Office for TechnologyCommercialization

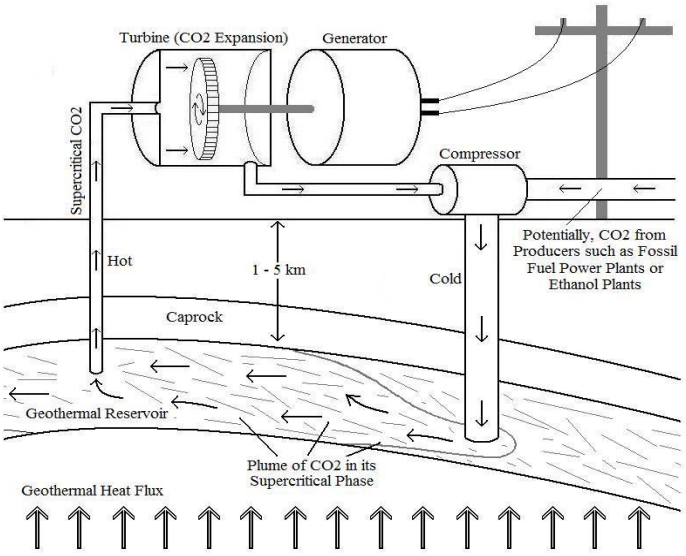
Geothermal Electricity Production Coupled with CO_2 Sequestration

Professor Martin Saar has developed a concept for a power plant that uses CO_2 as the working fluid in geothermal energy production including electricity and heat. This approach takes advantage of the much more favorable thermodynamic properties of CO_2, compared to water. Heat extraction efficiency and, hence, thermal energy recovery are expected to be significantly improved even in cases of low-temperature reservoirs. The technology significantly expands the viable geothermal sites that were previously thought unproductive due to the lack of adequate groundwater or thermal resource and provides strong economics through the natural synergies of CO_2 sequestration and geothermal energy production.

IP Summary:

Geothermal energy is a clean, renewable, and consistent source of electricity that has the capability to provide much of the Nation's and world's baseline electric power and space heating needs. A 2008 assessment by the US Geological Survey reported that high heat flow regions of the US could install, in addition to the current 2,500 MWe, 9,057 MWe of geothermal systems. Further, a recent study by the Massachusetts Institute of Technology estimated that with a relatively small investment in enhanced geothermal systems (EGS), EGS could be implemented to produce more than 100,000 MWe by 2050.

Unfortunately, traditional geothermal power plants that use water as the working fluid to transfer heat from depth to the Earth's surface are relatively inefficient. Therefore, electricity production from geothermal heat flow has so far been restricted to regions with high heat flow rates and significant quantities of groundwater near the Earth's surface. The high temperature requirements exclude large portions of the US and the world from utilizing geothermal energy for electricity production. Many of these problems may be overcome, however, by using CO_2 as the working fluid in geothermal electricity production. Because of the much more favorable thermodynamic properties of CO_2, compared to water, heat extraction efficiency and, hence, thermal energy recovery are expected to be



Learn about more groundbreaking discoveries at www.research.umn.edu/techcomm

UNIVERSITY OF MINNESOTA
Driven to Discover℠

significantly improved even in cases of lower-temperature reservoirs. Furthermore, permanent storage of CO_2 in the subsurface would be a desirable ancillary effect of the proposed CO_2-based geothermal approach. The system may thus be viewed as a geothermal power plant with negative carbon footprint that generates clean, renewable electric energy in regions formerly inaccessible to geothermal power technology while achieving CO_2 sequestration as a side benefit, with a potential for generating additional revenue in existing and proposed markets that trade CO_2 and other greenhouse gases.

The development of a CO_2-based geothermal reservoir and implementation of a geothermal power plant that uses a fraction of geologically injected CO_2 as the working fluid while sequestering the remainder in the subsurface reservoir is the objective of the technology. Such a system would operate similarly to a geothermal power plant that uses very hot ground-water in geothermally active regions. Variants within the invention include a range of options from the utilization of direct and indirect use of CO_2 as a working fluid in the surface power generation block to the degree in which carbon dioxide is sequestered in the application of the technology.

However, due to its utilization of CO_2 rather than water, such a system could operate in low heat flow regions worldwide as long as geologic formations, suitable for geologic CO_2 sequestration, are present. In the proposed system, a plume of injected and geothermally heated CO_2 would be tapped by a well and the heated, high pressure CO_2 would rise through a well to the surface and drive a turbine, which would power a generator, producing electricity. After passing through the power generation cycle, the CO_2 would be condensed, compressed to subsurface pressure conditions, and returned to the much larger CO_2 sequestration stream, thereby closing the cycle. In addition, to the synergistic benefits derived from the coupling of CO_2 sequestration and geothermal power using CO_2 as a working fluid, the approach significantly expands the viable the exploitation of geothermal resources.

Technical Merit:

The proposed system constitutes a new combination of existing technology, it is both a revolutionary and an evolutionary system. Revolutionary because CO_2 has not been successfully used as geothermal power plant working fluid to date and evolutionary because all separate components of the system (subsurface fluid (and even CO_2) injection, turbines to be used with the supercritical CO_2, piping, drilling ~1km boreholes, etc.) have been implemented (separately) before. This will greatly increase the likelihood of successful implementation and reduces both construction and operation costs (compared to an energy system that would comprise new/unknown technologies), which should increase profits.

Office for Technology Commercialization

Patent Landscape:

Provisional application has been filed

Questions / Information:

Russ Straate
Venture & Licensing Programs

Phone 612.625.5878
E-mail rstraate@umn.edu

Learn about more groundbreaking discoveries at www.research.umn.edu/techcomm