WHAT IS GEOTHERMAL ENERGY?

An abundant source of energy--geothermal energy--is right under our feet. This energy is the natural heat of the earth, stored in rocks and in water or steam that fills pores and fractures in the rocks.

The heat of the earth naturally increases with increasing depth towards the center of the earth. This natural increase in heat is called the geothermal gradient. Geothermal resource areas have elevated geothermal gradients; the temperature increases more rapidly with depth than is normal. Geothermal exploration searches for those areas in which heat can be found at anomalously shallow levels within the earth's crust. Figure 1 illustrates the difference between a normal geothermal gradient and a geothermal resource area with an elevated gradient.

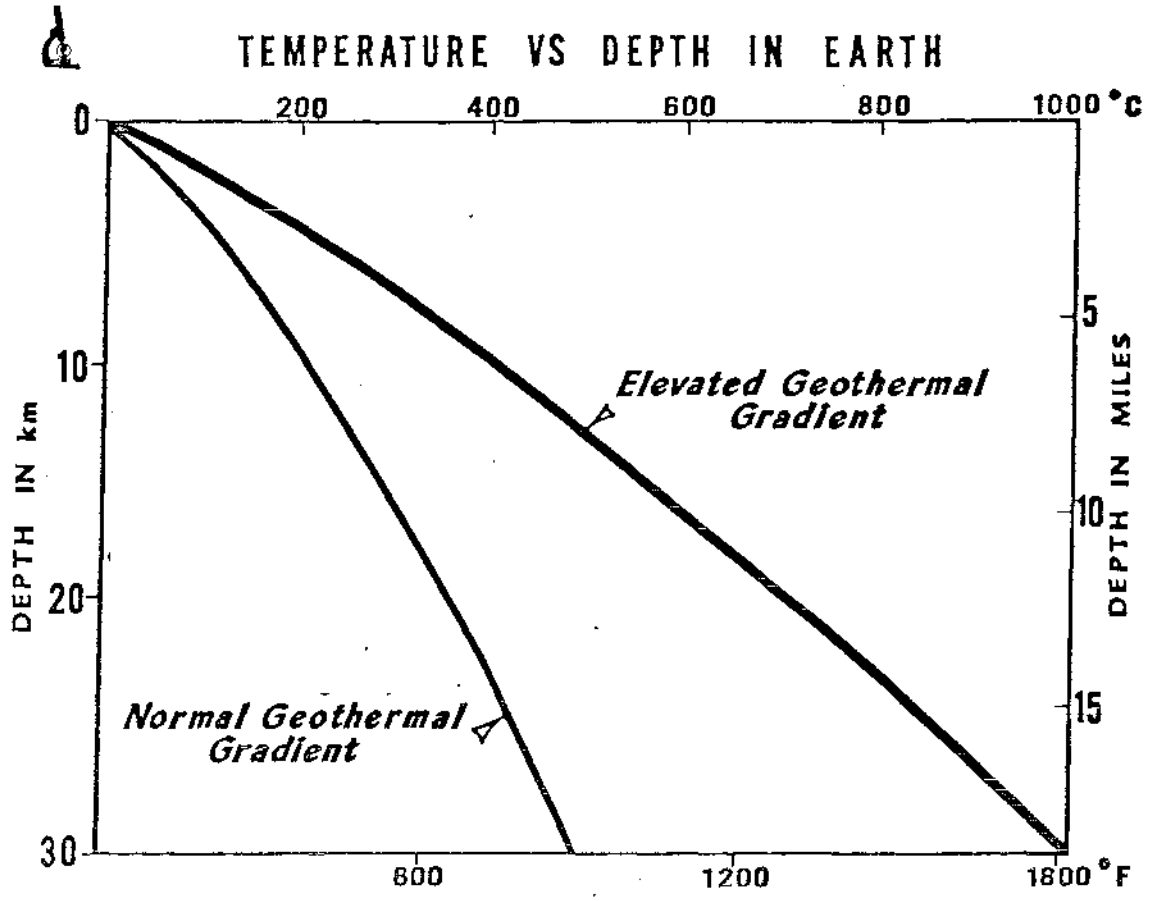

Figure 1. Normal and elevated geothermal gradients.

HYDROTHERMAL GEOTHERMAL SYSTEMS

Hydrothermal means hot water. Hydrothermal geothermal systems contain either hot water or in rare instances, steam. Geysers, fumaroles, and hot springs sometimes form above hydrothermal systems. However, not all hydrothermal systems provide us with such spectacular displays. Some are hidden and have no surface expression. Many of the hydrothermal areas in this country are in the west. Hydrothermal waters have a wide range of temperatures. A few systems are over 200°C (400°F). However, water as cool as 18°C (65°F) can be used in many ways. All of the geothermal energy that is currently used in this country comes from hydrothermal systems.

GEOPRESSURED-GEOTHERMAL SYSTEMS

The pore spaces in deeply buried sandstone and shale sometimes contain hot, salty, natural gas-bearing waters that are under pressure. These waters are known as geopressured-geothermal fluids. Most of the known geopressured-geothermal systems occur in the Gulf region of Texas and Louisiana where they are sometimes discovered in very deep oil and gas wells. Although the technology necessary to use the energy from geopressured areas is not yet fully developed, these systems are a potential source of geothermal energy and natural gas.

OTHER GEOTHERMAL SYSTEMS

Most granitic rocks contain small quantities of naturally occurring radioactive elements. The gradual decay of these elements produces heat. If these granites are buried by a thick layer of sediment, this heat may warm surrounding rocks and any nearby water. Portions of New England and the

Atlantic Coastal Plain may have this type of geothermal resource. Some areas of hot rock contain no water. If water can be made to circulate through these hot, dry, rock systems, hot water may be produced. Many experiments are currently underway to test the feasibility of using this type of geothermal system.

WHERE CAN GEOTHERMAL RESOURCES BE FOUND?

Geothermal energy has been found at many locations throughout the world. Resources hot enough to produce electricity are found at Larderello, Italy, the Geysers in northern California, in the Imperial Valley of southern California, at Roosevelt Hot Springs in Utah, Valles Caldera in northern New Mexico, at Desert Peak in Nevada, in Hawaii, Japan, Mexico, and Central and South America.

The United States Geological Survey estimates that about 50 systems in the nation with temperatures greater than 150°C (300°F) have the potential for electric power generation. Geothermal energy is also used for direct heat applications such as processing, drying, and space conditioning in the United States and Japan, the Phillipines, Iceland, Russia, Hungary, and at other locations. An estimated 37 states in the nation have resources that can be used for direct applications.

ELECTRICAL POWER GENERATION

The first geothermal resource to be developed commercially was in Larderello, Italy. An experimental generator was first operated in 1904, and a 250 kilowatt (kW) system was installed in 1913. Today, Italy can produce about 390,000 kW of geothermal electricity.

In the U. S. geothermal power production began on a small scale in 1920 at the Geysers in California. Large scale development started in 1960 and now 608,000 kW are on-line. This is enough power to supply the electricity needs of a city the size of San Francisco. In the Imperial Valley of southern California, efforts are underway to tap hot brine waters for geothermal energy. A Department of Energy (DOE) flash steam demonstration power plant is under construction at the Valles Caldera in northern New Mexico, and a 50,000 kW plant is being designed for the Roosevelt field in southwestern Utah. At the Raft River site in southern Idaho, a binary cycle plant is being built to demonstrate the effective use of geothermal waters with temperatures as low as 150°C (300°F) for the generation of electric power.

Other countries using geothermal energy for electric power generation include New Zealand, where the Wairakei system supplies a 192,000 kW plant; Russia, Japan, and Iceland, and Mexico, where a 75,000 kW plant at Cerro Prieto began operating in 1973.

DIRECT APPLICATIONS

Geothermal water has been used in the United States for mineral baths and space heating since the 1800's. A district heating system, dating to the 1890's, heats more than 100 homes in Boise, Idaho. A large number of homes are heated from individual geothermal wells in Klamath Falls, Oregon. More recently in that city, a district heating system has provided heat for the Oregon Institute of Technology campus.

Other geothermal applications in the western states include greenhouses, fish farming, roadway deicing, space conditioning (heating and cooling),

drying of agricultural products; and food and dairy product processing. Additional commerical and industrial applications appear feasible and are under investigation. These include various cooking, drying, separation, and refrigeration processes. Other applications include the evaporation/ crystallization industry, ore processing, fertilizer production industry, and alcohol production industry. In some case, it appears feasible to combine several applications which use geothermal fluid at several decreasing temperatures, each application extracting heat and passing the slightly cooled water to the next application until the water becomes cold.

WHAT IS HAPPENING NOW?

About 608,000 kW of power now are being generated in the U.S. and about 40,000 kW of geothermal energy are being used in direct applications. These quantities are expected to increase to 9,500,000 and 2,000,000 kW respectively, by the year 2000.

The Department of Energy has developed a number of programs to encourage the private sector to utilize geothermal energy. The Program Research and Development Announcement or PRDA program funds engineering and economic feasibility studies of geothermal utilization. The Program Opportunity Notice or PON funds demonstrations of hydrothermal energy use. Loan guarantees for development projects are provided through the Geothermal Loan Guarantee Program. A limited amount of technical assistance is provided to potential users of geothermal energy through firms under contract to DOE. These and other programs are offered to help speed up the early use of this valuable resource.

WHAT DOES IT COST?

The cost of geothermal energy is dependent on the resource accessibility, chemical quality, and temperature, as well as the means employed for disposal of the spent fluid. Deep drilling, long transmission distances, poor water quality, low temperature, and elaborate disposal systems generally contribute to increased cost for geothermal energy. The amount of heat that can be economically extracted from a stream of warm fluid increases with the temperature of the fluid. The cost of competing energy sources also varies from location to location; geothermal energy has been shown to be cost competitive under a variety of circumstances. Additionally, supplies of geothermal energy are not subject to shortage or cutoff due to action of foreign governments or transportation problems.

WILL IT HELP?

The balance of payments and our dependence upon foreign sources of energy will be reduced as the use of geothermal energy increases. The minimal impact on the environment makes geothermal energy an excellent answer to our energy needs.