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Sustainability

Geothermal 101: The heat at your feet!

13 August 2026

Key takeaways

- Geothermal energy uses heat from within the Earth to generate electricity and provide heating and cooling. While conventional hydrothermal projects rely on naturally occurring underground heat, fluid and permeability, newer technologies are expanding development beyond traditional resources.
- Power plant designs are largely determined by underground heat levels, with higher-temperature reservoirs supporting direct steam generation and lower-temperature ones requiring more engineered systems that expand development opportunities.
- Beyond electricity generation, geothermal energy can also support heating, cooling, industrial processes and heat pumps - broadening its potential market - while permitting reforms and evolving state and federal policies increasingly influence the pace and economics of deployment.

Geothermal fundamentals

What is it?

Geothermal energy harnesses the Earth's internal heat, typically by drilling into hot underground rocks and using naturally occurring or engineered fluid systems to bring that heat to the surface for electricity generation, heating or cooling. While conventional projects rely on naturally occurring underground heat, fluid and permeability (the ability of rock to allow fluids to flow through it), newer approaches are expanding beyond traditional hydrothermal fields, according to BofA Global Research.

Geothermal technologies can be grouped into four main types (Exhibit 1):

- **Conventional hydrothermal**: This method uses naturally occurring underground reservoirs where heat, fluid and permeability already exist together. It is the industry's foundational technology and the benchmark against which newer technologies are evaluated.

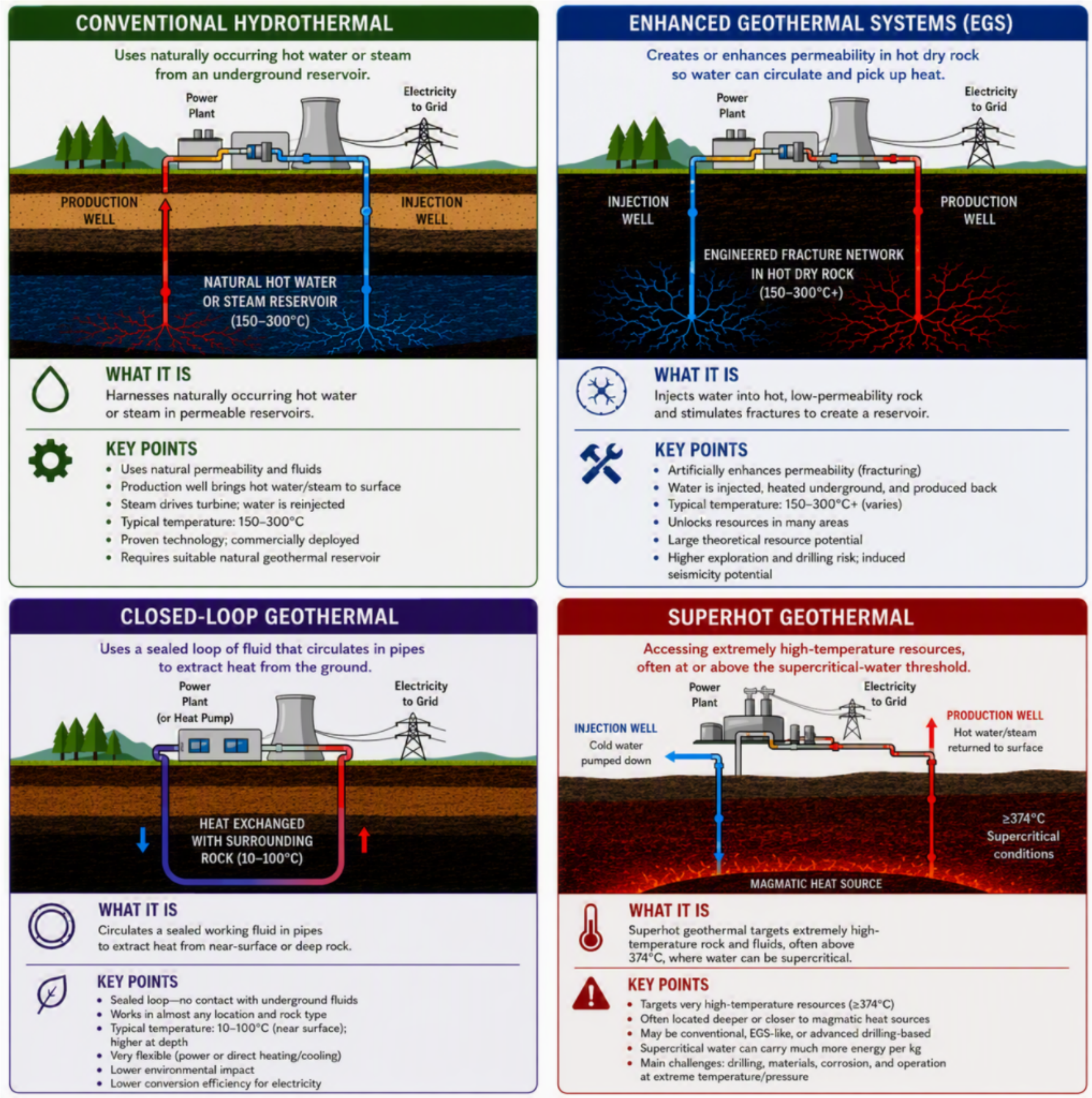
- **Enhanced geothermal systems (EGS):** This approach uses drilling and reservoir stimulation techniques to create engineered reservoirs in hot rock where natural permeability and/or fluid flow is insufficient. It offers the clearest pathway to expand geothermal development beyond the narrow footprint of conventional resources. By engineering reservoirs rather than relying on naturally favorable underground conditions, EGS has the potential to broaden the sector's resource base and become the primary long-term growth technology, according to BofA Global Research.

- **Closed-loop geothermal**: This method circulates fluid through underground wellbores or pipe networks rather than relying on naturally permeable rock formations and reservoirs. It is differentiated by its focus on reducing dependence on natural reservoirs and moving toward a more engineered and potentially more repeatable system design. The central question remains whether performance and economics can be proven at scale, as lower heat-transfer efficiency may require more complex designs and a higher costs to deliver competitive output.

- **Superhot geothermal:** The most ambitious segment of the geothermal landscape, targeting extremely high-temperature resources (generally above 375 degrees Celsius). If successful, it could materially improve project economics by increasing energy output per well and enhancing overall plant efficiency. This category, however, remains the most technically demanding and least mature, per BofA Global Research.

Exhibit 1: Conventional hydrothermal uses naturally occurring reservoirs; EGS engineers permeability in hot rock; closed-loop systems circulate fluid through sealed wells; and superhot geothermal targets much higher-temperature resources

Infographic illustrating four core approaches to geothermal energy



Source: BofA Global Research

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Power plant configuration

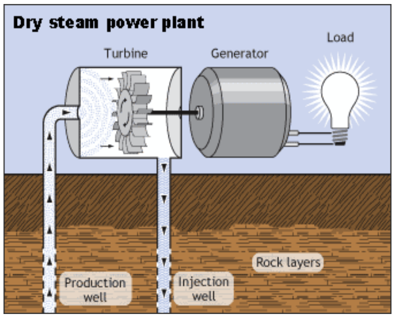
Geothermal power plant configurations are primarily determined by reservoir temperature and fluid characteristics. The hotter and drier the resource, the more directly it can drive a turbine, while lower-temperature resources typically require an intermediate working fluid and have different economic characteristics.

- **Dry steam (Exhibit 2):** The simplest power plant configuration, used where the reservoir naturally produces steam. In this design, steam flows directly from the reservoir to the turbine, making the surface plant relatively straightforward and efficient where resource quality is high. Its economic advantage lies in its simplicity and strong operational performance. Even so, it is also the rarest major plant type because suitable reservoirs are uncommon.

- **Flash steam (Exhibit 3):** Flash steam plants, the most common conventional geothermal technology, use high-temperature underground water to generate steam that drives a turbine. While effective in proven, energy-rich reservoirs, they require complex fluid management and are less adaptable to lower-quality or dispersed geothermal resources than next-generation systems.

- **Binary cycle (Exhibit 4):** Typically used for moderate-temperature resources. Heat is transferred to a secondary working fluid with a lower boiling point, which then vaporizes and drives the turbine. This approach broadens the usable resource base, supporting development in areas unsuitable for dry steam or flash designs, according to BofA Global Research. The tradeoff is lower conversion efficiency, meaning project economics depend more heavily on drilling costs, flow rates and plant optimization.

Exhibit 2: Dry steam plants use naturally occurring underground steam to directly spin a turbine
Illustration of a dry steam power plant



Source: BofA Global Research, US Energy Information Administration (EIA)
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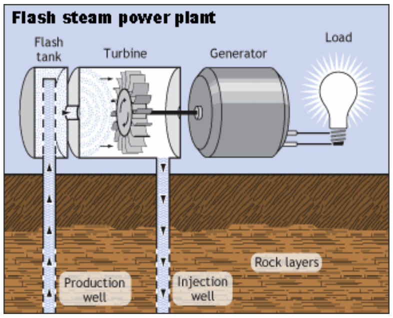
Exhibit 3: Hot geothermal water is brought to the surface, "flashed" into steam, and used to spin a turbine
Illustration of flash steam power plant



Source: BofA Global Research, EIA
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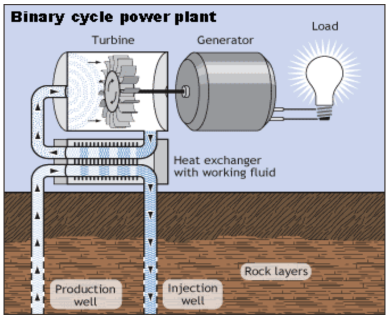
Exhibit 4: Moderate-temperature geothermal water transfers heat to a secondary working fluid
Illustration of binary cycle power plant



Source: BofA Global Research, EIA
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Some geothermal projects use hybrid or combined-cycle designs – such as flash/binary configurations – to improve resource recovery by extracting energy from both the steam and the remaining hot liquid. While less common than the three primary plant types, these hybrid approaches show how plant design can be tailored to maximize output from a specific reservoir. They can improve project economics where the resource supports them, but they also add engineering complexity and are typically most applicable in mature fields with well-understood reservoir behavior.

In practice, temperature remains the driver of technology choice: the highest-temperature resources favor dry steam or flash, while progressively lower-temperature resources shift toward binary and other more engineered solutions.

Non-power geothermal applications

Beyond electricity generation, geothermal energy can also be used for district heating and cooling systems, industrial heat and geothermal heat pumps – all of which expand the sector's potential market beyond utility-scale power. These applications help diversify revenue streams, broaden the customer base and position geothermal as a contributor to both the power transition and the decarbonization of buildings and industrial heat, per BofA Global Research.

Development sequence

Geothermal development typically follows a staged sequence:

1. **Exploration and resource characterization:** The earliest stages, when developers assess subsurface temperature, permeability and fluid potential. This is critical because resource quality ultimately determines plant design, output and project economics.

2. **Resource confirmation and drilling**: Wells are drilled to establish whether the project can support commercial production. This is one of the most economically important phases because subsurface risk, well success and drilling cost are major determinants of project value. Where required, reservoir development or stimulation follows, helping to create or enhance fluid flow and support long-term productivity – particularly in next-generation geothermal systems.

3. **Plant construction and interconnection**: Surface facilities are designed to match the resource type and temperature. This stage is important because design and execution affect capital intensity and long-term operating efficiency, according to BofA Global Research.

4. **Operations and reservoir management**: This includes fluid reinjection and performance monitoring, which are essential for sustaining output, preserving reservoir life and supporting long-term cash flow.

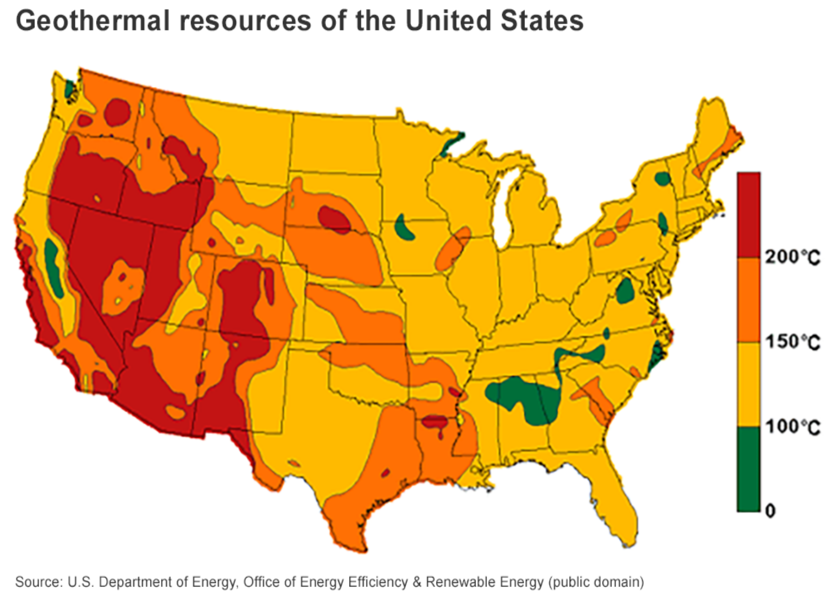
Resource base and market opportunity

Geothermal represents a small share of installed capacity in the US power mix, but its strategic value is increasing as grids place a higher premium on clean, firm, high-capacity-factor generation rather than intermittent sources alone. Globally, geothermal accounts for less than 1% of energy demand, while installed US capacity provides roughly 0.4% of total US energy supply. However, BofA Global Research views the sector as underpenetrated relative to its potential, with scope for sustained long-term growth if costs continue to fall and deployment becomes more scalable and repeatable.

Historically, geothermal development has been concentrated in regions with high-quality hydrothermal resources, limiting the market to a relatively narrow set of geographies and capping conventional growth (Exhibit 5). That constraint is beginning to ease as next-generation technologies, such as EGS and closed-loop systems, seek access to hotter rock across a much broader range of locations. This expansion of available resources could increase both project pipelines and the range of potential commercial applications, per BofA Global Research.

Exhibit 5: US geothermal resources are concentrated out west

US map of geothermal resources



Source: BofA Global Research, US Department of Energy Office of Energy Efficiency & Renewable Energy

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Scale scenarios

The question is not whether geothermal energy works, but whether it can scale. The Department of Energy's (DOE) GeoVision analysis suggests US geothermal capacity could rise to 60 gigawatts (GW) by 2050 under favorable technology improvement assumptions. More recent DOE commercialization work points to even greater potential for next-generation geothermal if drilling productivity, financing and execution improve. The International Energy Agency (IEA) similarly sees a pathway to large-scale global deployment, particularly if project risks decline and costs begin to follow patterns similar to those of other energy technologies that have scaled through innovation and repetition.

Permitting & policy

Permitting

For geothermal, project permitting is a core economic variable. DOE's permitting guidance and GeoVision analysis both highlight project timelines, environmental review and land-access approvals as significant barriers to development. Delays in these areas can extend construction timelines, increase carrying costs and delay revenue generation.

According to BofA Global Research, this is why recent state actions matter. California's AB 531, enacted in October 2025, expanded access to the California Energy Commission's opt-in permitting pathway for geothermal projects, providing developers with a faster state-level route through environmental review. Colorado's HB25-1165, signed by Governor Polis in May 2025, was designed to support geothermal deployment and improve permitting clarity. Similarly, Washington's SB 6039, signed in March 2024, combined data collection with exploration support and updated state leasing rules to help advance development.

Federal regulators have also taken steps to reduce permitting timelines. In April 2026, the Bureau of Land Management established a categorical exclusion for certain low-impact geothermal exploration activities, helping developers assess geothermal resources more quickly while streamlining approvals.

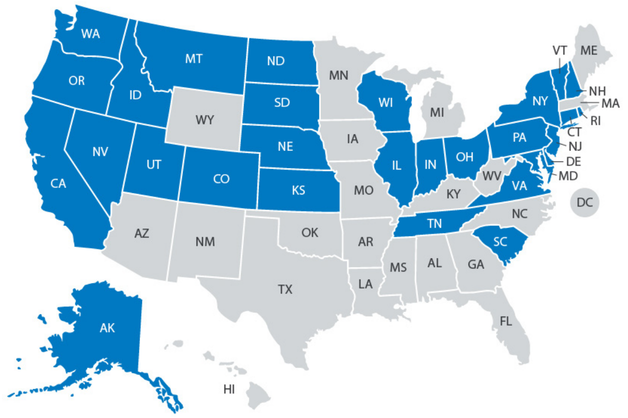
Policy

Geothermal has historically received less targeted policy support than other forms of clean energy, such as wind and solar. However, this gap is beginning to narrow, as nearly 30 states offer incentives for geothermal power, and a growing number are also supporting geothermal heating and cooling (Exhibit 6).

Momentum at the state level is increasingly evident in both regulatory and legislative priorities (Exhibit 7). New Mexico's 2024 Geothermal Resources Development Act underscores growing legislative interest in geothermal development, while California has taken steps to streamline geothermal siting and environmental review.

The federal backdrop is more mixed. DOE's tax-credit guidance notes that legislation enacted on July 4, 2025, changed the landscape for geothermal heat-pump incentives. Industry summaries indicate residential credits were reduced after 2025, while support for commercial geothermal has remained comparatively more durable.

Exhibit 6: 29 states offer incentives for geothermal electricity projects
States with existing incentive policies for geothermal power



Source: BofA Global Research, National Laboratory of the Rockies
Note: Data as of December 2025.

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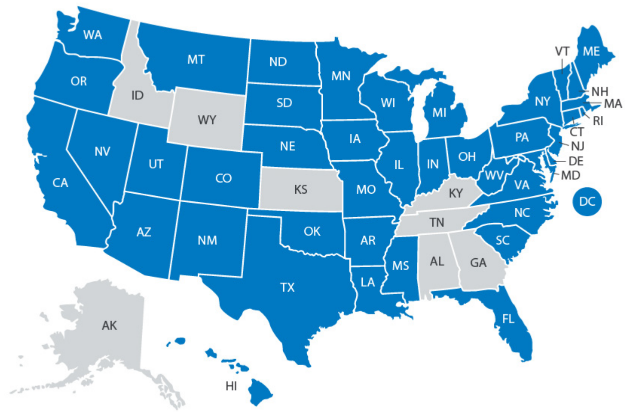
Exhibit 7: Most states have existing geothermal regulatory policies
States with existing regulatory policies for geothermal power



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Disclosures