Fallon FORGE

Frequently Asked Questions

Geothermal Research Observatory

What is FORGE?

FORGE stands for Frontier Observatory for Research in Geothermal Energy. FORGE is a U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy (EERE) Geothermal Technologies Office (GTO) program to investigate potential locations for a national enhanced geothermal systems (EGS) field laboratory. The FORGE program is divided into three phases. During Phase 1, five locations were chosen for continued planning and development of a conceptual geologic model. Fallon was one of the five sites. At the end of Phase 1, two sites were down selected (Fallon and a site in Utah) to move into 2 in preparation for full site characterization that will include required environmental reviews. Full implementation occurs during Phase 3 at a single FORGE site, and will include testing and evaluation of new and innovative EGS technologies.

What are Enhanced Geothermal Systems (EGS)?

Conventional geothermal systems are located in areas where high subsurface heat, permeable rock, and underground fluid all naturally coexist. These three conditions interact to create a natural underground heat exchanger (transferring heat from the rock to the moving fluids) that allows recovery of the earth's energy (by drilling wells and producing hot water, steam, or both) to generate electricity. Nearly all geothermal power produced worldwide is supplied by conventional geothermal reservoirs.

By contrast, EGS are hot, but with low permeability and a low fluid content. Once an EGS heat source is located—typically in deep, hard rock—researchers drill deep wells and hydraulically stimulate the underground rock to increase permeability, thus creating a geothermal reservoir. Water injected into one or more wells passes through the zone of enhanced permeability, picking up heat along the way, and is extracted through a production well. After reaching the surface, the hot water and/or steam is used to produce power in the same way as in conventional geothermal systems.

The practice of manipulating pre-existing fractures in the subsurface to enhance permeability, which is key to EGS, is a subject of active research in the United States and other countries.

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Who are the key players?	With funding from the U.S. Department of Energy's Geothermal Technologies Office (GTO), the Fallon FORGE project has a team of geothermal experts led by Sandia National Laboratories. The U.S. Navy, led by the Navy Geothermal Program Office, and Ormat Nevada Inc. are key partners in the project because they own or lease the land dedicated to the FORGE project and bring extensive geothermal experience to the team. Both the Navy and Ormat have drilled wells in the area that demonstrate very favorable conditions (temperature, depth, low-permeability rock) for advancing EGS technology. The project team also includes representatives from Lawrence Berkeley National Laboratory; University of Nevada–Reno; U.S. Geological Survey (Menlo Park, California); GeothermEx/Schlumberger; and Itasca Consulting Group, Inc.
Which organization(s) are funding this project?	Funding for FORGE is provided by the U.S. Department of Energy's Geothermal Technologies Office.
What, if any, additional costs will fall outside project funding?	The initial phase of the FORGE project is funded entirely by the U.S. Department of Energy. Future phases will involve cost sharing. FORGE recipients and sub-recipients who are domestic institutions of higher education, national laboratories, federal entities, or domestic non-profit organizations are exempt from cost sharing.
What is the relationship between the U.S. Navy and the project?	Operations will take place on lands under the control of the U.S. Navy and Ormat Nevada Inc. The Fallon FORGE team will guide the activities with the consent and participation of the U.S. Navy, Ormat Nevada Inc., and the Bureau of Land Management (BLM).
What is the role of the BLM?	BLM is responsible for permitting most geothermal activities on Federal lands, including land owned by the U.S. Navy. However, the Navy will issue any permits required on Fallon FORGE grounds not within BLM leases.
Is National Environmental Policy Act (NEPA) compliance required for this project?	Yes, NEPA is required on all Department of Defense (DoD) installations. The 2011 Salt Wells Environmental Impact Statement (EIS) that was completed for the FORGE area will serve as the governing document for future geothermal activities on the Fallon FORGE property. Any additional NEPA requirements associated with FORGE can be derived from the Salt Wells EIS.

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Is drilling anticipated as part of the project? If so, where and how deep?

In Phase 1, the project focused on developing a conceptual geologic model and planning the activities to occur in later phases. During Phase 2, detailed plans will be developed for EGS experiments that will be conducted at the site. Permits for those activities will be acquired, if needed. In Phases 2C and 3, it is anticipated that multiple deep wells will be drilled at the site, to depths ranging from 1,500 m to 2,000 m. Additional shallow wells will be drilled for monitoring subsurface activities. The project will leverage data from existing wells drilled within and near Fallon by Ormat Nevada Inc. and the U.S. Navy.

What types of activities are expected to occur in Phase 3 of the FORGE project?

Plans for EGS experiments and activities are still under development. Anticipated activities include, but are not limited to, the following:

- drilling new wells and characterizing the rock fabric and mineralogical composition in detail
- conducting injection tests
- conducting stimulations of existing and new wells and circulation tests between wells
- using innovative well completion techniques that allow for manipulation of fractures in multiple zones within a single well
- performing tracer testing using reactive and non-reactive tracers

All work undertaken at the site is aimed at understanding how to manipulate the fracture system in a way that enhances permeability while allowing sufficient fluid residence time for heat exchange as the injected water travels through the system to the production well, thus tapping the vast heat reserves in the area. All activities will be closely monitored using a variety of sophisticated techniques, contributing to a thorough understanding of initiating and controlling underground processes.

Are there similar EGS experimental sites elsewhere?

The Fallon FORGE site was 1 of 5 DOE-funded Phase 1 projects. Ultimately, DOE plans to fund only a single FORGE project. The other Phase 1 FORGE projects are in Nevada, Idaho, Utah and Oregon. In addition to these projects, EGS is the subject of research and development by various governments, including the United States and the European Union. Dedicated EGS experimental sites have been implemented in the United States (Fenton Hill, New Mexico), the UK (Rosemanowes, Cornwall), and the European Union (Soultz-Sous Forêts, France). In addition, EGS experimentation has been undertaken at several operating geothermal project sites in Nevada (Desert Peak, Bradys), Idaho (Raft River) and California (Coso, The Geysers).

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Where does the name "Fallon" come from? And where exactly is it?	The city of Fallon lies approximately 7 miles northwest of the proposed Fallon FORGE site in Churchill County, Nevada. Fallon is a community of approximately 8,400 people about 62 miles east of Reno. The Fallon site is home to the Naval Air Station (NAS), a training station that has been the home of the U.S. Naval Strike and Air Warfare Center including the TOPGUN training program since 1996. The city of Fallon, NAS Fallon, and the nearby Reno metropolitan area each provide critical infrastructure and facilities that will be useful for the FORGE project.
What makes the proposed Fallon site a good location for FORGE?	Fallon has all the required characteristics of a world-class EGS site, in terms of depth, temperature, and low permeability. Previous drilling in the area, both on NAS land and adjacent BLM land leased to Ormat Nevada Inc., has contributed significantly to researchers' knowledge of the subsurface. None of the wells drilled to date have encountered good permeability in crystalline rock. All of the deeper wells encountered high temperatures in the FORGE required range that were also representative of temperature vs. depth conditions in much of the Great Basin. The site has a willing landowner (the U.S. Navy) with a significant interest in developing new sources of resilient power and a neighboring lease holder (Ormat Nevada Inc.) seeking to realize value from its investment. The site has an existing seismic monitoring network and a massive amount of hot granitic and metamorphic rock at a reasonably shallow depth, which lowers overall costs of drilling and drilling-related activities. Further, relatively high tectonic strain rates and investigated stress states in the area will facilitate hydraulic fracturing of the rock. The site is accessible year-round, and the Fallon FORGE team is closely coordinating with the U.S. Navy to ensure that the important mission of Fallon proceeds without interference from FORGE research and development activities.
How much water will this project use?	Enhanced geothermal systems need water to operate effectively. The water requirements for FORGE will be on the order of a few million gallons per stimulation, and it is anticipated that up to 3 to 6 wells may be stimulated.
Where will you get the water you need for this project?	The primary source of water for stimulations and other activities will be the geothermal fluid produced from Well 84-31, one of the wells already drilled by Ormat Nevada Inc. This water is from a zone unrelated to shallower reservoirs used for drinking and agriculture in the region and it is from a source that will not affect any local supplies or farming needs.

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Will injection of fluids affect seismic activities in the area?	Fluid injection at the FORGE site will cause micro-earthquakes (also referred to as micro-seismicity). Micro-seismicity is related to minor movements along small fractures affected by injection and production activities. Although most micro-seismicity associated with geothermal reservoirs is not felt at the surface, subsurface seismic activity will be carefully monitored by a micro-seismic monitoring network. An Induced Seismicity Mitigation Plan has been developed for the project, detailing mitigation and communication strategies.
Will injection of fluids increase the risk of a significant earthquake?	Micro-seismicity associated with fluid removal and injection has been observed and monitored for decades around several Nevada geothermal fields near Fallon. No injection in or near these fields has been linked to significant earthquakes. Micro-seismicity helps researchers understand subsurface processes and optimize resource use, but will not increase the risk of a potentially damaging earthquake in Churchill County. As a result of detailed characterization of the subsurface, the FORGE project is designed to avoid faults that have the potential to produce damaging earthquakes.
How will the project protect local interests during each Phase?	Unimpeded by the FORGE project, local tribes will continue to access sacred sites, namely the Grimes Point archeological site and Fallon Paiute-Shoshone Reservation and Colony that lie approximately 6 miles to the north and northeast of the Fallon FORGE site. The research project will attract some increased economic activity in the area, particularly in the logistical support drilling and hospitality sectors. The FORGE site will also provide educational opportunities for area schools and universities. After completion of the FORGE project, EGS development could have a positive impact on the area in two ways: (1) by demonstrating a new source of clean power that can be replicated in other communities; and (2) by providing the U.S. Navy with resilient power, ensuring that it can continue its important mission at Fallon.
How are you going to protect cultural sites in and around the FORGE project areas?	Because the FORGE team will use existing access roads and will build minimal infrastructure (a few well pads, wells, and pipelines) in a well-surveyed area, cultural sites will be respected. Any new developments will be planned in such a way as to create no adverse effects or disturbance.
What happens to the site at the end of the 5-year research project?	The infrastructure to be developed for the FORGE project will be minimal, consisting of a few well pads, wells, and pipelines. It is possible that these may continue to be used for experiments, geothermal production, or injection after the FORGE project is finished. If there is no use for this infrastructure at the completion of the project, reclamation will be performed as needed.