

The Basics of Enhanced Geothermal Systems

The U.S. Department of Energy's (DOE) Geothermal Technologies Program (GTP), with support from DOE's national laboratories, conducts research, development, and demonstration projects throughout the United States on Enhanced Geothermal Systems (EGS).

Characteristics of Geothermal Systems

- high-temperature rock,
- fluid saturation, and
- sufficient permeability to allow geothermal fluid to flow throughout the system



During the process of creating an EGS reservoir, rocks may slip along pre-existing fractures, which may produce microseismic events. Induced seismicity, which can result from stimulation, helps to identify the extent of the fracture network in the reservoir. In almost all cases, these events in the deep reservoir are of such low magnitude that they are not felt at the surface.



Photo credit: Ram Power Corp.

What are EGS?

EGS are engineered reservoirs created to produce energy from geothermal resources that are otherwise not economical due to a lack of fluid and/or permeability.

EGS Resource Potential

EGS technology can enhance existing geothermal systems and create new systems where appropriate thermal and geologic characteristics occur. EGS has the potential for accessing the Earth's vast resources of heat located at depth to help meet the energy needs of the United States.

USGS estimates 500,000 MWe of EGS geothermal resource potential lies beneath the western United States. This is approximately half of the current installed electric power generating capacity in the United States.¹

Benefits of EGS Development

- EGS emit little to no greenhouse gases. Most power plants use a closed-loop binary cycle and will have no greenhouse gas emissions other than vapor from water that may be used for cooling.
- EGS will increase energy production by producing geothermal energy in new environments and at various depths.
- EGS has enormous potential to be an important contributor to the U.S. energy portfolio as a source of clean and renewable energy.
- Geothermal energy has the ability to produce energy consistently and around the clock.
- EGS has the potential to create high-paying, long-term jobs. In 2008, the geothermal industry accounted for 25,000 jobs.

¹ <http://pubs.usgs.gov/fs/2008/3082/pdf/fs2008-3082.pdf>

EGS Reservoir Development and Operation

Step 1: Identify a Site

In order to select an appropriate EGS site, it is crucial to understand the geologic characteristics of the area through field exploration. After surface exploration, an exploratory well is drilled to determine the permeability of the resource, and whether fluid is present. If the site possesses the necessary characteristics, an injection well is planned.

Step 2: Create a Reservoir

- Drill an injection well into hot basement rock with limited fluid content and permeability.
- Inject water at sufficient pressure (or temperature differential) to propagate fractures by: opening existing fractures or creating new fractures. Continue pumping water to reopen old fractures and extend existing fractures throughout the developing reservoir.
- Drill a production well into the fracture network intersecting as many of the flow points as possible.

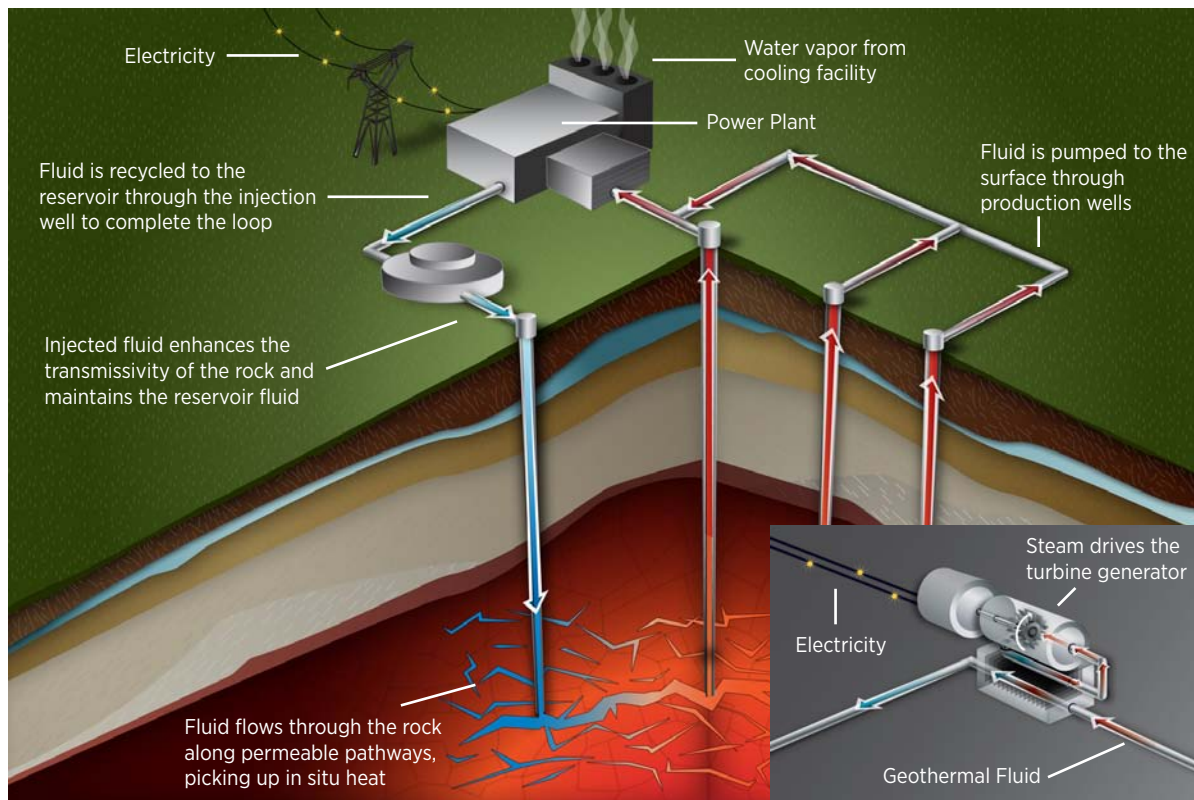
The resulting circulation loop allows water to circulate through the enhanced reservoir along permeable pathways, picking up in situ heat. The hot water is then pumped to the surface through the production well (see diagram below).

Step 3: Operate the Power Plant and Maintain the Reservoir

- At the surface, the water heats a working fluid that produces vapor to drive a turbine-generator.
- Vapor travels through the turbine-generator to create electricity.
- The original geothermal water is recycled into the reservoir through the injection well to complete the circulation loop.

EGS may be expanded by adding additional production and injection wells. This allows heat extraction from large volumes of rock and increases power generation capabilities.

To watch an animation of the EGS process, visit: www.geothermal.energy.gov/egs_animation.html



Visit the GTP website at www.geothermal.energy.gov for more information on the program, EGS and existing EGS sites. Questions regarding GTP or EGS activities should be directed to geothermal@ee.doe.gov.