

The background of the slide is a close-up photograph of a rock face, showing various textures, cracks, and mineral deposits in shades of brown, tan, and grey. A solid blue horizontal band is overlaid across the middle of the image, containing the text.

Subsurface Heat + Fluids + Permeable Rock

Creating Geothermal Energy

Idaho National Laboratory 

The logo for Idaho National Laboratory (INL) features the letters "INL" in a bold, white, sans-serif font. A white swoosh underline starts under the "I", goes under the "N", and loops around the "L".

The Raft River Plant in southern Idaho is one of the first binary geothermal energy production facilities in the United States.



Few of today's energy sources provide a steady supply of clean, renewable energy and are abundant the world over.

An emerging technology known as Enhanced Geothermal Systems (EGS) is changing that. EGS has the potential to revolutionize geothermal and renewable energy.

EGS taps into the vast heat flowing in the Earth's crust and transforms it into a source of baseload electricity, a trait most other renewables lack. And unlike wind or solar, EGS has a relatively small footprint.

How does EGS work?

Conventional geothermal power plants are located at sites where heat, water and permeable rock already exist in the subsurface. Few places of sufficient size have all three characteristics and finding them can be difficult and expensive.

EGS eliminates the need for pre-existing subsurface water and/or permeable rock. With EGS, fluid is injected into hot rock that has been fractured to create fluid flow pathways. This man-

made process brings heat to the surface to produce electricity.

EGS greatly expands the number of locations that could produce electricity from geothermal resources – including sites once considered unsuitable for conventional geothermal plants.

Research, development and deployment

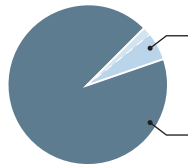
While EGS is promising, more research is needed to advance the technology so it can be deployed commercially.

Technologies such as those used to fracture rock must be tested and validated and more information is needed about the long-term behavior of the heat reservoirs created by this process. Field tests are needed to improve key technologies and to prove EGS is viable.

Establishing an U.S. DOE EGS Field Laboratory on the Snake River Plain could advance this technology and lead to widespread implementation of geothermal energy.

Potential geothermal resources in 13 Western states:

Source: U.S. Geological Survey



Conventional geothermal
9 to 30 gigawatts of electricity

Enhanced Geothermal Systems
500 gigawatts of electricity



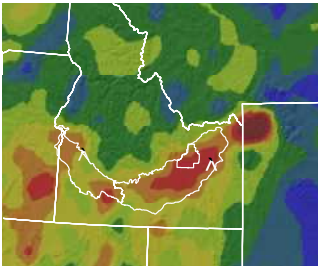
The Snake River Plain is one of the hottest places at accessible depths in the United States.

The Snake River Plain, which encompasses much of southeastern Idaho, is located along the track of the Yellowstone Hot Spot, an area renowned for its geothermal activity.

A research site on the Snake River Plain would benefit public and private entities. Public sector researchers could use it to refine and prove EGS technologies while private companies could focus on improving specific technologies. Both could lead to greater implementation of this clean, renewable energy source.

Several characteristics make the Snake River Plain well suited for an EGS Field Laboratory, including:

- **High heat flow and subsurface temperatures.** The area has some of the highest recorded heat flow and subsurface temperatures at accessible depths in the United States.



The Snake River Plain was formed as the North American plate drifted over the Yellowstone Hotspot 3 to 12 million years ago. The hotspot provided a source of heat that was injected into the crust and is responsible for the geothermal features we see today in Yellowstone National Park. This process emplaced heat that could be mined to generate geothermal energy on the Plain.

- **Prolific regional aquifer system:** Creating and operating an Enhanced Geothermal System requires significant amounts of water—for hydrofracturing or hydroshearing to create the heat reservoir and also for long-term operational testing. At the EGS Field Laboratory, researchers would primarily use water from the Snake River Plain Aquifer—one of the nations most prolific water resources.
- **Extensive infrastructure and accessible terrain:** Much of the Snake River Plain is accessible year round. The area contains hundreds of existing wells that could provide substantial data for an EGS Field Laboratory.
- **A rich history of scientific study and support.** Researchers have long studied the Snake River Plain's water resources and geothermal energy potential. The United States Geological Survey maintains a field office at Idaho National Laboratory and works closely with INL staff.



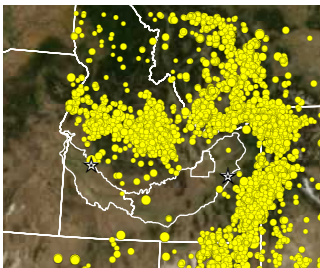
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8

Researchers from INL and the Center for Advanced Energy Studies (CAES) are creating a "Virtual Snake River Plain" so they can view and analyze subsurface data in unique ways.

Idaho National Laboratory researchers have long studied the subsurface characteristics of the Snake River Plain, including seismic activity, rock structure and properties, subsurface temperatures and its vast aquifer. They helped develop the Raft River Plant, one of the first binary geothermal energy production facilities in the United States, and have a proven track record of collaborating with academia and industry.

In addition to experienced personnel and favorable geologic conditions, INL has several key capabilities that make the Snake River Plain and the INL an ideal location to house an EGS Field Laboratory:

- The INL is situated on 984 square miles of secure federal property, a land area nearly the size of Rhode Island.
- An established permitting process that accommodates large-scale projects.



The Snake River Plain is seismically quiet compared to the surrounding mountains. This map shows seismic events with magnitudes greater than 2.5 between 1850 and 2007.

This indicates favorable conditions for EGS.

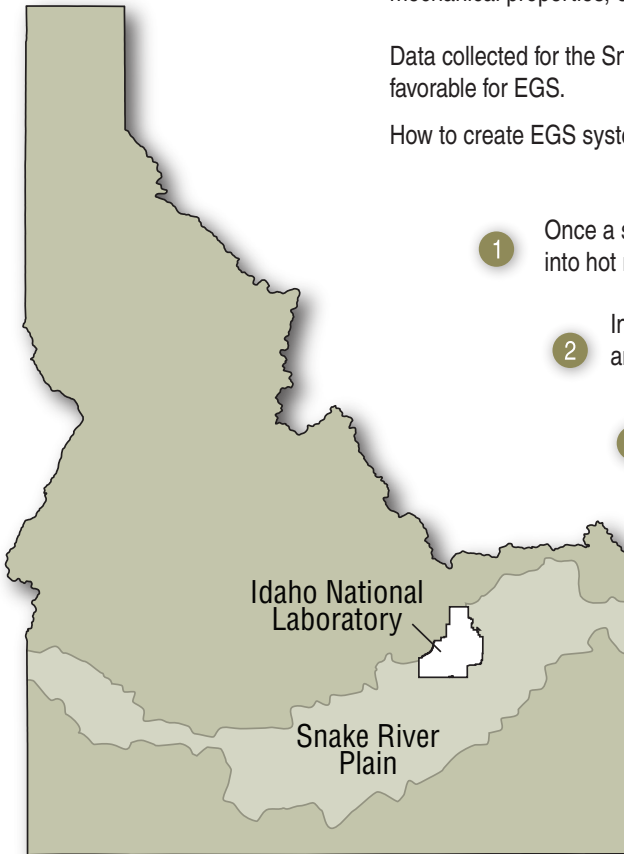
- A seismic monitoring network that has operated for decades.
- Extensive water rights (to fill a reservoir and makeup of subsurface water losses) on the Snake River Plain aquifer.
- An Energy Systems Complex designed to solve problems related to integrating renewable energy with conventional power generation, specifically examining intermittency and distributed generation sources.
- Transmission capabilities and a dedicated power grid to test EGS plant design and performance (once a reservoir is created).
- Collaborative relationships with universities, government agencies and other organizations.

Researchers evaluate several subsurface characteristics when identifying a potential site for Enhanced Geothermal Systems (EGS), including temperature, rock permeability and mechanical properties, earth stress directions and fluid.

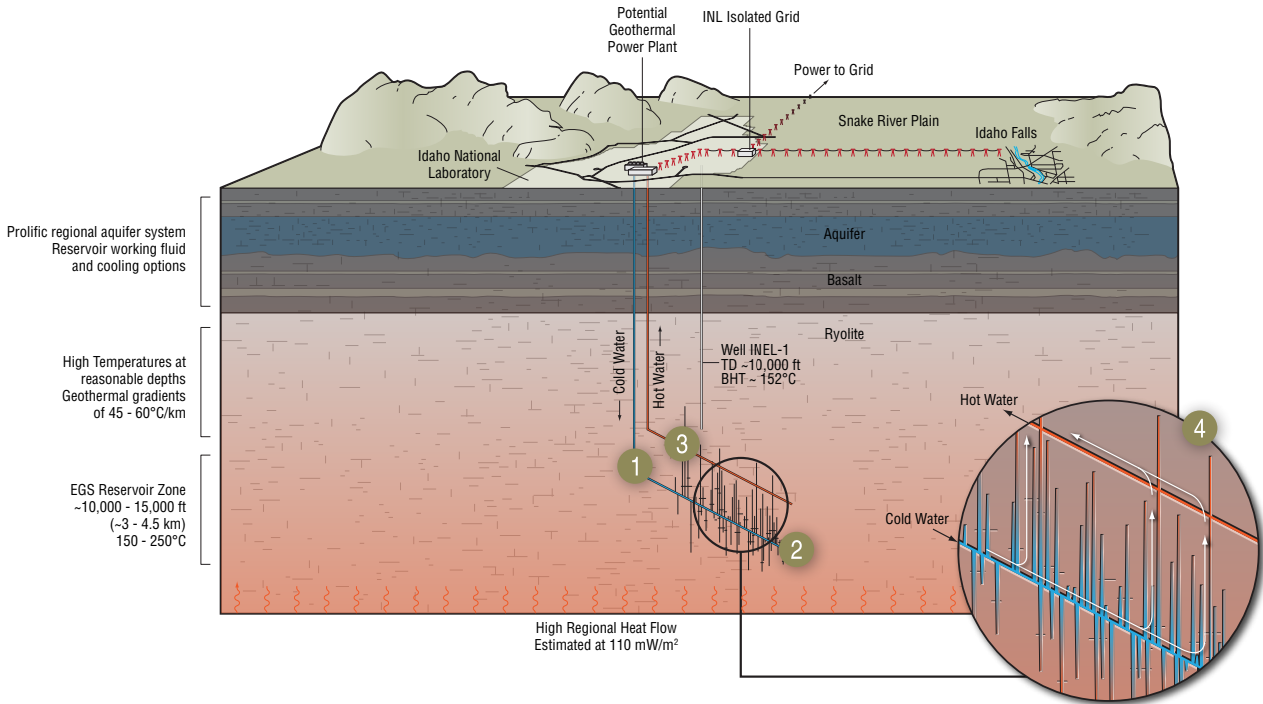
Data collected for the Snake River Plain indicate conditions are favorable for EGS.

How to create EGS systems:

- 1 Once a site is identified, drill an injection well into hot rock.
- 2 Inject cold water at high pressure to fracture rock and create flow paths and a heat reservoir.
- 3 Drill a production well through the fractures so it intersects the flow paths.
- 4 The two wells create a circulation loop in which water flows through the heat reservoir and is pumped out of the production well to generate electricity.



Idaho



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CAES Center for Advanced
Energy Studies