Geothermal Energy in Utah: A Safe Technology With Limited Environmental Impacts

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Geothermal energy—heat from the Earth's core—can provide steady, flexible electricity while producing nearly zero carbon emissions.

In 2024, 78% of Utah's electricity was generated from burning coal (45%) and natural gas (33%), which emit pollution and carbon dioxide that reduce air quality and contribute to climate change (U.S. Energy Information Administration [EIA], 2025a; Utah Division of Air Quality, 2023). One rapidly emerging cleaner option is geothermal energy development—tapping the Earth's internal heat to generate electricity (Figure 1). A key strength of geothermal energy is its ability to deliver consistent power with near-zero carbon emissions (Horne et al., 2025). Unlike solar and wind, which depend on sunlight and weather, geothermal energy can enhance grid reliability by providing steady, baseload electricity or flexible, dispatchable electricity depending on needs and implementation (Aljubran & Horne, 2024). Because geothermal power plants emit little to no air pollution and carbon dioxide, expanding Utah's geothermal capacity could help improve air quality and reduce greenhouse gas emissions statewide (Utah Division of Air Quality, 2023).

Conditions favorable for geothermal energy development occur where the Earth's internal heat is near the surface, making it accessible through drilling (U.S. Department of Energy [DOE], n.d.-a). However, extracting this heat via geothermal wells raises environmental questions. Here, we provide an overview of geothermal energy and its potential environmental implications in Utah. We highlight that recent geothermal projects in Utah do not use fresh water and that new well designs are expected to reduce the consumption of salty, brackish water. If these efforts are successful, geothermal energy would have lower water consumption, reduced seismic risk, and a similarly low land-use footprint compared to fossil fuel sources of electricity.

Figure 1. *Fervo Energy's Cape Station Enhanced Geothermal System (EGS) Power Plant in Beaver County, Utah*

Source: Cape Station, 2025, used with permission from Fervo Energy

Geothermal Energy Basics

Geothermal energy harnesses the Earth's internal heat to produce electricity, directly heat and cool buildings, or provide hot water for heating or industrial purposes (U.S. DOE, n.d.-a). In Utah, geothermal heat is mainly accessed through three types of systems:

1. Hydrothermal
2. Deep sedimentary basin
3. Enhanced geothermal (EGS)

All three use existing or injected water below the Earth's surface to create steam, which can be used to spin a turbine or as a direct heat source (Figure 2; Szymanski & Hardwick, 2025). Hydrothermal and deep sedimentary basin systems rely on naturally occurring heat and permeable rocks near the surface, while EGS involves creating artificial permeability by engineering pathways in hot, dry rock (Anderson, 2013; U.S. DOE, n.d.-b, n.d.-c).

Given that hydrothermal and deep sedimentary basin systems require specific natural conditions, the use of EGS transforms geothermal energy from a site-specific resource to one with broader potential—especially in western Utah (Szymanski & Hardwick, 2025). Commercial development of EGS facilities in Utah is advancing rapidly. The geothermal company Fervo Energy expects Cape Station, its EGS power plant in Beaver County, Utah, to begin operations in 2026 (Figure 1; LaBonty et al., 2026).

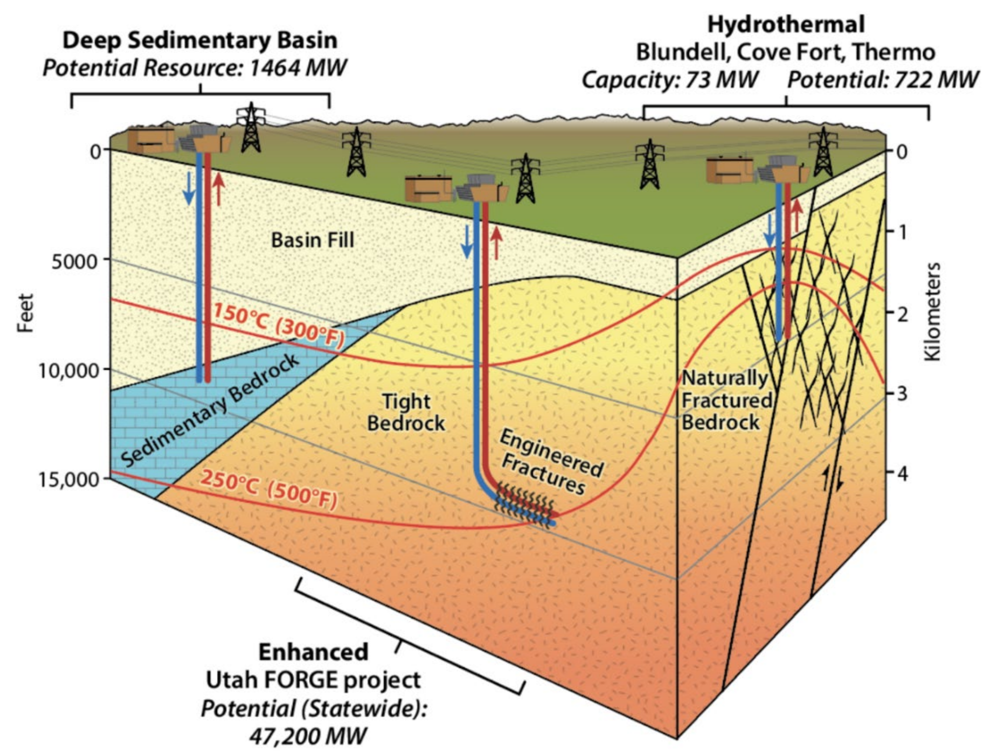

Figure 2. *Three Types of Systems That Access Geothermal Heat for Energy Production*
Note. In Utah, enhanced geothermal systems (EGS) are needed to access over 95% of Utah's geothermal energy. MW = megawatt.

Source: Szymanski & Hardwick, 2025, used with permission from the Utah Geological Survey

Environmental Considerations for Geothermal Energy Development

Geothermal energy development opens opportunities but also raises questions about water consumption and other environmental impacts. Because future development of geothermal energy in Utah will largely use EGS methods, we focus below on the environmental impacts of EGS for geothermal power production (Szymanski & Hardwick, 2025).

Water Consumption

Water consumption by power plants varies depending on the energy source and cooling system (Figure 3). Generating electricity from wind and solar power consumes the least water, followed by natural gas, nuclear energy, and coal. The lowest water consumption rates for nuclear and natural gas power plants are for facilities that use dry and/or hybrid cooling systems (U.S. EIA, 2018). Water consumption by recently tested EGS power plants is comparatively high, but Fervo Energy anticipates lowering water consumption substantially as they continue to refine their technology.

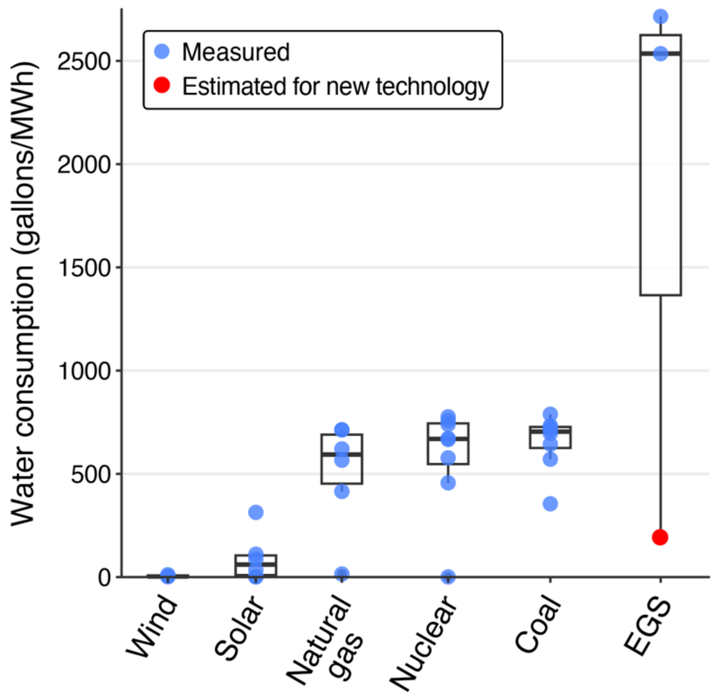

Figure 3. *Water Consumption Per Megawatt-Hour (MWh) of Electricity Generated at Power Plants Using Different Energy Sources*

Notes. Water consumption rates for wind, solar, and nuclear are for power plants in the United States (Deo, 2025). Water consumption rates for natural gas and coal are for power plants in Utah (U.S. EIA, 2025; Utah Public Service Commission, 2025). Water consumption rates for EGS are based on tests performed at Project Red in Nevada and at the Frontier Observatory for Research in Geothermal Energy (FORGE) laboratory in Utah. The red circle indicates Fervo Energy's estimate for future water consumption at their EGS binary cycle power plants (Fervo Energy, 2025).

Data sources: Deo, 2023; U.S. EIA, 2025b; Fervo Energy, 2025; Utah Public Service Commission, 2025

To minimize water consumption, Fervo Energy uses binary cycle power plants, where hot water is brought up from the subsurface, and the heat is transferred to a separate working fluid that is vaporized and spins a turbine. This working fluid is then condensed and reused, rather than evaporated and lost (U.S. DOE, 2019). Fervo Energy also does not use fresh water at its EGS power plants, unlike coal and natural gas power plants in Utah (U.S. EIA, 2025b). Instead, Fervo Energy drills wells up to 2,500 feet deep, far below typical freshwater well depths, to obtain brackish water that is too salty for agriculture or municipal use (Fervo Energy, 2025). However, consuming large amounts of water from deep sources could still affect the structural stability of the aquifers and the water table over time, making low water consumption a top priority (Utah Geological Survey, n.d.).

Water consumption by EGS binary cycle power plants occurs at two points during the project's life cycle (Fervo Energy, 2025): (1) Construction (one-time use) and (2) operation (continuous use).

Construction

Power plant construction accounts for **1%–8%** of total EGS water consumption (Fervo Energy, 2025). Construction includes drilling wells and stimulating them by injecting large volumes of water or other fluids at high pressure to fracture hot rock and create a subsurface reservoir for fluid circulation. Stimulation is typically a one-time event but can require millions of gallons of water. Over the 30-year lifespan of an EGS well, Fervo Energy estimates that drilling and reservoir stimulation would consume about 15 gallons of water per megawatt-hour (MWh) of electricity generated.

Operation

Power plant operation accounts for **92%–99%** of total EGS water consumption (Fervo Energy, 2025). During operation, continuous fluid circulation is required to sustain heat transfer and maintain pressure within the engineered reservoir. Water that seeps out of the reservoir or that is lost during circulation must be replaced. Recent tests at two EGS facilities, Project Red in Nevada and the Frontier Observatory for Research in Geothermal Energy (FORGE) laboratory in Utah, had 10%–20% and 14% water loss, respectively (Fervo Energy, 2025). We report water consumption at EGS power plants based on these results (Figure 3). However, those results were based on 37- and 30-day tests, and the amount of water lost would be expected to decrease as the reservoir becomes pressurized and saturated with water. Fervo Energy also plans to reduce water loss by using a more efficient type of well. The company posits that longer testing windows and their more efficient well type will reduce water loss to below 1%, yielding a total water consumption rate of 195 gallons/MWh (Figure 3, red dot). This would make water consumption by EGS power plants lower than other potential sources of baseload or dispatchable electricity that do not use dry or hybrid cooling systems.

Induced Seismicity

Induced seismicity—earthquakes caused by human activity—can result from oil and gas extraction as well as EGS (Moein, 2023). In the United States, earthquakes caused by oil and gas operations are primarily due to wastewater disposal, not the use of fluid to fracture rock (Rubinstein & Mahani, 2015). Since EGS just uses fluid to fracture rock but does not generate wastewater that requires disposal, its overall risk of induced seismicity is lower compared to oil and gas operations.

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In EGS, induced seismicity is most likely to occur during stimulation to form the reservoir (Zhou et al., 2024). This process intentionally creates or reactivates fractures, but the rapid changes in fluid pressure and stress can also trigger small earthquakes along preexisting faults. While most of these events are too small to be felt at the surface, some EGS projects have induced larger events that, in some cases, halted operations (Zhou et al., 2024). Managing induced seismicity is important to ensure that geothermal energy development is safe and sustainable.

The U.S. Department of Energy provides a framework for managing induced seismicity that is built on thorough site assessment, real-time seismic monitoring, and operational response protocols (Majer et al., 2012). Best practices include identifying nearby fault zones before stimulation, using dense seismic networks to detect microearthquakes as they occur, and applying a “traffic light system” that adjusts or halts injection if seismic activity exceeds certain thresholds (Zhou et al., 2024). At Fervo Energy’s Cape Station EGS project in Beaver County, Utah, 17 third-party seismometers are in place as well as six seismometers that belong to the company (Fervo Energy, 2024). Some of these are on the surface, and others are hundreds of feet below ground. Earthquakes above a 2.0 magnitude trigger a pause in operations and potential adjustments. Fervo Energy immediately notifies local stakeholders if any earthquake exceeds a 3.0 magnitude. In addition to promoting safety, monitoring fine-scale seismic activity can help confirm successful creation of fracture networks during stimulation (Li et al., 2024).

Impacts on Ecosystems and Wildlife

Establishing power plants often entails clearing vegetation and building infrastructure that can fragment habitats and disrupt wildlife (International Association for Impact Assessment, 2024). However, for the amount of electricity produced, EGS facilities have a relatively small footprint—well below wind and solar and comparable to coal, natural gas, and nuclear power plants (Table 1; Mai et al., 2025).

Table 1. *Land Area Needed to Produce 1 Megawatt (MW) of Electricity for Energy Sources in the United States*

Energy source	Acres needed to produce 1 MW of electricity
Coal	1.9
Enhanced geothermal system (EGS)	2.0
Natural gas	2.0
Nuclear	2.4
Solar	19.0
Wind	37.4

Data sources: Bolinger & Bolinger, 2022; Enevoldsen & Jacobson, 2021; Lawrence Berkeley National Laboratory, 2025; Mallah et al., 2025; Stevens et al., 2017

Conclusion

Geothermal energy has the potential to transform Utah's electricity landscape, driving a future with improved air quality, lower carbon emissions, and fewer environmental impacts. As of March 2025, EGS power plants in Utah could offer baseload or dispatchable electricity while emitting little to no air pollution and carbon dioxide, consuming very little fresh water, posing minimal earthquake risk, and using just a small amount of land.

New techniques being developed by Fervo Energy are aiming to reduce the amount of brackish water that EGS power plants consume to less than half the amount of fresh water that most of Utah's coal and natural gas power plants consume (Figure 3). Furthermore, other companies (e.g., Rodatherm) are exploring closed-loop geothermal systems that would largely eliminate water consumption (LaBonty et al., 2026). Taken together, developing Utah's plentiful geothermal resources could meaningfully reduce harmful emissions and support an energy system that balances electricity production with environmental stewardship.

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