

Floating power plants

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Instead of rooftops, the ocean could soon serve as a location for solar panels.
Credit: Empa

Paper, tin cans, glass—the world recycles as much as possible. So why not declare the greenhouse gas carbon dioxide (CO₂) a recycling product as well? Liquid fuels based on carbon will continue to play an important role in the future—despite international efforts to reduce them. So it

seems sensible to recover the CO₂ exhaust from the environment and use it again.

Researchers from ETH Zurich, PSI and the Universities of Zurich, Bern and the Norwegian University of Science and Technology (NTNU), together with a team from Empa, have calculated this idea and have shown that solar methanol islands could produce enough [fuel](#) in the long term to make all CO₂ emitted from transportation sources neutral—worldwide. In the middle of the oceans, hydrogen (H₂) is to be produced from [solar energy](#) (and water), which is then converted into methanol on site using CO₂ extracted from the seawater. To this end, the researchers analyzed in detail a scenario that still seems purely hypothetical, but already provides the basis for a possible implementation. They present their results in the journal *Proceedings of the National Academy of Sciences (PNAS)*.

From sun to electricity to hydrogen to methanol

The idea is based on solar islands, i.e. floating platforms equipped with photovoltaic systems. However, since [solar power](#) cannot be stored and transported from there, a [solar power plant](#) on the sea makes no sense. Liquid methanol (CH₃OH) as well as gaseous methane (CH₄) can be produced from carbon dioxide and hydrogen. The researchers' idea is that the [raw materials](#) could be obtained directly from the ocean or produced there.

There are already large-scale power-to-gas [plants](#) that convert hydrogen and CO₂ into fuel—including the "move" demonstration platform on the Empa campus in Dübendorf. The question therefore arises: why go to sea with it? Why not, as existing plants do, extract CO₂ from the air? The answer is simple: the space required for a worldwide supply of fuel would be enormous. "An area of around 170,000 km² would be needed to produce the annual demand for global freight transport," explains

Andreas Borgschulte of Empa's Advanced Analytical Technologies lab. This could best be achieved by solar power systems at sea, a previously unused area that does not belong to anyone. CO₂ can also be extracted from the air at sea, but an attractive—and still obvious—alternative would be to use the roughly 125 times higher CO₂ concentration of seawater for the "carbon dioxide harvest."

More possibilities for methanol

In existing plants, the CO₂ extracted from the atmosphere is mostly used to produce methane, which would also be possible on the solar islands. In the course of their considerations, however, the researchers decided to produce a liquid fuel because it is easier to transport. In addition, methanol can be used not only as a fuel, but also to manufacture other chemical products, such as precursors for polymer production. The possibilities for its use (and the profits that can be achieved with it) are therefore much greater.

However, such a "[methanol](#) island" has its price: The construction of such a chemical plant on the ocean would cost around 90 million US dollars. This would consist of around 70 photovoltaic islands with a diameter of around 100 m² and a ship with the electrolysis and synthesis plants. This would result in a total area of around 550,000 m². But a single cluster is far from sufficient to achieve a zero balance of CO₂. A total of 170,000 such [islands](#) would be needed to recycle as much CO₂ as is currently emitted—a utopian goal, but one worth pursuing. "Great ideas are needed—small solutions only supply small parts of the world, but not all of it," says Borgschulte.

More information: Bruce D. Patterson et al. Renewable CO₂ recycling and synthetic fuel production in a marine environment, *Proceedings of the National Academy of Sciences* (2019). [DOI: 10.1073/pnas.1902335116](https://doi.org/10.1073/pnas.1902335116)

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