Removing carbon dioxide while generating power

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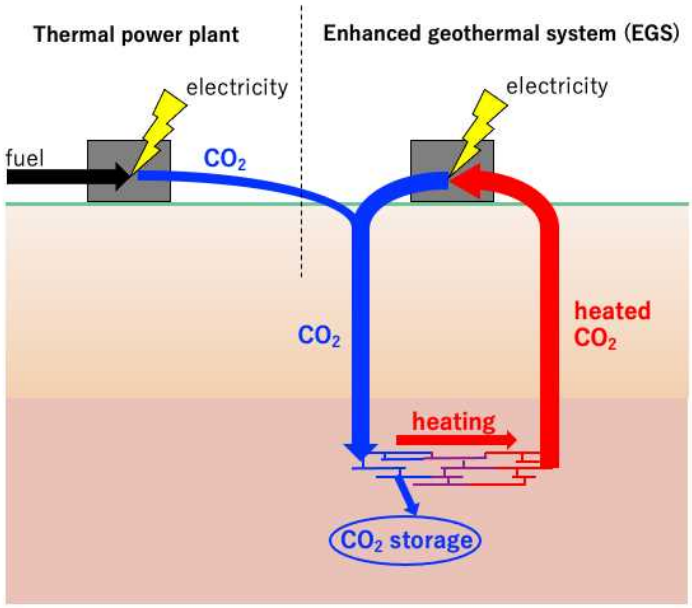

Suppose you could choose the type of power generation that your electricity comes from. Which power generation method would you choose?

Not many people may like to choose thermal power that burns fossil fuels such as coal, oil, or natural gas, but in reality, this is where your electricity most likely comes from. Thermal power is still the most common source of electricity in many countries across the world, and the greenhouse gases, especially carbon dioxide, that are produced in this method are becoming more and more of a problem as global warming continues to progress.

As “clean” sources of power that do not produce greenhouse gases are sought for, recent research has discovered the possibility of a striking system. The proposed method of using carbon dioxide in a power generation process called Enhanced Geothermal

System (EGS) is not just clean; it can even take in greenhouse gases to store away.

Geothermal energy uses heat from inside the Earth to produce electricity. Since there is no need to burn anything, it is a clean source of energy. It is estimated that the Earth crust receives about 1.3 times the amount of heat that humans consume, so even if we were to supply all the energy used in the world with geothermal energy alone, it would still be sustainable. However, geothermal power plants are not as widespread because of the method that has been widely used. This method uses reservoirs of hot fluid close to the ground surface, but it can only be applied in the few regions where volcanic activity is occurring, such as the Western United States, Iceland, and Japan. Therefore, an alternative method is needed to spread the use of geothermal energy.

EGS was proposed in the 1970s as a new type of geothermal power that can be applied in a broader area. Anywhere on Earth, the temperature below the ground rises as one goes deeper underground. While the average rate is around 30°C every kilometer of depth, there are many large regions, such as Eastern Australia, Western Canada, and Central Europe, where the rate is even higher due to radioactive elements underground. These areas are where EGS is best suited, and since they are not restricted to volcanically active regions, EGS can expand the area where geothermal energy can be used.

EGS uses the underground heat to generate power, injecting fluid into hot rock that lies about 5 kilometers below the surface where it reaches 200°C. After the fluid has run through fractures made in the rock and collected heat, it is extracted to the surface and sent to the generator plant, where it drives a turbine, producing electricity. The fluid is then sent back underground to be re-heated, thus forming a closed loop. Water was initially used as the heat transmission fluid, but several issues arose regarding its efficiency.

Water can cause several problems in EGS. One is that it reacts with minerals contained in rock, so it can dissolve rock to create shorter pathways while clogging up longer ones. When this happens, water is not heated as much as expected. In addition, some of the water will escape the system during the heat collection process, so water must continuously be added to account for the loss. Research was conducted to search for more effective fluids, and it was in this context that a splendid discovery was made.

Numerical simulations of fluid dynamics and heat transfer in EGS found that carbon dioxide is a wonderful substance to use as the heat transmission fluid in EGS. Not only is it superior to water in its ability to transport heat, as shown by simulations conducted by Karsten Preuss at the Lawrence Berkeley National Laboratory, [1] but it causes less trouble in terms of interaction with the rock, and its use can even contribute to prevent global warming.

The use of carbon dioxide can suppress interaction with the rock because carbon dioxide, unlike water, is a non-polar substance. This means it will not dissolve or react with most of the minerals in fractured rocks. Therefore, it will not change the routes and thicknesses of the pathways, helping to sustain an effective state of heat transfer in rocks for a longer period. This is not to say that there will not be any loss of fluid in rock fractures at all, but for carbon dioxide this is actually an advantage because this greenhouse gas is trapped underground.

If carbon dioxide produced from burning coal in thermal power plants, for example, can be used in EGS, less carbon dioxide will be released into the atmosphere and will be fixed underground instead. Calculations have found that supposing 5% of the injected carbon dioxide is trapped underground, an EGS power plant can consume all the carbon dioxide emitted from a moderately large coal-fired power plant. Therefore, EGS can be seen as a system that can store carbon dioxide underground in addition to generating electricity.

This EGS using carbon dioxide is an attractive method of power generation that could solve the problem of global warming in a twofold manner: it raises the efficiency of a clean energy source while sending carbon dioxide underground for storage. Although EGS is a new power generation system and research is ongoing, it will certainly play an important role in sustaining our planet's environment once its use spreads. In the meantime, we as the society must raise its awareness so that its development is pushed forward.

References

[1] Pruess, K. (2006). Enhanced geothermal systems (EGS) using CO_2 as working fluid—A novel approach for generating renewable energy with simultaneous sequestration of carbon. Geothermics, 35(4), 351-367.