Five ways to turn carbon dioxide from pollution to a valuable product

January 21 2020, by Ella Adlen and Cameron Hepburn

Credit: Marcin Jozwiak from Pexels

It's far easier to avoid burning fossil fuels than it is to clean up CO_2 emissions once they're in the Earth's atmosphere. But the world no longer has the luxury of choice—drastic emission reductions and rapid

CO_2 removal and storage will both be necessary to avoid the worst impacts of global heating.

What if, instead of wasting all that CO_2, it could be turned into something useful? There's currently little economic incentive for industries that emit CO_2 to capture it, let alone to draw it directly down from the atmosphere. Identifying valuable products and how to make them might kickstart CO_2 removal on an industrial scale, and help bring down emissions in the process. In our recent paper, we set out to clarify what these processes and products might be.

We considered processes that use CO_2 captured from industrial emissions, and also biological processes that can directly draw down CO_2 from the air. We projected that between one and ten gigatons of CO_2 could be utilized per year by 2050, at costs of under USD$100 (£77) per ton of CO_2. Humans currently emit 37 gigatons of CO_2 a year, and we need to reduce our impact to net zero by around 2050. Some estimates suggest this might mean removing around ten gigatons of CO_2 a year from 2050 onward. Some of these ideas for using CO_2, if implemented properly, could play a role in making that more economically viable.

Some ideas for using CO_2 might not get off the drawing board. But with the right investment and incentives, others may move from niche research projects into credible plans, and from the work of small businesses to the goal of entire industries. Here is a selection of the ways that one person's pollution could become another's product.

1. Make buildings

There are several ways in which buildings can be constructed with materials made from CO_2. The first is obvious: use wood. Growing and sustainably harvesting trees for building means that CO_2 is taken from the atmosphere, converted into a valuable commercial product, and

stored as carbon in long-lived buildings.

It also reduces demand for cement, which is responsible for 10-15% of global greenhouse gas emissions through its production. New technologies, such as cross-laminated timber or acetylated wood, are making this substitution ever easier.

The second way is to use and then store CO_2 in concrete-making processes, by curing cement or in the manufacture of other ingredients like aggregate.

2. Create plastic products

CO_2 can be used in polymers to make durable plastics for cars and buildings. Around 60% of plastics have applications in sectors other than packaging. Plastics made from CO_2 could displace plastic products made from fossil fuels for these sectors, particularly as they don't require toxic or dirty ingredients such as phosgenes or epoxides, and can be cheaper to make than fossil-fuel based materials. Because the CO_2 molecule is a stable part of the backbone of the polymer, it can be stored in these materials for as long as they last.

Credit: Marcin Jozwiak from Pexels

3. Make fuel or fertilizers

CO_2 can be used as a feedstock for many chemical processes, with hundreds of potential end products, including hydrocarbon fuels and urea fertilizers.

Fuels made from CO_2 can exist in the form of methanol as well as more complex products like so-called synfuels. These fuels can often be blended or moved around using existing infrastructure like pipes and tankers. And although CO_2 fuels are currently very costly to manufacture, in the future they might be valuable in niches like aviation

or long-distance shipping, which are more difficult to decarbonize than trains and cars because they need fuels with higher energy densities.

If the CO_2 product is a fuel or a fertilizer, the CO_2 ends up back in the atmosphere once used. While two uses of the carbon is better than one, if the carbon atom originally came from a fossil fuel, it's not a long-term solution. To be climate neutral, the CO_2 feedstock will have to be sourced from the air—so the CO_2 is taken from the atmosphere, made into fuel, and then emitted back to the atmosphere. This is currently expensive and technically challenging. Crucially, the energy required for this process also needs to be renewable.

4. Increase crop yields

There's emerging evidence that increasing the amount of carbon in soils can also increase crop yields. This is a natural form of CO_2 utilization that already happens—scientists and farmers can just give it a helping hand. One particularly promising way is by using biochar—plant material that has been converted into a stable form of organic carbon via a process known as pyrolysis. Biochar buried in soils could store carbon for the long term and increase crop yields.

The general benefits of replenishing and maintaining carbon in the soil are well established, but using soil as a store of carbon is challenging because it is easily disturbed.

5. Extract more oil

Counter-intuitively, it's possible to both produce oil and store CO_2. That's because injecting CO_2 into an oil well increases the amount of oil that can be recovered—so-called "CO_2 enhanced oil recovery".

It is actually possible to operate the well so that more CO_2 is put into it than is emitted in the process of producing the oil and burning it. But policy changes would be needed to incentivize this—oil companies would not do it otherwise. And it's a temporary fix. In a world that has fully decarbonized, demand for fossil oil should be close to zero.

Nonetheless, this could be a short-term way to stimulate much needed demand for CO_2 capture, as emitters could sell their waste CO_2 to oil producers.

All these options for using CO_2 have potential, but making them a reality will need a clear understanding of the possible unintended consequences. Many could be failures, so it'd be unwise to rely solely on any one of them, but instead, spread bets widely.

Provided by The Conversation