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Opportunities in Geothermal Power

Special Report

Geothermal power – using the enormous heat generated in the Earth's core by the radioactive decay of unstable elements – could prove to be the cleanest, greenest, and most abundant source of energy we have ever used. Literally beneath our feet is a white-hot, seeing mass of magma that generates temperatures of up to 9,000 degrees Fahrenheit. The heat is used to generate electricity or heat facilities.

Geothermal energy is so sustainable that the first modern site, established in Lardarello, Italy, in 1904, is still producing power. The existing plant has been in operation since 1913, and was interrupted only once, by a World War II bomb.

Although geothermal energy is experiencing a relatively recent resurgence, it's hardly new. It has been powering the United States since 1922, and currently produces 65 percent more power in the United States than solar and wind. Yet despite its commercial success since 1960, geothermal's full potential is just starting to be tapped by a few visionary companies.

The reservoirs of steam and hot water that make large-scale geothermal generation possible are primarily located in the western states, Alaska, Hawaii, and other parts of the Pacific Rim's "Ring of Fire." Although through new enhanced geothermal technologies, geothermal power can theoretically be tapped pretty much anywhere.

What is Geothermal Power

In a traditional geothermal plant, steam or superheated water from deep inside the Earth is used to drive a turbine and generate electricity.

The designs typically come in two types: steam plants and binary plants.

1.) Steam plants : Steam plants use steam or hot water resources (generally hotter than 300 degrees Fahrenheit). Either the steam comes directly from the source or extremely hot, high-pressure water is injected into the well and then depressurized (flashed) to produce steam. The steam turns the turbines, which drive generators that produce electricity.

In a traditional plant, a geothermal well is drilled, typically 5,000 to 10,000 feet deep, in order to access water that has trickled down through cracks in the Earth's crust and collected in subterranean reservoirs where it is heated by magma from the Earth's core and becomes super-heated steam (usually over 500 degrees Fahrenheit).

After the steam has spent its energy driving the turbines, it is reinjected into the geothermal reservoir to be reheated and used again. With proper management of geothermal resource, it can be truly renewable.

2.) Binary cycle plants : In a more modern binary cycle plant, a geothermal fluid is cycled through the production well and passed through a heat exchanger, which transfers the heat to a secondary "working fluid" that has a lower boiling point. This causes the working fluid to flash into vapor, which turns the turbines that drive the generators. The working fluid is then recycled through the system.

Due to the lower boiling point of the working fluid, binary cycle plants have the advantage of being able to harvest heat from a dry hole, or from a lower temperature resource (between 100 degrees Fahrenheit and 300 degrees Fahrenheit).

Geothermal Heat Pumps

The geothermal technologies we have discussed so far are suited to generating electricity at a commercial power plant scale, and should not be confused with the totally different technology used in "geothermal" (or "ground source") heat pumps. These are essentially HVAC units which are commonly used for heating and cooling in residential or commercial buildings. They exchange heat with the Earth using pipes buried about five feet deep in the ground, where the temperature is stable year-round at about 55 degrees.

By cycling a fluid through a heat exchanger, geothermal heat pumps can draw heat from the ground in the winter, and discharge heat underground in the summer. These units tend to be more efficient and cost-effective than their traditional counterparts, because the thermal energy they draw from the Earth is free (although they still use electricity to run the compressors, pumps and fans).

Benefits of Geothermal Power

Geothermal power holds several advantages over other forms of renewable energy, and many advantages over fossil fuels:

- It's one of the cheapest forms of energy, and the cheapest of all forms of renewable energy. At a typical cost of around 5 cents per kWh, it's about half the price of grid utility power, on a par with the lowest-cost power sources available.
- Geothermal energy produces nearly 50 times less carbon dioxide, nitric oxide, and sulfur emissions than traditional fossil-fuel power plants.
- Modern binary cycle geothermal generators have no emissions. They make no smog, no toxic chemicals, and no waste.

- Watt for watt, geothermal plants are tiny compared to other power plants.

- Geothermal power plants use no fuel because they provide all their own power. That is, except for older plants, like the Geysers in California which are now starting use solar PV to run the pumps that inject water into the wells.

- They require no power storage, unlike large-scale solar and win plants. Simply shut down the cycle and the power stays underground.

- They run at 89 to 97 percent uptime. This makes geothermal power the most reliable form of power we have.

- Geothermal plants have minimal aesthetic impact. Units that harvest heat from underground hot water sources, and reinject it back into the ground, can be very low profile.

- The supply of geothermal energy is virtually inexhaustible.

Massive Potential

Today's roughly 10,000 megawatts of installed worldwide geothermal capacity is but a tiny fraction of the power that's there, however. The recoverable share of the heat energy found beneath American soil alone is about 14 million quads – or about 140,000 times our current annual energy consumption. It's just a matter of actually getting it.

One of the more interesting applications of geothermal technology is in co-production from oil and natural gas reservoirs that have trapped water, usually at a depth of two to four miles underground. This water ranges from 190 to 390 degrees Fahrenheit, and while a nuisance for the oil and gas industry, it offers good potential for modern binary geothermal plants. For example, in West Texas, nearly 100 barrels of hot water are co-produced along with every barrel of oil, which is then reinjected into the ground.

Significant hot water resources of this type have been found in at least 11 states, mostly in the West. It is often commingled with natural gas, which can also be produced profitably. The National Renewable Energy Laboratory estimates that such resources could produce between 400 and 2,200 MW of power in Texas alone, and as much as 70,000 MW (about 10 percent of the nation's electrical needs) nationwide over the next 20 years.

The greatest potential for geothermal development, however, may be found not just in specialized sites with particular geological characteristics, but literally anywhere.

According to a 2006 MIT study, there are over 100 million quads of accessible geothermal energy worldwide – when the entire worldwide consumption of energy is only 400 quads. That's enough to meet the world's total current energy needs for 30,000 years.

The MIT scenario is based on the use of “enhanced geothermal systems” technology, in which two holes are drilled at least 10 km down into hard rock, and the rock between them is fractured. Water is pumped down one hole and harvested as steam when it comes back up the other, which is then used to spin a turbine. Such facilities could be built almost anywhere in the world, sine adequate heat is available at those depths worldwide.

The report estimates that “a cumulative capacity of more than 100,000 megawatts from enhanced geothermal systems (EGS) can be achieved in the United States within 50 years with a modest, multi-year investment for R&D in several field projects in the United States.” With an investment of $800 million to $1 billion, the report estimates that the United States could produce more than 100 gigawatts of electricity by 2050, equal to the combined out put of all its nuclear power plants. And if EGS could tap just 40 percent of the heat under the United States, it would meet demand 56,000 times over.

This is the future, my friends. And this is where tomorrow's energy profits will be found.

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