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Swiss project explores different storage pathways for CO_2

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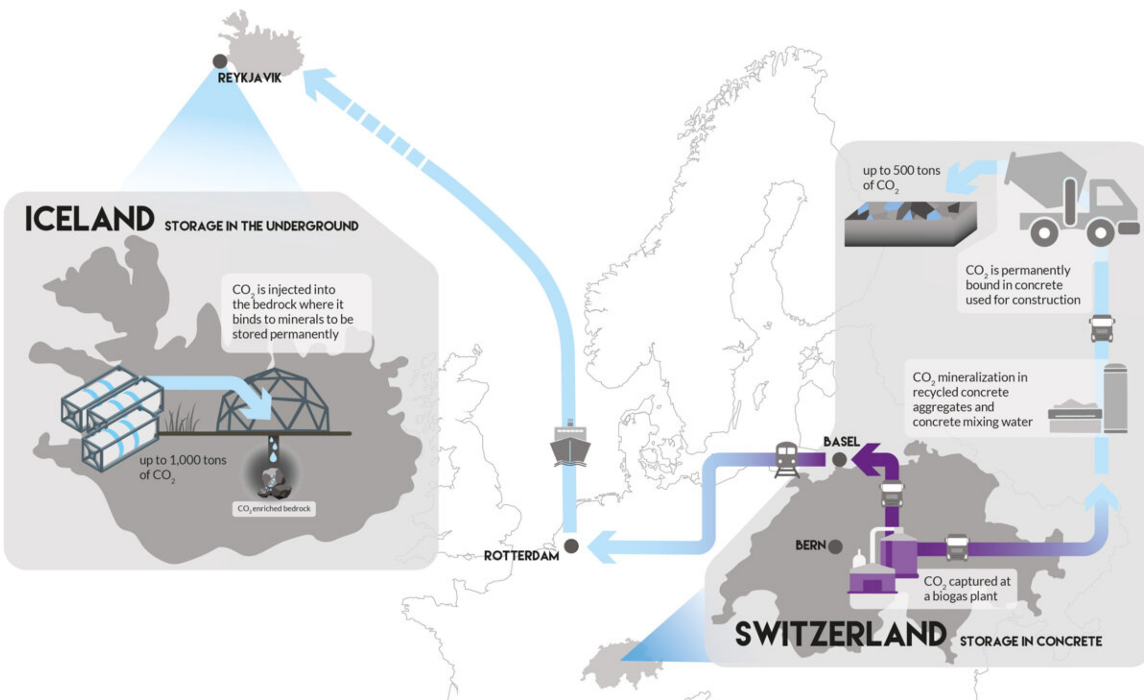

The diagram shows the process chain from CO_2 capture in Switzerland to underground storage in Iceland or in concrete for construction. Credit: DemoUpCARMA / ETH Zurich

Switzerland has set itself an ambitious goal: to reduce the country's greenhouse gas emissions to net zero by 2050. But this will require more than just a massive expansion of renewable energies and saving measures.

The federal government assumes that hard-to-abate CO_2 emissions, e.g., from incineration plants, will amount to 12 million tons a year. Some of the CO_2 emitted therefore needs to be removed again from the atmosphere. The question is, how? And what should be done with it?

Two different storage pathways explored

These questions were investigated as part of a pilot project led by ETH Zurich that brought together a broad consortium of partners from science and industry. The researchers explored two solutions for permanent storage of CO_2:

1. Mineralization in recycled demolition concrete manufactured in Switzerland
2. Mineralization in a geological reservoir in Iceland

The project used carbon dioxide emissions from a waste water treatment plant in Bern. The researchers performed a life cycle analysis that covered the entire chain—from the capture and liquefaction of CO_2 at the point of origin, to its transport and permanent storage. They also calculated how much new CO_2 is produced along the entire chain. In addition, different solutions were explored for carbon capture methods and technologies for a waste incineration plant and a cement manufacturing plant.

Already a positive carbon footprint

The project has demonstrated that both pathways are technically feasible and have a positive climate impact. In all the examples examined, the amount of CO_2 stored exceeded the emissions produced along the transport chain. When storing in recycled demolition concrete, the efficiency and thus the ratio between stored emissions and resulting new emissions is 90%; when transporting Swiss CO_2 and then storing it in a geological reservoir in Iceland, it's around 80%.

This efficiency should improve in future as most of the new emissions arise from transporting the containers by rail and ship, and some of these modes of transport still use energy from coal-fired power stations as well as fossil fuels. If in future CO_2 is to be exported on a large scale, constructing a pipeline would be a potential solution.

One aspect that did surprise researchers, on the other hand, was the regulatory difficulties encountered when trying to transport CO_2 through several countries to Iceland. This was the first instance of cross-border carbon dioxide transport for storage. "A lot of CO_2 is needed in the food production industry, and can be transported across borders without any problem, labeled as chemicals. But if the carbon dioxide is in the form of waste—as in our case—the regulatory environment is very unclear," explains Marco Mazzotti, project coordinator and ETH professor.

The project team therefore came to the conclusion: If Switzerland wants to store CO_2 on a large scale and create incentives for companies in future, it needs to work with its European neighbors to agree on clear regulations.

Many research questions still unanswered

Even though the technologies trialed in the project function correctly, much research is still needed in the area of CO_2 management. It is also vital to make sure the technologies are worked up to a commercial scale. In 2023 ETH Zurich, together with its partners in politics, science and industry, set up the "Coalition for Green Energy and Storage," one of whose aims is to accelerate the adoption and roll-out on an industrial scale of existing technologies for capturing CO_2, producing carbon-neutral gases and fossil fuels, and permanently storing CO_2.

Another question ETH researchers are addressing is whether CO_2 can also be stored underground closer to home, in Switzerland. A possible injection test in a borehole in Trüllikon no longer required by the National Cooperative for the Disposal of Radioactive Waste (NAGRA) could provide some initial answers.

Provided by ETH Zurich

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