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Hot rocks in Earth's crust offer hope for clean energy, but beware of tremors

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BASEL, Switzerland (AP) - When tremors started cracking walls and bathroom tiles in this Swiss city on the Rhine, the engineers knew they had a problem.

"The glass vases on the shelf rattled, and there was a loud bang," Catherine Wueest, a teashop owner, recalls. "I thought a truck had crashed into the building."

But the 3.4 magnitude tremor on the evening of Dec. 8 was no ordinary act of nature: It had been accidentally triggered by engineers drilling deep into the Earth's crust to tap its inner heat and thus break new ground - literally - in the world's search for new sources of energy.

Basel was wrecked by an earthquake in 1365, and no tremor, man-made or other, is to be taken lightly. After more, slightly smaller tremors followed, Basel authorities told Geopower Basel to put its project on hold.

But the power company hasn't given up. It's in a race with a firm in Australia to be the first to generate power commercially by boiling water on the rocks three miles underground.

On paper, the Basel project looks fairly straightforward: Drill down, shoot cold water into the shaft and bring it up again superheated and capable of generating enough power through a steam turbine to meet the electricity needs of 10,000 households, and heat 2,700 homes.

Scientists say this geothermal energy, clean, quiet and virtually inexhaustible, could fill the world's annual needs 250,000 times over with nearly zero impact on the climate or the environment.

A study released this year by the Massachusetts Institute of Technology said if 40 percent of the heat under the United States could be tapped, it would meet demand 56,000 times over. It said an investment of $800 million to $1 billion could produce more than 100 gigawatts of electricity by 2050, equaling the combined output of all 104 nuclear power plants in the U.S.

"The resource base for geothermal is enormous," Professor Jefferson Tester, the study's lead author, told The Associated Press.

But there are drawbacks - not just earthquakes but cost. A so-called hot rock well three miles deep in the United States would cost $7 million to $8 million, according to the MIT study. The average cost of drilling an oil well in the U.S. in 2004 was $1.44 million, according to the U.S. Energy Information Administration.

Also, rocks tapped by drilling would lose their heat after a few decades and new wells would have to be drilled elsewhere.

Bryan Mignone, an energy and climate-change specialist with the Brookings Institution in Washington, D.C., said alternative sources of energy face stiff price competition.

"Currently in the U.S. new technologies in the power sector are competing against coal, which is very cheap," he said.

Humans have used heat from the earth for thousands of years. The ancient Romans drew on hot springs for bathing and heating their homes. Geothermal energy is in use in 24 countries, including the U.S.

But those sources - geysers and hot springs - are close to the surface. Hot dry rock technology, also called "enhanced geothermal systems" or EGS, drills down to where the layers of granite are close to 400 degrees Fahrenheit. The equipment is similar to that used for oil, but needs to go much deeper, and be wider to accommodate the water cycle.

Hot dry rock technology is meant to stay well away from the 99 percent of the Earth's interior that is over 1,000 degrees.

Aeneas Wanner, a Swiss expert, says that if you imagine Earth as an egg, "a bore hole would only scratch the shell of the egg a little bit."

The United States led the way in demonstrating the concept with the Los Alamos geothermal project at Fenton Hill, N.M. The project begun in the 1970s demonstrated that drilling 15,000 feet deep was possible and that energy could then be extracted.

But the project came to a halt in 2000 when it ran out of funds. Meanwhile, the MIT report said, problems encountered in testing have been solved or can be managed - such as controlling how the water flows underground or limiting earthquakes and chemical interactions between water and rock.

Backers in the United States hope government funding will increase as oil and gas prices rise. But Steve Chalk, deputy assistant secretary for renewable energy, said the Department of Energy won't spend more money beyond the $2 million it has already allocated to hot rock technology.

However, he said the MIT study, which was funded by the Department of Energy, serves as a basis for studying the idea further.

Major energy companies, including Chevron Corp., Exxon Mobil Corp. and American Electric Power, told the AP they are following the research but not investing in it.

"This is an interesting technology for Chevron and we are currently evaluating its potential," said spokesman Alexander Yelland.

In Basel, the first shaft was bored last year by a 190-foot-tall drilling rig towering above nearby

apartment buildings. Water was pumped down the injection well in the test phase in December, and as expected, it heated to above 390 F as it seeped through the layers of rock below.

But that's where the water remains for the time being; it caused the rock layers to slip, causing the tremors and rumbles that spooked the townspeople.

Geopower Basel, had forecast some rock slippage. In fact, it said the location on top of a fault line - the upper Rhine trench - was an advantage because it meant the heat was closer to the Earth's surface.

But with $51 million already spent, drilling stopped and the official launch date was moved back from 2009 to 2012.

Still to be drilled are the two wells that would suck the pressurized, superheated water out of the cracks and up to the surface to create steam for driving a turbine and generating electricity. The water, having cooled to around 340 degrees, would heat hospitals, public buildings and homes before being pumped back into the ground for another waste-free, gas-free cycle.

The rival project near the southern Australian town of Innamincka faces more benign geological conditions and less population. Its target date for operations is now two years ahead of Basel's, aiming to produce 40 megawatts of electricity by the end of 2010, enough to supply over 30,000 households.

Experts say hot rock geothermal energy can operate 24 hours a day and doesn't depend on sun or wind. But it's decades away from serious rivalry with existing energy sources.

Susan Petty, one of the 18 co-authors of the MIT study, works for Black Mountain Technology, a company promoting hot rock energy. She predicts that 10 percent of the world's power could come from geothermal sources in the next 50 years, from the current 0.3 percent, rising to half in around 100 years.

Promoters of the technology say that while geothermal drilling is costly, it's cheaper to run once it's in place. The MIT study said it could provide electricity at competitive prices. Price comparisons indicate it could be cheaper than other forms of renewable energy, including biomass and solar power. "The outlook is very good that we can do it," said Karl Gawell, executive director of the Washington D.C.-based Geothermal Energy Association.

But others are waiting for proof that it's worth the expenditure.

"This technology sounds very promising," said Nick Nuttall, chief-spokesman of the U.N. Environment Program, "but let's wait and see."

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Hot rock heat mining could provide energy at competitive prices, according to a recent study by the Massachusetts Institute of Technology.

The power cost is expected to vary from site to site, depending mainly on geological conditions, experts said. The overall cost of building hot rock power plants will go down as the industry develops, they said.

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How existing geothermal energy compares to other renewable energies, in U.S. cents per kilowatt hour (Source: the International Energy Agency):

Geothermal: 2 to 12

Biomass: 2 to 16

Wind: 3 to 12

Solar: 18 to 50

Hydro: 2 to 16

An Australian hot rock power plant could produce electricity for an estimated 4.5 Australian cents (3.8 U.S. cents) per kilowatt hour, according to Queensland-based Geodynamics Limited.

The cost of hot rock power production in Europe has yet to be determined. In general it is expected to be more expensive than wind energy, but cheaper than solar energy, said Juerg Baumgaertner, a manager at a European Union geothermal research project in the French town of Soultz-sous-Forets.