

# Geothermal Energy Program

## TECHNOLOGY OVERVIEW

The Earth's crust is a bountiful source of energy – and fossil fuels are only part of the story. Geothermal ("Earth-heat") energy is by far the more abundant resource. To put it in perspective, the thermal energy in the uppermost six miles of the Earth's crust amounts to 50,000 times the energy of all oil and gas resources in the world.

The Geothermal Energy Program is researching two different applications of geothermal energy.

**Electricity production** using geothermal energy is based on conventional steam turbine and generator equipment, in which expanding steam taken from the ground spins the turbine/generator to produce electricity. In some cases a secondary working fluid is used to drive the turbine.

Geothermal power plants operate at high capacity factors (70%-100%) and have availability factors typically greater than 95%. Geothermal plants are one of the cleanest sources of electric power currently available.

**Direct use** involves using hot water from geothermal resources directly to provide heat for industrial processes, crop drying, greenhouses, aquaculture, or heating buildings. Geothermal district heating systems supply heat to multiple buildings through a network of pipes carrying water heated by geothermal resources. People at more than 120 locations (some of which include as many as 500 wells) are using geothermal energy for space and district heating. These direct use systems are located mainly in the western United States.

## U.S. DEPARTMENT OF ENERGY PROGRAM

The mission of the U.S. Department of Energy (DOE) Geothermal Energy Program is to work in partnership with U.S. industry to establish geothermal energy as an economically competitive contributor to the U.S. energy supply, capable of meeting a large portion of the nation's heat and power needs. The Program focuses on research and development that will help the United States attain substantial economic, environmental, and energy security benefits.

Over the years, an excellent working relationship has evolved between DOE and the U.S. geothermal industry. DOE's program includes research and development (R&D) in geosciences, drilling, and energy systems. Industry is mainly interested in R&D that will create solutions to immediate and pressing technological problems. As a result, DOE undertakes a program balanced between short-term goals, of greater interest to industry, and long-term goals, of importance to national energy interests. In many cases, DOE's long-term goals can be reached in increments by satisfying industry's short-term needs.

Each type of geothermal resource can make a significant contribution to meeting society's energy needs, and each has its unique technological challenges. Although the present geothermal industry is based solely on hydrothermal (hot water) resources, the long-term viability of geothermal energy lies in developing technology to harness the full range of geothermal energy. These include widespread resources, that require deeper drilling and/or injection of water to recover the heat stored in the subsurface rock.

Lewis Stewart, NREL/PX00061



**Geothermal power plants, such as this one at The Geysers steam field, supply 6% of California's electricity.**

# GEOTHERMAL ENERGY PROGRAM

## District Heating

The geothermal district heating system in the city of Klamath Falls, Oregon, provides heating and hot water to nearly 30 government and small business buildings.

- Peak load is about 3.5 MW thermal.
- The system also provides heat to melt snow on downtown sidewalks and crosswalks.
- Customers save money on heating costs, and are thrilled with not shoveling snow.

Eleven buildings on the Oregon Institute of Technology (OIT) campus, in northeast Klamath Falls, are on a separate geothermal district heating system. The OIT system saves about 11,000 barrels of oil each year.



Oregon Institute of Technology - Smothers, Many/PX08810

**The Oregon Institute of Technology has used a geothermal district heating system for almost 40 years.**

## MARKET POTENTIAL

The U.S. geothermal industry is a \$1.5-billion per year enterprise. Installed geothermal electrical generating capacity is approximately 2800 megawatts (MW) in the United States and 8000 MW worldwide. Currently identified hydrothermal resources could provide 25,000 MW - 50,000 MW of power in the United States and another 100,000 MW in the rest of the world.

Geothermal generating plants produce clean power and require very little land. They emit no nitrogen oxides, very low amounts of sulfur dioxide, and 1/1000 - 1/2000 of the carbon dioxide emitted from fossil-fueled power plants. The use of geothermal water directly for heating reduces the need for fossil-fuel-generated heat. Geothermal energy is clean, reliable, and sustainable.

The demand for new electrical power in the United States has been growing at annual rates of 2%-4%. Given an active and expanding economy and the pressures of competition in unregulated power markets, the need for additional generating capacity will continue to grow. Consumer choice initiatives and renewable portfolio standards on power generation will open up new markets for geothermal power. To meet the increased demand, many operating geothermal fields could be expanded, and many new fields await discovery.

With growing concerns about unstable energy prices, the market potential for a clean power source that provides electricity at \$0.05 to \$0.08 per kilowatt-hour is expanding. Today, geothermal power plants are located primarily in the western United States, an area that is characterized by a steadily increasing population and industrial base that requires reliable sources of electric power. International markets also have great potential - during the next 20 years, foreign countries are expected to spend \$25 to \$40 billion constructing geothermal power plants, creating a significant opportunity for U.S. suppliers of geothermal goods and services.

Direct-use applications are also growing rapidly and have considerable market and energy-savings potential. Over 9000 MW of installed thermal capacity exists worldwide today. The direct use world market grew by 2500 MW thermal capacity from 1995 to 2000.

### For More Information:

DOE Geothermal Energy Program  
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General technology information: Energy Efficiency and Renewable Energy Clearinghouse  
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