The United States Department of Energy's Geothermal Technologies Office (GTO) invests in the development of hydrothermal resources to generate geothermal energy. Current funding supports:

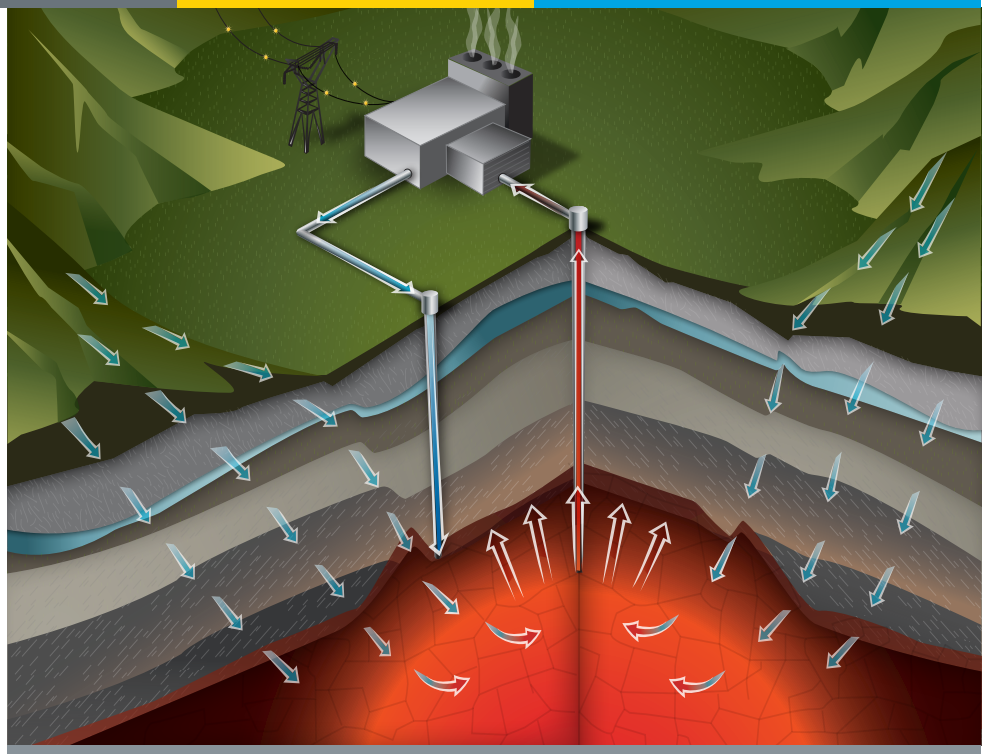
Play Fairway Analysis
Play Fairway Analysis uses an approach borrowed from the oil and gas sector that reduces uncertainty for drilling by compiling and mapping multiple types of data to identify the most promising areas for geothermal exploration.

Microborehole Drilling
Delivering high weight-on-bit (WOB), high torque rotational horsepower to a conventional drill bit does not scale down to the hole sizes necessary to realize the potential impacts of microdrilling. Sandia National Laboratories in collaboration with Foro Energy, LLC, Atlas Copco LLC, and Geothermal Resource Group, Inc. is working to develop low WOB methods for microhole drilling, to provide impactful cost-savings for geothermal exploration.

SubTER Crosscut
The US Energy Department and National Laboratories have created a crosscutting initiative focused on revolutionizing sustainable subsurface energy production and storage through improvements in the industry's ability to characterize and control subsurface fracture and fluid flow processes at increased resolution. All projects are currently in their second round of funding. In addition, DOE has recently released a FOA to continue to address subsurface research, development, and demonstration challenges.

National Lab Annual Operating Plans
The national labs carry out much of the research advancing the geothermal industry. Such research topics include: geothermometry, innovative seismic data processing, technology transfer from related industries, sedimentary geothermal feasibility, and resource reporting methodology.

Visit the Geothermal Technologies Office website at geothermal.energy.gov for more information on hydrothermal development, or contact geothermal@ee.doe.gov.



Geothermal energy, accessed through fluid in the hot rocks at a depth up to several miles, supplies a steady flow of high-pressure steam or water to create electricity.

Hydrothermal Resources

A geothermal resource requires fluid, heat, and permeability to generate electricity. Conventional hydrothermal resources contain all three components naturally. These geothermal systems can occur in widely diverse geologic settings, sometimes without clear surface manifestations of the underlying resource.

In 2008, the U.S. Geological Survey (USGS) estimated that 30 GWe of undiscovered geothermal resources exist in the western United States[1]– ten times the current installed capacity. Minimizing the risks and costs of discovering and characterizing these new geothermal energy sources is therefore vital to realizing geothermal as a significant contributor to the nation's baseload energy supply.

The Process

Developing a hydrothermal system begins with fully characterizing the resource. Once the subsurface is well understood and a geothermal prospect is identified, the reservoir is then accessed by drilling. After confirming sufficient resource, size, and extent, power plant development can begin.

[1] Williams, Colin F., Reed, Marshall J., Mariner, Robert H., DeAngelo, Jacob, Galanis, S. Peter, Jr. *Assessment of Moderate- and High-Temperature Geothermal Resources of the United States.* (U.S. Geological Survey Fact Sheet 2008-3082) http://pubs.usgs.gov/fs/2008/3082/.

Foro Energy will be developing laser microdrilling technology in conjunction with Sandia National Laboratories

Hydrothermal Resource Utilization

Step 1: Exploration

Properly characterizing the subsurface in hydrothermal settings is costly. In fact, resource confirmation relies on drilling multi-million dollar wells so that improving the chance of success has an immediate bottom line impact. The GTO invests in hydrothermal technology to: develop innovative geophysical subsurface signals to better characterize the subsurface prior to drilling; more accurately identify potential geothermal resources through Play Fairway Analysis to provide critical information and techniques that successfully target exploration areas, improve the accuracy of prospect maps, increase the ability to define resource extent; and, through exploration, result in better targeting which will lead to the advancement of a higher drilling success rate, decrease risk, and lower costs through the incorporation of more efficient oil and gas drilling techniques.

Step 2: Resource Characterization

Characterization methods utilize tools to help characterize resources. **Geology**, **geophysics**, **remote sensing**, **geochemistry**, and **combining and visualizing data** will help accelerate the discovery and utilization of undiscovered hydrothermal resources increasing exploration and confirmation well success rates.

Step 3: Resource Verification

Once a potential resource is identified through exhaustive resource characterization efforts, the focus shifts towards developing a detailed drilling plan where specific sites and methods are outlined. These plans often include the drilling of temperature gradient wells, slim and/or core holes, and, finally, production wells.

Well costs approach 50% of the total project cost for a geothermal project. These costs can also be a significant barrier to widespread deployment of geothermal power production. The Department of Energy continues to invest in advanced drilling technologies focused on increasing efficiency, decreasing drilling times, and reducing overall well costs.

Exploration methods are categorized into five groups:

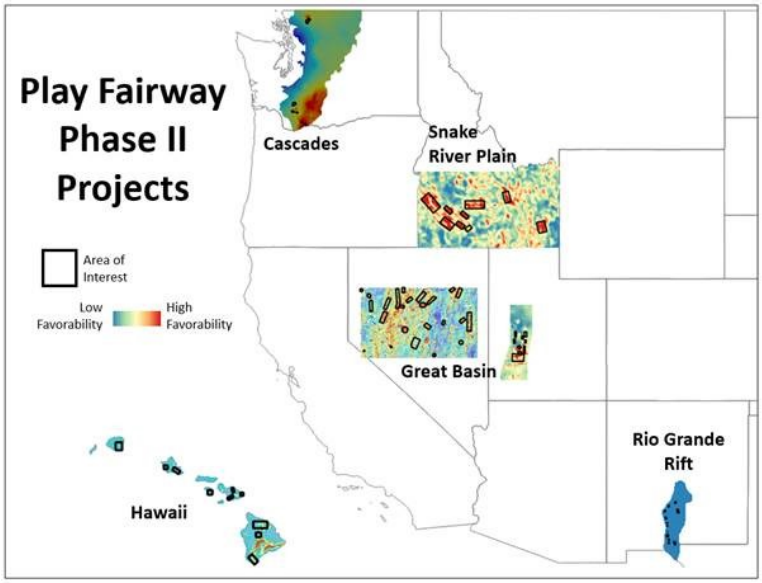
Geology
Characterizing geology—rock types, structures, faults, and temperatures– is a fundamental step in discovering new geothermal resources. This information comes from a diverse set of sources—field geology, maps, existing wellbores, etc.– which is then combined using cross-sections and mechanical relationships to create an accurate representation of the subsurface.

Geophysics
Potential field methods (e.g. gravity, magnetics, magnetotellurics), heat flow mapping, and advanced seismic techniques along with improvements in interpreting those data help identify and define hidden geothermal resources.

Remote Sensing
Geospatial data collected from air/space—LiDAR and InSAR, for example—are used to identify surface indicators of a geothermal resource for large or less accessible areas.

Geochemistry
Sub-soil gas, hydrocarbon, and isotope data, along with fluid samples from wells and springs, are used to identify possible up-flow areas and constrain sub-surface temperatures—a simple and cost-effective method to target resources with little or no surface expression.

Combining and Visualizing Data
Once exploration data has been collected, it is processed and incorporated into a geologic and/or reservoir model. Evaluating, weighting, updating, and visualizing data in 3D is essential to developing exploration drilling and development strategies.



After a competitive down-select following Phase I, six teams were selected to continue. Phase II activities will build upon the desktop studies of Phase I and will include new field data collection, analysis, refinement of exploration methodology, and updating of favorability maps.

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Visit geothermal.energy.gov or email geothermal@ee.doe.gov.

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