GEOTHERMAL: GETTING ENERGY FROM THE EARTH[1,2]

Lester R. Brown©

The heat in the upper six miles of the earth's crust contains 50,000 times as much energy as found in all the world's oil and gas reserves combined. Despite this abundance, only 10,700 megawatts of geothermal electricity generating capacity have been harnessed worldwide. Partly because of the dominance of the oil, gas, and coal industries, which have been providing cheap fuel by omitting the costs of climate change and air pollution from fuel prices, relatively little has been invested in developing the earth's geothermal heat resources. Over the last decade, geothermal energy has been growing at scarcely 3 percent a year.

Roughly half the world's existing generating capacity is in the United States and the Philippines. Indonesia, Mexico, Italy, and Japan account for most of the remainder. Altogether some 24 countries now convert geothermal energy into electricity. El Salvador, Iceland, and the Philippines respectively get 26, 25, and 18 percent of their electricity from geothermal power plants. The potential of geothermal energy to provide electricity, to heat homes, and to supply process heat for industry is vast. Among the countries rich in geothermal energy are those bordering the Pacific in the so-called Ring of Fire, including Chile, Peru, Colombia, Mexico, the United States, Canada, Russia, China, Japan, the Philippines, Indonesia, and Australia. Other geothermally rich countries include those along the Great Rift Valley of Africa, such as Kenya and Ethiopia, and those around the Eastern Mediterranean.

Beyond geothermal electrical generation, an estimated 100,000 thermal megawatts of geothermal energy are used directly—without conversion into electricity—to heat homes and greenhouses and as process heat in industry. This includes, for example, the energy used in hot baths in Japan and to heat homes in Iceland and greenhouses in Russia.

An interdisciplinary team of 13 scientists and engineers assembled by the Massachusetts Institute of Technology (MIT) in 2006 assessed U.S. geothermal electrical generating potential. Drawing on the latest technologies, including those used by oil and gas companies in drilling and in enhanced oil recovery, the team estimated that enhanced geothermal systems could be used to massively develop geothermal energy. This technology involves drilling down to the hot rock layer, fracturing the rock and pumping water into the cracked rock, then extracting the superheated water to drive a steam turbine. The MIT team notes that with this technology the United States has enough geothermal energy to meet its energy needs 2,000 times over.

Though it is still costly, this technology can be used almost anywhere to convert geothermal heat into electricity. Australia is currently the leader in developing pilot plants using this technology, followed by Germany and France. To fully realize this potential for the United States, the MIT team estimated that the government would need to invest $1 billion in geothermal research and development in the years immediately ahead, roughly the cost of one coal-fired power plant.

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[1] Earth Policy Institute, Book Byte, August 31, 2010, www.earthpolicy.org/index.php?/book_bytes/2010/pb4ch05_ss4

[2] Adapted from Chapter 5, "Stabilizing Climate: Shifting to Renewable Energy," in Lester R. Brown, Plan B 4.0: Mobilizing to Save Civilization (New York: W.W. Norton & Company, 2009), available on-line at www.earthpolicy.org/index.php?/books/pb4

Even before this exciting new technology is widely deployed, investors are moving ahead with existing technologies. For many years, U.S. geothermal energy was confined largely to the Geysers project north of San Francisco, easily the world's largest geothermal generating complex, with 850 megawatts of generating capacity. Now the United States, which has more than 3,000 megawatts of geothermal generation, is experiencing a geothermal renaissance. Some 152 power plants under development in 13 states are expected to nearly triple U.S. geothermal generating capacity. With California, Nevada, Oregon, Idaho, and Utah leading the way, and with many new companies in the field, the stage is set for massive U.S. geothermal development.

Indonesia, richly endowed with geothermal energy, stole the spotlight in 2008 when it announced a plan to develop 6,900 megawatts of geothermal generating capacity. The Philippines is also planning a number of new projects. Among the Great Rift countries in Africa—including Tanzania, Kenya, Uganda, Eritrea, Ethiopia, and Djibouti—Kenya is the early leader. It now has over 100 megawatts of geothermal generating capacity and is planning 1,200 more megawatts by 2015. This would nearly double its current electrical generating capacity of 1,300 megawatts from all sources. Japan, which has a total of 535 megawatts of generating capacity, was an early leader in this field. Now, following nearly two decades of inactivity, this geothermally rich country—long known for its thousands of hot baths-is again beginning to build geothermal power plants.

In Europe, Germany has 5 small geothermal power plants in operation and some 150 plants in the pipeline. Werner Bussmann, head of the German Geothermal Association, says, "Geothermal sources could supply Germany's electricity needs 600 times over."

Beyond geothermal power plants, geothermal (ground source) heat pumps are now being widely used for both heating and cooling. These take advantage of the remarkable stability of the earth's temperature near the surface and then use that as a source of heat in the winter when the air temperature is low and a source of cooling in the summer when the temperature is high. The great attraction of this technology is that it can provide both heating and cooling and do so with 25-50 percent less electricity than would be needed with conventional systems. In Germany, for example, there are now 178,000 geothermal heat pumps operating in residential or commercial buildings. This base is growing steadily, as at least 25,000 new pumps are installed each year.

In the direct use of geothermal heat, Iceland and France are among the leaders. Iceland's use of geothermal energy to heat almost 90 percent of its homes has largely eliminated coal for this use. Geothermal energy accounts for more than one third of Iceland's total energy use. Following the two oil price hikes in the 1970s, some 70 geothermal heating facilities were constructed in France, providing both heat and hot water for an estimated 200,000 residences. Other countries that have extensive geothermally based district-heating systems include China, Japan, and Turkey.

Geothermal heat is ideal for greenhouses in northern countries. Russia, Hungary, Iceland, and the United States are among the many countries that use it to produce fresh vegetables in the winter. With rising oil prices boosting fresh produce transport costs, this practice will likely become far more common in the years ahead.

Among the 22 countries using geothermal energy for aquaculture are China, Israel, and the United States. In California, for example, 15 fish farms annually produce some 10 million

pounds of tilapia, striped bass, and catfish using warm water from underground.

Hot underground water is widely used for both bathing and swimming. Japan has 2,800 spas, 5,500 public bathhouses, and 15,600 hotels and inns that use geothermal hot water. Iceland uses geothermal energy to heat 135 public swimming pools, most of them year-round open-air pools. Hungary heats 1,200 swimming pools with geothermal energy.

If the four most populous countries located on the Pacific Ring of Fire—the United States, Japan, China, and Indonesia—were to seriously invest in developing their geothermal resources, they could easily make this a leading world energy source. With a conservatively estimated potential in the United States and Japan alone of 240,000 megawatts of generation, it is easy to envisage a world with thousands of geothermal power plants generating some 200,000 megawatts of electricity by 2020. For direct use of geothermal heat, the 2020 Plan B goal is 500,000 thermal megawatts. All together, the geothermal potential is enormous.