With a potential resource capacity of 30 GW nationwide, conventional hydrothermal resources rely on permeable rock and abundant fluid to access the earth's heat naturally. Low-temperature and co-produced resources represent a small but growing sector of hydrothermal development in geothermal resources below 150°C (300°F). Considered non-conventional hydrothermal resources, these technologies are bringing valuable returns on investment in the near-term, using unique power production methods.

Low-Temperature Resources

Increasingly, low-temperature resources below 150°C—once reserved for direct-use applications such as heating, greenhouses, fisheries, and mineral recovery—can now be used for power generation under the right conditions. Low-temperature resources have the potential to draw geothermal resources from across the nation, not just the hotter western states.

Co-produced Resources

Co-produced resources use hot fluid that is a byproduct of oil, gas, and other mineral extraction efforts to generate electricity, with the potential to reduce dependence on foreign energy and extend the economic life of oil and gas fields. The quality of the resource depends on water volume and temperature.

Geothermal Power/ Oil & Gas Co-production Resource Capacity

- 823,000 oil and gas wells in the U.S. produce hot water concurrent with oil and gas production.
- The water produced annually by oil and gas fields could generate up to 3 GW of clean, base-load power using binary geothermal units.
- U.S. oil and gas industry already invests beyond hydrocarbons.

The industry invested almost $16 billion for advanced technologies before 2008.

Visit the Geothermal Technologies Office (GTO) website at **geothermal.energy.gov** for more information on low-temperature and co-produced resources, or contact **geothermal@ee.doe.gov**.

Photo courtesy of Terra Gen

Dixie Valley Bottoming Binary Plant: Terra-Gen was funded by the American Recovery and Reinvestment Act of 2009 to demonstrate the technical and economic feasibility of electricity generation from nonconventional geothermal resources of 223°F, employing the first commercial use of a supercritical cycle at a geothermal power plant inlet temperature of less than 300°F. Since September 2012, the plant has been online and producing 6 MW gross.

Low-Temperature and Co-Produced Resources

The U.S. Department of Energy's (DOE) Geothermal Technologies Office (GTO), in partnership with DOE's national laboratories, universities, and small businesses conducts research, development, and demonstration projects throughout the United States on low-temperature and co-produced geothermal resources. Recent funding opportunities have enabled GTO to support work that extends into sedimentary basins, including geothermal resources colocated within oil and natural gas fields. The Office strives to demonstrate innovative technologies that will lead to advanced geothermal energy use and electricity production in these currently underutilized resource areas.

There are numerous applications for low-temperature geothermal energy beyond power generation, including spas, industrial processes, direct space heating, aquaculture, agricultural drying, and snow melting. Direct use low-temperature installations continue to gain ground in the United States.

In general, low-temperature geothermal resources are more difficult to extract electrical power from since the highest temperature in the power generation cycle has a very strong effect on the overall efficiency. However, low-temperature resources are widely available, and with newer technologies, power generation and electricity unit installations have doubled in the United States in the last 15 years.

Because they are so plentiful, low-temperature resources have the potential to make a large contribution to the national geothermal portfolio. The U.S. Geological Survey is currently in the process of updating their assessment of untapped low-temperature geothermal resources in the United States and should have results in FY13.

Photo courtesy of Electratherm

Heat from geothermal fluids at the Florida Canyon mine in Northern Nevada—once an unused byproduct of gold mining—will be generating up to 70 kW of electric power for $0.06–$0.08/kWh, thanks to an investment by the DOE Geothermal Technologies Office. DOE awarded ElectraTherm of Reno, Nevada, approximately $1 million to adapt its patented "Green Machine" technology—a modular low-temperature heat-to-power generator—for geothermal applications. The new prototype is specifically optimized for harsh downhole environments, and the rugged, weather-proof enclosure provides a replicable model for plug-and-play deployment wherever low-temperature geothermal fluids are available.

Technology Benefits

- Capacity range from 50 kW to more than 10 MW
- Design flexibility and reduced construction lead times
- Scalable plant sizes based on local geothermal resource and demand
- Ability to utilize off-the-shelf units, easily adaptable to higher output when more generation potential is identified

Learn More

For more information please contact:

Tim Reinhardt, Co-Production Technology Manager
Geothermal Technologies Office
U.S. Department of Energy
timothy.reinhardt@ee.doe.gov

Project Highlights

In June 2010, DOE issued a funding opportunity announcement to evaluate the feasibility and demonstrate the technical and economic potential of energy production from nonconventional geothermal resources, including low-temperature, co-produced, and geopressured resources. Several projects are underway in the United States, including:

Analysis of Low-Temperature Utilization — West Virginia University

Objective: Perform in-depth analysis of low-temperature geothermal resources in the eastern United States. *The analysis could lead to better supply and techno-economic estimates for DOE models.*

Small Scale Electrical Power Generation from Heat Co-Produced in Geothermal Fluid — Mining Operation: ElectraTherm

Objective: Demonstrate the technical and economic feasibility of small scale power generation from low temperature co-produced fluids. *Electratherm has successfully demonstrated the technical and economic feasibility of geothermal energy production through a state-of-the-art Organic Rankine Cycle (ORC) heat-to-power generator.*

Advanced Low Temperature Geothermal Power Cycle — The "Bald Mountain" Project: Technip

Objective: Validate the theoretical as well as actual performance advantages of an advanced ammonia-water mixed fluid cycle (Project Cycle) over current ORC. *The technology has the potential to lower the minimum temperature range required for commercial generating facilities, and the Project Cycle could allow geothermal resources that are currently commercially unviable to become feasible for development.*

Novel Energy Conversion Equipment for Low Temperature Geothermal Resources — Johnson Controls, Inc.

Objective: Develop electricity-generating equipment from low-temperature geothermal resources at a cost at least 20% less than current technology. *This equipment could play a leading role in realizing renewable energy and its potential to create new jobs and reduce emissions.*

Development of New Biphasic Metal Organic Working Fluids for Subcritical Geothermal Systems: — Pacific Northwest National Laboratory

Objective: Develop a new type of biphasic working fluid for subcritical geothermal systems that utilizes microporous metal-organic solids as the primary heat carrier and heat transfer medium to support an ORC. *This technology could increase the efficiency of binary-cycle plants and consequently increase geothermal power output.*

A Revolutionary Hybrid Thermodynamic Cycle for Binary Geothermal Power Plants: — Oak Ridge National Laboratory

Objective: Demonstrate an innovative cycle that uses chemically unique working fluid combinations that facilitate phase transition by embedding a part of a Rankine cycle within a part of a Brayton cycle forming an overall closed hybrid cycle. *This new cycle technology could dramatically increase power production relative to investment and operating cost when compared to the ORC system operating within the same source temperature limits.*

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