

Low-Temperature Geothermal Power Generation with HVAC Hardware

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Abstract

Demand is growing for affordable, domestic renewable energy sources, driven by global warming concerns, tighter emissions controls, ever-increasing fossil fuel costs, and a desire to be less dependent on energy sources in politically unstable areas of the world.

Unstable infra-structure, and inconsistent and inefficient delivery are driving demand for reliable power.

Geothermal power systems are one of the few renewable energy sources that can generate power at full capacity all the time, in contrast to solar, wind, and hydro, which are all subject to variations in availability of energy input (sun, wind, and water level).

Geothermal energy is renewable because its source is the almost unlimited amount of heat generated by the Earth's core. Even though geothermal power plants are dependent on an underground reservoir of hot water, the volume of hot water taken out of the earth can be re-injected, making it a renewable and sustainable energy source. (Source: US DOE Geothermal Technologies Program website).

In addition, the cost of geothermal power is unaffected by oil prices, which have doubled in the past three years. Geothermal energy can be extracted without burning a fossil fuel such as coal, gas, or oil, making it a non-fossil fueled, zero-combustion, zero emission energy source.

UTC Power

UTC has developed an Organic Rankine Cycle (ORC) vapor power cycle utilizing a refrigerant (and organic based), instead of water/steam, as the working fluid. Because it is refrigerant based, commercial off-the-shelf air-conditioning and refrigeration equipment can be simply used for the bulk of the system.

The ORC turbine is very close to identical to a standard centrifugal vapor compressor used in water-cooled chillers. The shell and tube heat exchangers used for the vaporizer-evaporator, and condenser, are nearly the same to the chiller barrels found in the standard water chiller. This

combination of equipment and supply chain synergy has created an extremely cost effective geothermal power plant.

Closed-cycle binary plants, such as UTC Power's PureCycle® geothermal power plant, release essentially no emissions. (Source: US DOE Geothermal Technologies Program website). UTC Power's PureCycle® geothermal system is a closed-cycle process that uses geothermal water to generate 225 kW of electrical power.

UTC Power is uniquely positioned in the market with its PureCycle® geothermal power plant, which delivers a variety of differentiating performance characteristics:

- The PureCycle® geothermal system can operate on a wide range of geothermal resource temperatures starting as low as 165°F (74°C) – the lowest temperature demonstrated anywhere in the world.
- By operating at lower temperatures than conventional geothermal systems, the PureCycle® geothermal system enables geothermal wells deemed unproductive because they are below 300°F (149°C) to become viable energy sources.
- Ease of install/maintenance, including dramatically reduced onsite.
- Modular skid mounted packages can be sized and deployed according to need
- Can be 100% remotely monitored – for remote unattended operation.

Geothermal Market

While estimates vary on geothermal resource potential based on identified/unidentified resources, temperature range and other factors, the International Geothermal Association forecasts global geothermal capacity will rise as much as 10 percent a year through 2010, three times the pace of the past decade.

- The Western Governors Association forecasts that 13,000 MW of geothermal energy can be developed on specific sites in the western U.S. within a reasonable time frame. Of these, 5,600 MW are considered by the geothermal industry to be viable for commercial development by 2015.
- To put these figures in context, according to the Geothermal Energy Association (GEA), in 2003 geothermal was the third largest source of renewable energy in the United States.
 - The United States has nearly 2,800 megawatts of electricity connected to the grid.
 - As the world's largest producer of geothermal energy, the U.S. generates a yearly average of 15 billion kilowatt hours of power, comparable to burning about 25 million barrels of oil or 6 million short tons of coal per year or 150 billion cubic feet of natural gas.

- Between January and May 2005, there were 483 megawatts of new geothermal power purchase agreements signed. These new projects are located throughout California, Nevada, Arizona, and Idaho, and represent the power generation equivalent of the total 2,000 megawatts of wind projects operating throughout California today. (Source GEA)
- *International*: According to a 2005 ENEL report, geothermal supplies 8,900 MW to 24 countries worldwide.
 - Geothermal energy today meets the total electricity needs of some 60 million people worldwide — roughly the population of the United Kingdom.
 - Since 2000, geothermal generation has tripled in France, Russia, and Kenya.
- ~250,000 gas/oil wells currently capped in the United States are potential sources for PureCycle® geothermal product.
- 50% of geothermal sources within Continental US are <300 °F.

Chena Hot Springs

Chena Hot Springs Resort, located near Fairbanks, Alaska, partnered with UTC, the U.S. Department of Energy, the Alaska Energy Authority and the Denali Commission to demonstrate the geothermal technology.

- The first unit was commissioned in July 2006.
- A second unit was commissioned in December 2006.
- UTC Power's two PureCycle® geothermal systems at Chena Hot Springs, near Fairbanks, Alaska, enjoy 99.4% availability vs. the average availability of 14% for solar and 25% for wind.

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