CASCADE INSTITUTE

BREAKING NEW GROUND

GEOTHERMAL IN 2024

A geothermal breakthrough is taking place in 2024

Until recently, geothermal power's potential for growth was limited, because the technology needed just the right conditions. Whether enough heat could be found at accessible depths was hard to determine at the surface, so projects were subject to the same kind of hit-and-miss exploration risk as oil and gas. Development focused on well-defined resources. Geothermal remained a niche source of energy.

But technology breakthroughs have unlocked geothermal potential well beyond these limits.

These breakthroughs have given geothermal a completely new value proposition.

Commercial developments

The world's biggest companies are making big bets on geothermal. Commercial investment is driven by surging demand for clean, reliable power.

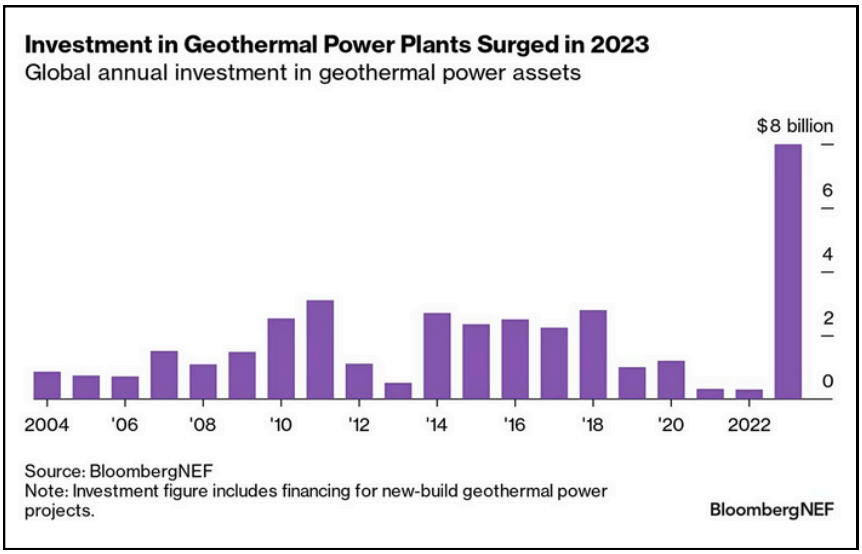
In particular, "Big Tech" is leading geothermal investment to power their expanding data centers for artificial intelligence and cloud computing. As a source of clean baseload power, geothermal is well-positioned to meet soaring demand from digital industries.

Examples include:

- **Google:** In November 2023, Google announced it would buy 3.5 MW of power from Fervo's enhanced geothermal system (EGS) pilot project. Google now intends to buy an additional 115 MW of power from Fervo. Google identifies EGS as "one of the most promising opportunities" to provide clean baseload power for its operations.
- **Microsoft:** In May 2024, Microsoft announced it will use geothermal power from Kenya's world-class geothermal resources to power its East Africa data center campus.
- **Meta:** In August 2024, Meta announced a partnership with Sage Geosystems to expand the use of geothermal power in the US. Sage intends to deliver power in 2027 and scale up to 150 MW.

These announcements highlight the worldwide surge in geothermal investment (see chart). But much more is coming.

The IEA forecasts that, to meet net-zero targets, global investment in low-emission power will have to exceed US $1.3 trillion annually by 2035. This massive increase in investment will create a huge market opportunity for Canada—one allowing the country to leverage its existing oil and gas expertise, especially in drilling, to advance geothermal. As an early example, the Canadian geothermal firm Eavor has already secured over $180 million in investment.



Technology breakthroughs

Conventional geothermal depends on finding porous bodies of hot rock that already contain water (natural reservoirs). The hot water is pumped to the surface to produce power and then recycled back underground. Reservoirs must be close enough to the surface (typically 3-5 km) to be cost effective, and locating them creates significant exploration risk.

Next-generation geothermal technologies greatly reduce this risk by creating artificial reservoirs. Artificial reservoirs expand the potential for geothermal by several orders of magnitude. Two key technologies are being developed and demonstrated:

1. **Enhanced Geothermal Systems (EGS)** create networks of fractures in the rock to enhance its natural porosity and improve the flow of water. Firms such as Fervo in the US have not only demonstrated that EGS is viable, but achieved significant performance improvements in 2024.

2. **Advanced Geothermal Systems (AGS)** operate like a radiator, circulating water through a continuous loop up to the surface. The Canadian firm Eavor has demonstrated this technology in Alberta.

These breakthroughs have happened in parallel with rapidly falling costs. Getting costs down is critical because, if effective artificial reservoirs can be created, the only barrier to cost-effective geothermal power is well depth. Deeper is better, since power increases rapidly with temperature, and temperature increases with depth.

Conventional geothermal wells are drilled into soft, sedimentary rock relatively close to the surface, but far more heat is available in hard igneous and metamorphic rock farther down. Although drilling beyond 5 km into this hard rock is typically unfeasible with standard practices, new technologies could unlock even greater depths. The Cascade Institute detailed these emerging technologies in a recent report, Drilling for Superhot Geothermal Energy: a Technology Gap Analysis. Key opportunities include:

- **Existing Technologies** from oil and gas are being repurposed for geothermal. These include horizontal drilling, hydraulic fracturing, and modified diamond drill bits. Fervo has used these bits in the US to reduce drilling times by 70 percent and costs by 50 percent.

- **Emerging Technologies** including plasma and millimeter-wave drilling could ultimately reduce costs much more.

The US Department of Energy's Geothermal Liftoff report forecasts that EGS costs could fall to just $45 per Megawatt-hour (MWh) by 2035, which is competitive with unabated natural gas and well below the costs of new nuclear power.

A proposal for Canada

Canada is well-positioned to compete and become a geothermal leader. Canada's world-class oil and gas sector has the skills and expertise needed to advance geothermal.

The Cascade Institute has published an Ultradeep Geothermal Research and Action Roadmap to chart the way forward on geothermal energy innovation in Canada.

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