From surface to the reservoir, solving your geothermal challenges for over 50 years
Geothermal
CLEAN, RENEWABLE AND PLENTIFUL, GEOTHERMAL ENERGY HOLDS HUGE PROMISE WORLDWIDE

Economically produced around the world, geothermal is a current or potential source of energy for many countries. In addition, enhanced geothermal systems (EGS) initiatives have the potential of opening new opportunities to access even deeper, hotter and more energy-rich geothermal reservoirs. Taken together, it’s easy to see why the interest and investment in geothermal is projected to run high for decades to come.

In EGS projects, partnering with a company that can place fractures and understands fracture growth is vital

Halliburton is the market leader in fracturing services, offering the industry’s widest range of fracturing and acidizing systems specifically designed to stimulate geothermal wells.

The Halliburton Advantage

Since the 1950s, Halliburton has been the full-service leader in geothermal technologies and processes

Today, we continue to provide a full range of geothermal expertise, services and breakthrough technologies to meet unique geothermal challenges, as well as support expanding geothermal development around the world.

To date, we have participated in significant geothermal projects in countries such as the United States, the Philippines, Indonesia, Japan, Australia, New Zealand, Germany, Denmark, Sweden, Mexico, Costa Rica and Kenya. And we are involved in numerous additional geothermal initiatives for upcoming projects, including enhanced geothermal systems (EGS).
The Halliburton Advantage

Breakthrough Halliburton geothermal technologies
While “conventional” geothermal operations remain an important focus for Halliburton, our state-of-the-art microseismic fracture mapping and pressure pumping capabilities are a natural fit for the industry’s growing interest in EGS. These Halliburton technologies, involving rock fracturing and water injection, can help economically access, enhance and produce significantly higher amounts of energy by drilling deeper and capitalizing on the promise held by super-hot “dry rock.”

Extra resilient drill bits for rock with significant compressive strength
Geothermal conditions call for drill bits that can handle extreme abrasion and high temperatures. Halliburton’s high tech, reliable roller-cone drill bits provide increased bearing capacity and more. All our bits go through Halliburton’s Design at the Customer Interface (DatCISM) process, the first process to offer customized bit design for specific customer applications.

High temperature logging-while-drilling (LWD) technology for severely challenging conditions
To take on geothermal’s hard drilling environments, Halliburton offers operators the industry’s first high-temperature rotary-steerable tool—the Solar™ Geo-Pilot® XHP system. This unique rotary steerable drilling tool delivers faster rates of penetration, improved hole quality and more accurate wellbore placement. To meet the industry’s coming EGS needs for even more resilient LWD technology, Halliburton is currently developing its next generation of ultra-high-pressure, high-temperature LWD tools.
Halliburton’s ThermaLock™ cement enhances long-term production
This specially formulated calcium phosphate cementing technology protects casing from contact with corrosive fluids, resisting cement degradation caused by carbon-dioxide exposure and ultra-high temperatures.

Halliburton’s reverse cementing takes the heat and relieves the pressure
Cement and casing integrity challenges multiply as geothermal operators go deeper and encounter more extreme pressure, temperature, drilling and environmental conditions. Today, Halliburton’s proven high-pressure, high-temperature cementing solutions help extend the productive life of wells that tap geothermal reservoirs for energy power generation.

During geothermal drilling operations, lost circulation adversely affects data transmission
If mud pulse technology is being used in these conditions, telemetry signals disappear once fluid loss occurs. Halliburton’s electromagnetic telemetry (EMT) measurement-while-drilling (MWD)/LWD system solves this problem, enabling uninterrupted data transmission without a continuous fluid column.
Real-time blending optimizes scale removal
Halliburton's Acid-on-the-Fly (AOF) blending system improves the acidizing process by enabling real-time adjustments to the acid blend while eliminating disposal issues since acid is blended only as it is used. This system also helps provide improved personnel safety and environmental performance.

Halliburton’s Pinnacle service delivers real-time geothermal monitoring solutions
Specializing in the optimization of hydraulic fracturing, Pinnacle is widely recognized as the world’s leading fracture-mapping and reservoir-monitoring authority. Its integrated approach to both conventional and enhanced geothermal systems combines fracture modeling, production data analysis, pressure transient analysis (well testing) and reservoir simulation, all providing operators with the data necessary to maximize economic returns.

Halliburton Consulting provides customized solutions based on operational and business objectives
These professionals have experience with every facet of the geothermal asset from geosciences and production operations to economics, and have worked in every major basin. Taking a collaborative approach, they leverage specific asset knowledge along with industry expertise, best practices, and proven tools and methodologies to optimize asset performance.

Halliburton Project Management can tackle your biggest development challenges.
Working in a scalable fashion that can encompass one rig or entire assets, they can supplement an existing crew or manage the total project. Project Management teams integrate health, safety and environmental core values into all business activities, striving to proactively meet regulatory requirements and mitigate risks to help lower operating costs.
For Geothermal,
Get the Halliburton Advantage

For over 50 years, Halliburton experts have met the world’s geothermal energy challenges.

Only Halliburton can do it all in geothermal. And we have the track record to prove it. In both traditional geothermal and emerging enhanced geothermals systems (EGS) operations, Halliburton has the ability to provide technological and environmental solutions that others simply can’t provide. More than just the world leader in geothermal pressure pumping, we are a “one stop” solution for directional drilling, cementing, fluids, pumping services, logging/casing inspection and more—including proven project management.
**GEOTHERMAL ENERGY FAST FACTS**

**Geothermal energy is clean, renewable and plentiful**
Around the world, geothermal energy—generated from heat that originates at the earth's core—is widely and affordably produced, providing enough power to satisfy the electrical needs of more than 60 million homes.

According to a recent International Geothermal Association survey, countries or locales producing geothermal power include the Argentina, Austria, Australia, China, Costa Rica, El Salvador, Ethiopia, France (island of Guadeloupe), Guatemala, Iceland, Indonesia, Italy, Japan, Kenya, Mexico, Nicaragua, Papua New Guinea, the Philippines, Portugal (the Azores), Russia, Taiwan, Thailand, Turkey, the United States and Zambia. Many other countries are in the process of developing geothermal energy for electrical use.

**Where it all starts**
Geothermal energy begins at the earth's molten iron core, approximately 4,000 miles beneath the surface where temperatures exceed those found on the surface of the sun. This heat gradually rises through a 1,800-mile-thick mantle of magma and rock to the earth's crust, a relatively thin layer of matter that extends three to five miles under the earth's oceans and 15 to 35 miles beneath land masses.

**Turning steam into electricity**
Here in the earth's crust, that heat interacts with rock and naturally occurring water to superheat the water. Accessed by drilling wells at depths from 2,000 to 11,000 feet, this steam or hot water is brought to the earth's surface where on-site steam turbines or a binary power plant convert it into electricity.
Enhanced geothermal systems (EGS) hold exceptional promise
An alternative to depending on naturally occurring hydrothermal reservoirs, EGS reservoirs are made by drilling wells into hot rock and fracturing the rock sufficiently to enable a fluid such as water to flow between the wells. Traveling along permeable pathways, this fluid picks up in situ heat and exits the reservoir via production wells. At the surface, the heated fluid passes through a power plant where electricity is generated. Upon leaving the power plant, the fluid returns to the reservoir to complete the circulation loop. The plant will have no greenhouse gas emissions other than vapor from water that may be used for cooling.
ENVIRONMENTAL BENEFITS

Minimal environmental impact
Besides providing a plentiful, renewable and affordable source of electricity, geothermal energy has minimal impact on the environment.

However, while geothermal does pose far fewer environmental challenges than most other energy or industrial operations, toxic gases and minerals are occasionally encountered as the search for more productive and sustainable reservoirs expands. These elements require mitigation. Current recovery methods have proven to be extremely effective, as have scrubbing techniques that protect the air from emissions such as hydrogen-sulfide gas.

Low carbon dioxide (CO₂) emissions
CO₂ is a natural byproduct of geothermal steam, but it is less than four percent of what is typically released by coal and other fossil fuel plants. In a closed loop geothermal system, there are no CO₂ emissions.

Fewer on-site chemicals, less environmental exposure
Once wells start producing, naturally occurring scale can be removed by acidizing techniques. To minimize acid handling at the wellsite, Halliburton’s acid components arrive in dry form and are then mixed on site in a special AOF blender. This process greatly minimizes environmental exposure to pre-mixed chemicals along the transport route from the supplier’s facility to the destination. It also ensures that only the precise amount of acid needed is mixed, thereby eliminating disposal issues.

A smaller footprint than conventional energy extraction operations
Because minimal equipment is required, a relatively small area of land is needed for injection and production wells. Add the fact that geothermal generating stations are located right on the site—which means they don’t have to take up space somewhere else—and it is easy to see why geothermal has less impact above and below the surface than other energy operations.
What’s your geothermal challenge?
For solutions, contact your Halliburton representative,
or visit us at www.halliburton.com/geothermal
Sales of Halliburton products and services will be in accord solely with the terms and conditions contained in the contract between Halliburton and the customer that is applicable to the sale.