Carved in stone? Turning carbon dioxide into rock, for good

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Hellisheidi Power Plant. Photo:Arni Saeberg

Scientists have successfully captured otherwise emitted CO_2, and turned it into carbonate minerals deep underground in less than two years.

Global CO_2 emissions reached an all-time high in 2018 according to a report by the International Energy Agency (IEA). "As a result of higher energy consumption, global energy-related CO_2 emissions increased to 33.1 Gt CO_2, up 1.7%," the IEA says, underscoring the need for faster and stronger action to tackle climate change.

Some scientists have been working on novel methods to mitigate global warming, including the upscaling of carbon capture and storage (CCS). The EU-funded CarbFix2 project has made great strides in developing a secure, efficient and cost-effective process and technology for permanent CO_2 mineral storage in the subsurface.

CCS technology has been around since the 1970s, albeit in limited use due to various barriers to its widespread uptake—with cost being the most significant hurdle. CCS involves trapping CO_2 emitted from large point sources such as power plants, compressing it and transporting it to a suitable storage site where it's injected into the ground. During this process that uses storage in deep geological formations, CO_2 is converted into a high-pressure liquid-like form known as supercritical CO_2. This CO_2 is injected directly into sedimentary rocks in depleted oil and gas reservoirs and coal beds, or in saline formations. However, the conventional CCS method carries a risk. The gas can leak back into the atmosphere "or into overlying fresh-water aquifers," as noted on the project website.

Safer technology

Project partners believe their method is safer than traditional CCS techniques "because it involves immediate solubility storage as well as rapid mineral storage which permanently immobilizes CO_2." The website explains how the risk of leakage is tackled: "Much of this risk is eliminated once the injected CO_2 is dissolved into the aqueous phase, as CO_2 saturated water is denser than CO_2-free water. Chemical reactions between the basaltic host rock and CO_2 loaded injection water have also been shown to be rapid, resulting in over 95% permanent mineral CO_2 sequestration in under two years."

The ongoing CarbFix2 (Upscaling and optimizing subsurface, in situ carbon mineralization as an economically viable industrial option) project builds upon the success of its predecessor CarbFix (Creating the technology for safe, long-term carbon storage in the subsurface) that ran between 2011 and 2014. It injected CO_2 dissolved in water into reactive basaltic rocks, and the technology was tested at a geothermal power plant in Hellisheidi, Iceland. The power plant co-produces electricity and hot water from the Hengill central volcano. As explained on the project website, CarbFix2 was launched "to make the CarbFix geological storage method both economically viable with a complete CCS chain, and to make the technology transportable throughout Europe."

Following successful pilot-scale injections in 2012, experimental industrial-scale injection started in 2014. The FAQs page notes: "CO_2 and H_2S [hydrogen sulfide] emissions from Hellisheidi power plant are captured in a gas abatement plant through a simple scrubbing process, dissolved in condensate from the power plant and returned back home to the geothermal system within the basaltic bedrock where they came from."

In a news article on "Iceland Review," Dr. Sandra Ósk Snæbjörnsdóttir, geologist/geochemist at CarbFix2 project coordinator Reykjavík Energy, says: "Now we are binding around one third of the carbon dioxide the station produces, around 12,000 tonnes per year." She hopes the power station could become completely carbon neutral within the next few years.

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