antonio. Further, the Office of Energy Assurance has stated that geothermal is its number one new energy prospect, even above small modular reactors, which I think is quite significant.”

The Ellington project is expected to cost around \$35 million. If the prototype works as expected, several financial institutions, including Sage’s current investors, have expressed interest in funding the first power plant. The process will take 2 to 4 years, depending upon how long it takes to obtain permits.

Outside of Texas, all eyes interested in forwarding geothermal energy are on Utah and the FORGE project. The DOE Geothermal Technologies Office (GTO) has made significant investments in research to eliminate impediments to developing EGS. One major current project is the Frontier Observatory for Research in Geothermal Energy (FORGE). FORGE has established an EGS field test site near Milford, Utah, for the research and testing of EGS concepts and technologies to identify a commercial EGS pathway.

The FORGE team completed drilling for the [project’s first highly deviated deep well](#) in less than half of the originally anticipated drilling schedule. The results were largely enabled by the transfer of technologies, methods, and ways of working from the oil and gas industry into the project. The well will serve as the injector for an injection-production well pair, with at-depth temperatures close to 226°C (438.8°F).

This year, a second deep deviated well, the production well, will be drilled to intersect the hydraulic fractures. The connectivity of the fractures between the two wells will be established or improved, and short-term circulation testing will begin to assess the thermal viability geothermal reservoir.

## The Way Forward

Traditional geothermal has been around for more than a century, but there remains uncertainty—both scientific and legal—regarding the path to commercial geothermal power generation in Texas and beyond.

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established legal precedents, rules of construction under Texas case law, and statutory law have led to the conclusion that “geothermal energy and its associated resources belong to the surface owner of real property in Texas, absent a controlling document to the contrary.”

With ownership a looming question, yet another is the permitting process, which at a federal level has been termed “arduous and painful”, in some cases taking a decade to resolve. At the state level, things are a bit better and geothermal again can benefit from the oil and gas industry and its knowledge when it comes to regulatory and permitting regimes familiar with drilling.

“You can piggyback on oil and gas industry jurisprudence and everything else in the state as a foundation to help go fast,” said Wisian. “That’s where we can start over the next 5 or 10 years getting geothermal really accelerated.”

Bringing down costs is also critical to making geothermal competitive with wind, solar, and natural gas. Geothermal projects will soon have the same production tax credits as other clean energy projects, thanks to the US Inflation Reduction Act.

The study showed almost 83% of oil and gas companies have or will develop geothermal strategies, which the report believes will assist in cutting the time to commercialization.

[Chevron announced in December it was forming a joint venture with a geothermal investment firm Baseload Capital](#) to develop geothermal projects in the US. The venture has identified Weepah Hills in Esmeralda County, Nevada, for its first project. The area has had previous geothermal research and exploration.

“I think geothermal today with its level of venture capital investment, startup activity, research activity, policy environment, scale of the projects reminds me of the way wind looked in Texas in the early 2000s and the way solar looked around 2008, or 2009, which means it’s poised for really rapid growth over the next 20 years,” Weber said.

However, much more investment is needed for field deployments of power- and heat-generation projects utilizing scalable geothermal technologies like EGS and AGS. The current level of investment in the EGS and AGS startups as well as the two DOE-funded projects is less than \$2 billion compared to, for instance, the \$24.6 billion of investment in new wind power projects for utility-scale land-based wind power capacity added in 2020.

## For Further Reading

[Integrated Subsurface Characterization of a Low-Temperature Geothermal Test Site, Gulf Coast, Texas](#) by *Shuvajit Bhattacharya, Ken Wisian, and Alexandros Savvaidis, University of Texas at Austin; and Mike Eros, Sage Geosystems.*

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