Berkeley lab-led team works on storing CO2 underground to extract electricity

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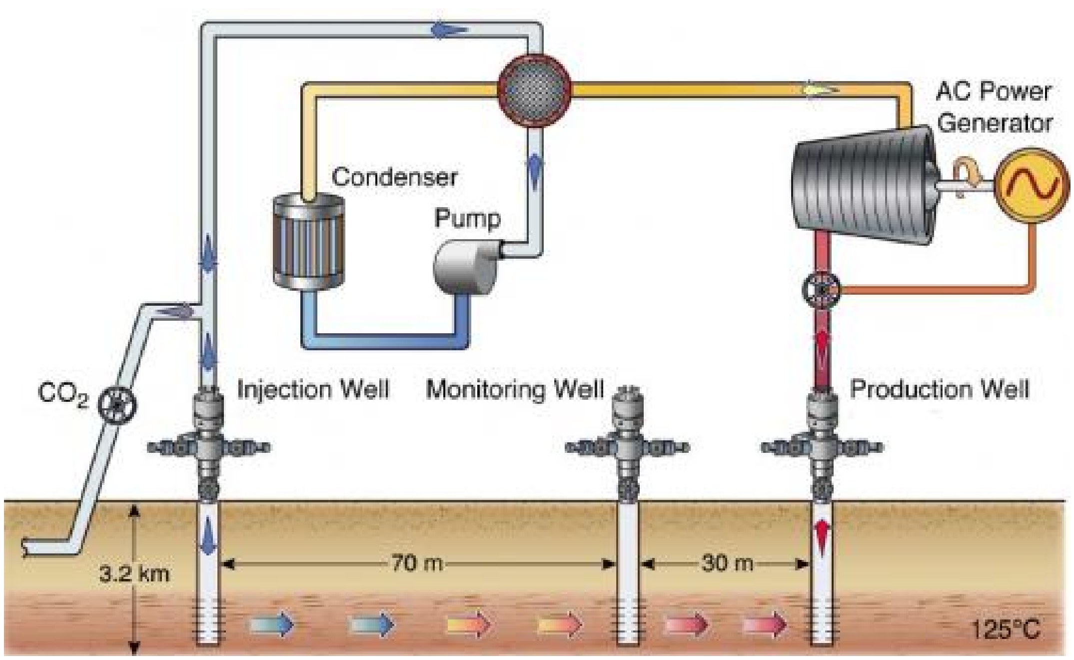

This looks like a maze, but it's actually a schematic of a way to combine CO2 storage and geothermal energy production. Starting with CO2 on the left, follow the arrows to learn how the proposed pilot test will work.

About a year from now, two nondescript shipping containers will be installed in a field in Cranfield, Mississippi. They'll house turbines designed to generate electricity in a way that's never been done before. If initial tests go well, the technology could lead to a new source of clean, domestic energy and a new way to fight climate change.

A team led by Lawrence Berkeley National Laboratory (Berkeley Lab) scientists hopes to become the first in the world to produce electricity from the Earth's heat using CO_2. They also want to permanently store some of the CO2 underground, where it can't contribute to climate change.

The group received $5 million from the Department of Energy earlier this summer to design and test the technology.

"This is the first project intended to convert geothermally heated CO_2 into useful electricity," says Barry Freifeld, a mechanical engineer in Berkeley Lab's Earth Sciences Division who leads the effort.

The idea is to inject CO_2 three kilometers underground into a sedimentary layer that's 125 degrees Celsius. CO_2 enters a supercritical state under these conditions, meaning it has both liquid and gas properties.

The CO_2 will then be pulled to the surface and fed into a turbine that converts heat into electricity. Next, it will loop back underground and through the cycle again. Over time, some of it will be permanently trapped in the sediment. More CO_2 will be continuously added to the system to keep the turbines spinning.

The technology could help offset the cost of geologic carbon storage, a promising climate change mitigation strategy that involves capturing CO_2 from large stationary sources and pumping it deep underground. This enables the burning of fossil fuels without releasing the greenhouse gas into the atmosphere. But it's expensive.

"Carbon storage takes a lot of power – large pumps and compressors are needed. We may be able to bring down its costs by generating electricity on the side," says Freifeld.

It also offers a new way to tap geothermal energy, which is a tough sell in arid regions where every drop of water is spoken for. For more than a decade, scientists at Berkeley Lab and elsewhere have theorized that supercritical CO_2 can be used instead of water. Their work has shown that supercritical CO_2 is better than water at mining heat from the subsurface. But no one has tried to do it until now.

In the project's first stage, Ohio-based Echogen Power Systems will design a turbine that can handle "dirty" supercritical CO2 laden with hydrocarbons and water accrued during its subsurface journey. Scientists from the University of Texas at Austin will analyze the environmental impacts of the process over its entire life span.

Berkeley Lab scientists will use numerical models to predict how the reservoir will evolve over time as more and more CO2 courses through it. They'll also determine how much energy can be extracted from the CO_2 by coupling reservoir models with Echogen's turbine models.

In the second stage, the team will build and test the turbine. If that goes well, they'll operate it during a pilot test at the Southeast Regional Carbon Sequestration Partnership's Cranfield site, where a Department of Energy-funded CO_2 injection project has been underway since 2009. The site's three-kilometer deep reservoir has proven to be an ideal site for carbon sequestration. Much of the infrastructure needed for the test is already in place, including injection and production wells. The CO_2 will come from a pipeline operated by Texas-based Denbury Resources.

It's too early to tell how much electricity the technology can generate in the U.S. That depends on the scale of carbon capture and storage operations and the availability of deep reservoirs that can both heat and store CO_2.

The technology also takes advantage of a problem common to conventional geothermal energy. Between five and ten percent of the water injected in these systems is “lost” as it travels through the pore spaces. As this happens, more water must be added, perhaps from municipal sources that have little to spare.

“But we actually want some of the CO_2 to become trapped,” says Freifeld. “Our approach relies on this gradual loss as a way to store a power plant’s CO_2 underground rather than emitting it into the atmosphere. Our planned demonstration is the first attempt at proving that we can simultaneously mitigate greenhouse gas induced climate change and generate clean baseload power using geothermal energy.”

Provided by Lawrence Berkeley National Laboratory