



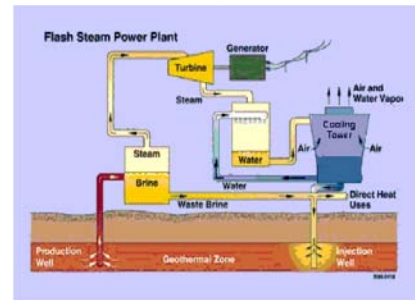
Geothermal Development on Public Lands

Geothermal energy is stored deep under the earth’s crust as heat and pressurized fluids. These resources can be used for electricity production or to heat and cool buildings. Geothermal power plants operate by drilling wells up to 10,000 feet into the ground to extract hydrothermal fluids such as reservoirs of steam, brine, and hot water, which turn turbines to create electrical energy. To generate electricity from geothermal energy, the site must have temperatures of at least 200°F, although higher productivity can be achieved at 350°F.

Technology

Geothermal power plants fall under three basic categories depending on the temperature of the fluid and the pressure of the system:

- **Direct-steam plants**, used at sites with high-quality steam which is routed directly into a steam turbine.
- **Binary plants**, which use geothermal fluids to heat a secondary fluid that vaporizes at a lower temperature than the fluids. The secondary fluid vapor spins turbines to create electricity and is condensed back into liquid to be reused in the process.
- **Flash plants**, which extract pressurized water from wells. When the water reaches the surface, part of it vaporizes into steam which is separated from the liquid and used to directly turn the turbines.¹



Source: Idaho National Laboratory

Binary and flash plants enable geothermal fluids to be re-injected into the earth to be reheated and eventually reused.

Emerging technologies could provide massive potential for energy development, but great uncertainties regarding environmental, technological and economic challenges remain. “Enhanced geothermal systems” (EGS), also known as “hot dry rock” geothermal energy, can tap the earth’s heat where no geothermal fluids are present, but require pumping water deep into the ground to fracture hot layers of rock below. Presently, there are only two operating EGS plants, in Soultz-sous-Forets, France and Landau, Germany.²

¹ U.S. Department of Energy Office of Geothermal Technologies. “Energy Conversion.” <http://www1.eere.energy.gov/geothermal/pdfs/conversion.pdf>

² Yale Environment 360. “Deep Geothermal: The Untapped Energy Source.” <http://e360.yale.edu/content/feature.msp?id=2077>

Efficiency

Geothermal power plants convert heat to electricity, and to be profitable, the plant must be very efficient in this process. The efficiency of geothermal power plants is measured by the amount of electricity produced from a unit of geothermal fluid. Temperature plays an important role in geothermal plants, as they operate at much lower temperatures than fossil-fuel and nuclear-powered plants (122°- 482°F versus 1022°F).³ Because these temperatures



Source: US Department of Energy

are so low, their heat-to-electricity conversion efficiencies are also low, and thus the type of plant and other technologies must be well-attuned to site-specific conditions in order to maximize the power produced. However, geothermal plants have an 86-95% capacity factor, the highest of any renewable technologies.⁴

Geothermal engineers are working to make the heat-to-electricity conversion process more efficient. This can be done by improving power conversion with measures to upgrade or modify the geothermal turbines. New durable materials for handling hot fluids are being created, which protect the equipment from corroding. New methods for cooling equipment and handling waste disposal are also being implemented.⁵

Supply & Demand

According to Geothermal Energy Association, geothermal technologies generate approximately 15 billion kilowatt hours of energy per year in the U.S.⁶ In addition, geothermal energy comprises approximately 0.35 percent of the nation's total energy consumption.⁷

The U.S. Geological Survey estimated that 8,876 megawatts (MW) of power could be generated from geothermal resources in the western U.S. along with 27,598 MW from undiscovered resources. New technologies could add 345,100 to 727,900 MW of geothermal power.⁸ A 2008 Bureau of Land Management's (BLM) Environmental Impact Statement for geothermal energy in the western U.S. estimated that there are 5,540 MW of geothermal potential in its planning area, which could be viable for commercial electrical generation by 2015, with an additional 6,660 MW by 2025. This could be achieved with approximately 110 new power plants by 2015 and 132 more by 2025.⁹

³ U.S. Department of Energy Office of Geothermal Technologies. "Energy Conversion." <http://www1.eere.energy.gov/geothermal/pdfs/conversion.pdf>

⁴ Geothermal Energy Association. "Update on US Geothermal Power Production and Development." May 2007. <http://www.ge-energy.org/publications/reports/May2007GEAUpdateonUSGeothermalPowerProductionandDevelopment.pdf>

⁵ Ibid.

⁶ Geothermal Energy Association. "All About Geothermal Energy- Current Use." <http://www.ge-energy.org/aboutGE/currentUse.asp>

⁷ Energy Information Administration. "How much renewable energy do we use?" http://tonto.eia.doe.gov/energy_in_brief/renewable_energy.cfm

⁸ Bureau of Land Management. "Final BLM PEIS for Geothermal Leasing in the Western United States." Appendix A, page 1. http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_REALTY_AND_RESOURCE_PROTECTION_energy/geothermal_eis/final_programmatic.Par.23512.File.dat/vol3_final_appA.pdf

⁹ Bureau of Land Management. "Final BLM PEIS for Geothermal Leasing in the Western United States." page ES-6. http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_REALTY_AND_RESOURCE_PROTECTION_energy/geothermal_eis/final_programmatic.Par.86878.File.dat/vol1_final_exec_sum.pdf

The BLM currently oversees 29 geothermal power plants in California, Nevada and Utah. The plants have a total capacity of 1250 MW and can provide energy to 1.2 million homes.¹⁰

Permitting Process

Federal

For resources found on public lands, the Geothermal Steam Act of 1970 authorizes the BLM to lease public lands with geothermal potential and review applications for development. Lands with geothermal potential located in national forests or grasslands are leased by the Forest Service, but are permitted for development by the BLM.¹¹

The BLM issued new regulations for governing geothermal leasing and operations on federal lands in June 2007. Further, the agency has recently completed a Programmatic Environmental Impact Statement (PEIS) for geothermal development on public lands, signing a Record of Decision in December 2008. The project area covered includes the eleven western states and Alaska and analyzes a total of 530 million acres of public lands that have potential for geothermal development. The PEIS makes 190 million acres of lands in the planning area open for geothermal leasing and development.

After access to the land is granted, geothermal developers must acquire building permits, water rights, and mineral rights, as geothermal resources are considered mineral resources under federal law. Depending on where the plant is to be sited, other permits such as a notice of intent for exploration, a Geothermal Drilling Permit, construction permits and commercial permits may all be necessary. In addition, the developer is required to prepare an environmental review under the National Environmental Policy Act and/or state environmental statutes.¹²

State

The permit process differs slightly from state to state but generally follows the state's Environmental Policy Act. This includes specific permits for geothermal resource and core drilling, re-drilling, or deepening operations, which are reviewed by relevant state organizations such as the Department of Natural Resources. The permit usually requires a map by a licensed surveyor of the well location, the source of water supply, topographic features of the well site area such as drainage patterns, associated surface waters and wetlands. A statement describing proposed measures to be utilized for protection of the environment and methods for disposal of waste materials are also typically required.

Private

To receive a permit and begin construction of a geothermal power facility on private lands, geothermal developers must go through a lengthy federal review process conducted by the Federal Energy Regulatory Commission.

¹⁰ Bureau of Land Management. "Programmatic EIS for Geothermal Resources Frequently Asked Questions." http://www.blm.gov/or/energy/geothermal/files/geothermal_PEIS_FAQ_10-08.pdf

¹¹ Liz Battocletti. "An Introduction to Geothermal Permitting." Bob Lawrence and Associates, Inc. <http://www.docstoc.com/docs/2689043/An-Introduction-to-Geothermal-Permitting>

¹² Ibid.

Impacts

Although geothermal energy is a renewable resource with the potential to reduce the need for energy production from polluting fossil fuels, there are a number of environmental issues that the industry could pose to public lands. Acknowledging these concerns will help geothermal power plants to be sited and constructed in a smart and thoughtful manner.

Water

Some geothermal technologies use water in ways that are not “renewable.” The BLM’s Final PEIS for geothermal leasing notes that for flash steam facilities, “About 15-20 percent of the fluid would be lost due to flashing to steam and evaporation through cooling towers and ponds.”¹³ It also notes that groundwater resources could be depleted or the water table lowered during drilling. These impacts can be minimized by compliance with water quality and use regulations.

Land Use

Geothermal power plants require land for siting of facilities and for drilling. Industry representatives say that plants can be designed “to “blend-in” to their surroundings more so than fossil fired plants, and can be located on multiple-use lands that incorporate farming, skiing and hunting.”¹⁴ They are certainly less destructive to land than coal and natural gas plants, which disturb lands for mining and transportation of raw materials. In fact, according to the U.S. Department of Energy, “an entire geothermal field uses 1-8 acres per MW versus 5-10 acres per MW for nuclear operations and 19 acres per MW for coal power plants.”¹⁵ Nevertheless, thorough environmental reviews must be conducted in order to determine potential effects upon land and affected species.



Source: National Renewable Energy Laboratory

Emissions

Geothermal plants emit steam, not smoke. But they also emit some pollutants that are regulated under the Clean Air Act, including trace amounts of nitrogen oxides, sulfur dioxide, and carbon dioxide, though at very low levels. Geothermal plants often need to minimize impacts from the release of hydrogen sulfide because it is naturally present in some underground fluid reservoirs. While most emissions from geothermal power plants are so low as to not require federal regulation, California has stricter air standards and requires its geothermal plants to comply with those standards.¹⁶

¹³ Bureau of Land Management. “Final BLM PEIS for Geothermal Leasing in the Western United States.” page 2-49.

http://www.blm.gov/pgdata/etc/medialib/blm/wo/MINERALS_REALTY_AND_RESOURCE_PROTECTION_/energy/geothermal_eis/final_programmatic.Par.61394.File.dat/vol1_final_chap2.pdf

¹⁴ Geothermal Energy Association. “A Guide to Geothermal Energy and the Environment.” April, 2007. <http://www.geothermal.org/publications/reports/Environmental%20Guide.pdf>

¹⁵ U.S. Department of Energy. “Geothermal Power Plants – Minimizing Land Use and Impact.” http://www1.eere.energy.gov/geothermal/geopower_landuse.html

¹⁶ Geothermal Energy Association. “A Guide to Geothermal Energy and the Environment.” April, 2007. <http://www.geothermal.org/publications/reports/Environmental%20Guide.pdf>

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