An immense clean power source is pushing beyond volcanic hotspots and into the mainstream

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Almost 6,000 degrees Celsius. That is how hot Earth's inner core is. Earth's heat is already being put to use in geothermal power plants in

Iceland, for example, and many Swedish homeowners use geothermal heating to keep their homes warm. With next-generation technology, geothermal heat can be harnessed in many more locations. Could the heat beneath our feet be the green energy source of the future?

"It's definitely a form of energy that can be a valuable addition to the energy system. According to the International Energy Agency (IEA), the technical potential of next-generation geothermal systems is equivalent to up to 140 times the world's current electricity demand," says Maria Ask from the Department of Earth Sciences, who is conducting research in this field.

Eternal source of energy

Geothermal energy is, at least from a human perspective, an eternal source of energy—and climate-neutral. It is also a scalable and independent energy source that produces virtually no toxic waste. With the green transition, more and more people have become aware of the potential of geothermal energy. Energy crises and changing geopolitical conditions have also contributed to this increased interest.

"Geothermal energy production is growing rapidly worldwide, particularly in the U.S. and China. Technological advances have made geothermal energy more cost-effective and enabled it to be extracted from greater depths. The development of next-generation geothermal systems is making it possible to extract energy from a wider range of geological environments than the traditional ones.

"What's more, critical raw materials can sometimes be extracted in connection with geothermal production. The fastest progress is being made in countries that have developed specific national strategies and roadmaps for geothermal energy, with clear targets for expanded capacity," explains Ask.

Can compete with solar and wind power

According to the IEA, geothermal energy can compete effectively with solar and wind power, even when these are supplemented with battery storage.

"The deeper you go, the greater Earth's temperature. On average, the temperature of the bedrock rises by 25–30 degrees per kilometer, but there are significant variations depending on geological conditions. In active areas of Iceland, temperature gradients of 80–150 degrees per kilometer are common. Existing data in Sweden suggests that the gradient varies between 14 and 35 degrees per kilometer, but the evidence is limited in terms of both the number of sites surveyed and the depths reached," says Ask.

Today, large-scale geothermal heat extraction is mainly conducted in volcanic regions, such as Iceland and Italy, and from enormous depressions where thick, deep layers of sediment have been deposited, such as in southern Germany. Traditional geothermal systems only work in such environments. This is because they feature porous or fractured bedrock with natural reservoirs from which geothermal water is pumped.

Next-generation geothermal technologies

With next-generation geothermal technologies, even denser bedrock can be utilized, which significantly increases the number of areas worldwide suitable for geothermal energy extraction.

"Depending on the water's temperature and flow, heat and/or electricity can be extracted. Heat can be produced from shallow depths as low as around 10°C using heat pump technology, i.e. geothermal heating. At higher temperatures from greater depths, the heat can be fed directly

into district heating networks. Most existing Swedish district heating networks require water heated to over 100°C," explains Ask.

Geothermal energy has many advantages, but there are also a number of issues that need to be resolved before it can reach its full potential.

"The most significant challenge lies in establishing national strategies and roadmaps for geothermal energy. These need to be accompanied by long-term investment; the development of frameworks, regulations, financing and insurance; and research funding to boost geothermal development," Maria Ask.

Provided by Uppsala University

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