



CAROL WERNER
EXECUTIVE DIRECTOR

ENVIRONMENTAL AND ENERGY STUDY INSTITUTE
122 C STREET, N.W., SUITE 630 ■ WASHINGTON, D.C., 20001 ■ 202-628-1400 ■ www.eesi.org

Renewable Energy Fact Sheet

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Contact:

Fredric Beck (202) 662-1892, fbeck@eesi.org

Geothermal Energy **Tapping the energy in the Earth's core**

Key Facts

- Geothermal energy comes from the heat in the Earth's core. This heat creates underground reservoirs of steam and hot water, which can be tapped to generate electricity or to heat and cool buildings directly.
- Geothermal energy is the third largest source of renewable energy, behind hydropower and biomass. In 2003, it accounted for 7 percent of US electricity generated from renewable sources.
- The United States is the world's largest producer of geothermal energy. About 2,800 megawatts (MW) of geothermal electrical capacity is connected to the electrical grid in the United States; 8,000 MW of geothermal electrical capacity is installed worldwide.
- The US Geological Survey (USGS) has identified approximately 22,000 MW of geothermal resources sufficient for electrical power generation in the United States. In addition, low-temperature resources sufficient for direct-use and heat pumps are available across the country.
- The largest geothermal development in the world is at The Geysers in California. This plant, in operation since 1960, has a capacity of over 850 MW and satisfies nearly 70 percent of the average electrical demand for the Californian North Coast region.
- Electricity from The Geysers sells for \$0.03 to \$0.035 per kilowatt-hour (kWh), while electricity from newer geothermal plants costs between \$0.05 and \$0.08 per kWh. New geothermal power plants are now eligible for a Production Tax Credit for power produced in the first 5 years of operation.

Geothermal Technologies

- *Direct use processes:* Geothermal water of at least 70°F can be used directly for heating homes or offices, growing plants in greenhouses, heating water for fish farming, and for other industrial uses such as dehydrating onions and garlic or pasteurizing milk. Some cities, e.g. Boise, Idaho, pipe geothermal hot water under roads and sidewalks to melt snow. District heating applications use networks of piped hot water to heat buildings throughout a community.
- *Heat pumps:* A geothermal heat pump system takes advantage of the constant temperature (between 50°F and 60°F) of the upper ten feet of Earth's surface. In winter, heat from the relatively warmer ground is pumped into a building, while in summer, hot air from the building is pulled through a heat exchanger into the relatively cooler ground. Heat removed during the summer can also be used to heat water for the building.
- *Geothermal power plants:* Three types of geothermal power plants use turbines and electric generators to convert the earth's heat into electricity:
 - *Flash steam:* The most common type of geothermal power plant uses flash steam technology. Underground water at temperatures above 360°F is sprayed into a tank held at a much lower pressure than the water, causing some of the water to vaporize or "flash." This vapor is used to turn a turbine to generate electricity.

- *Dry steam*: Reservoirs of underground steam are found in some places, such as The Geysers in California. This steam is pumped directly to a turbine to power an electric generator.
- *Binary cycle*: A binary cycle plant uses moderate-temperature geothermal water (200-300°F). This hot geothermal water and a fluid with a lower boiling point are passed through a heat exchanger. The lower boiling point fluid then flashes to vapor and powers a turbine.

Benefits

- *Base load power*: Geothermal energy is available 24 hours a day and is not intermittent power.
- *Pollution prevention*: A geothermal steam plant emits 35 times less carbon dioxide (CO₂) than the average US coal power plant per kilowatt of electricity produced, according to the National Renewable Energy Laboratory (NREL). Every year, geothermal electricity plants prevent 4.1 million tons of CO₂ emissions that coal-powered plants would have generated. A geothermal plant's cooling towers emit mostly water vapor, and do not emit particulates, hydrogen sulfide, or nitrogen oxides.
- *Jobs and security*: Geothermal energy can be produced domestically, thereby providing jobs for Americans and helping to reduce security concerns associated with depending on foreign countries for oil and natural gas.

Cost

- Electricity from geothermal power plants costs between \$0.05 and \$0.08 per kWh. Direct use of geothermal resources is cost-competitive in many applications. For example, greenhouses using geothermal resources instead of traditional energy sources save on average 80 percent of their fuel costs—about 5 to 8 percent of their total operating costs, according to the US Department of Energy.

Issues

- *Subsidence and production declines*: Energy production at geothermal power plants may gradually decline over time, through a loss of water/steam or declining water temperatures. As water or steam is removed from an underground reservoir, the land above the reservoir may slowly start to sink. Municipalities can inject their treated wastewater into the underground reservoir to replenish the hot water supply and avoid land subsidence.
- *Induced seismicity*: Areas with good geothermal resources are almost always seismically active, and developing a geothermal resource can cause additional earthquakes. These induced quakes are usually small and imperceptible by humans, registering only 2 to 3 on the Richter scale.
- *Noise*: Geothermal plant construction is loud, but must remain below federal noise pollution limits. Once in operation, geothermal plants are quieter than fossil fuel generation plants. Installation time for a typical geothermal plant can be completed in one to two days.

For More Information

Geothermal Collaborative <http://www.geocollaborative.org>

Geothermal Energy Association <http://www.geo-energy.org>

National Renewable Energy Laboratory <http://www.nrel.gov/geothermal>

DOE Office of Energy Efficiency and Renewable Energy <http://www.eere.energy.gov/geothermal>

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