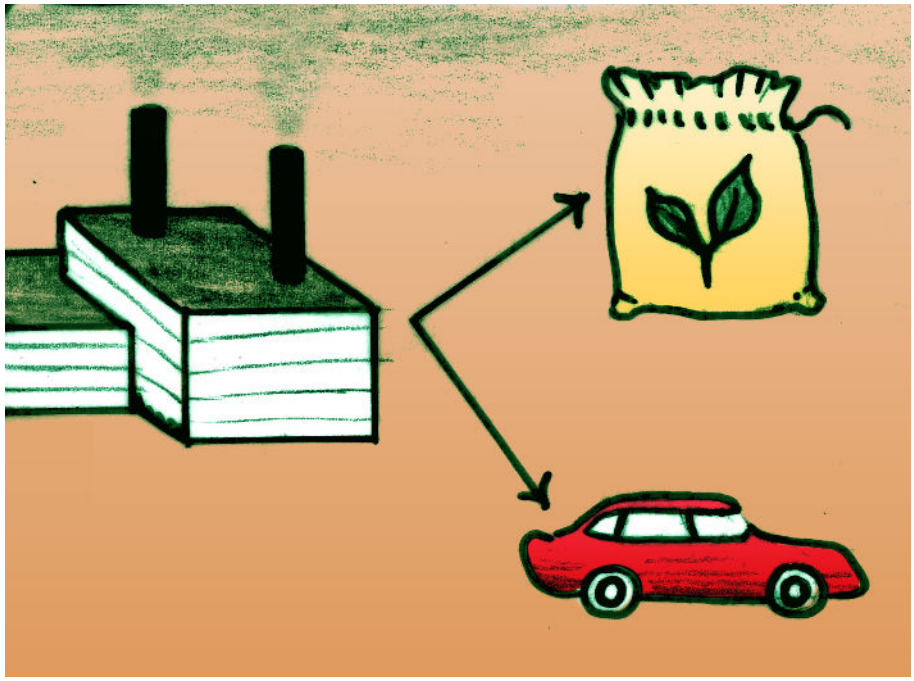
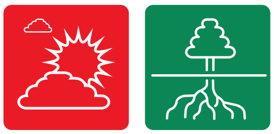
Carbon Capture Use and Storage



In theory, Carbon Capture Use and Stoage aims to convert captured carbon into products like fuel, fertilizer and plastic.

POINT OF INTERVENTION



OVERVIEW

Carbon Capture Use and Storage (CCUS) is a proposal to commodify CO2 that has been removed from the atmosphere by using it as a feedstock in manufacturing, so it becomes "stored" in manufactured goods. It is understood as an attempt to make CCS profitable and perhaps uncouple it from Enhanced Oil Recovery (See Carbon Capture and Storage (CCS) briefing for more background on this). Some CCUS scenarios are still theoretical and some technologies are being commercialized.

The primary critique of CCUS is that emissions are not effectively removed or sequestered but are embedded in products or used in a way that CO2 will be re-released into the atmosphere (it will be incinerated as waste or decompose). There are also additional emissions in the production, transport and infrastructure required. This means that overall, CCUS is likely to create emissions rather than reduce them.

REALITY CHECK

ENHANCED OIL RECOVERY (EOR)

While CCUS is an attempt to distance CCS from EOR, EOR is by far the single biggest user of captured CO2 and the most likely profitable market for it in the future. EOR is discussed in more detail in the CCS factsheet.

Briefly, EOR refers to extracting otherwise unrecoverable oil reserves. CO2 is injected into aging reservoirs and can extract 30-60% more of the oil originally available in the well. Naturally-occurring CO2 is used most commonly because it is cheap and widely available, but CO2 from anthropogenic sources is becoming more common,[i] particularly from CCS installations in North America.

For example, of 17 operational, commercial-scale CCS facilities world-wide, 13 of them send their

Climate-saving technology? CCUS is often more about EOR than reducing emissions (Richard Masoner / Cyclelicious).

captured CO2 for use in EOR, and of the four facilities listed as being under construction, three are for EOR.[ii] In this case, EOR in is certainly Carbon Capture and Use, but it is not Storage: most CO2 returns back to the surface with the pumped oil, and any CO2 that does stay underground enables even greater emissions from the extra oil that is pumped out and then burned.[iii]

TURNING CO2 INTO CHEMICALS AND FUELS

Another idea is to use CO2 by processing and converting it into chemicals and fuels. This can be achieved through carboxylation reactions where the CO2 molecule is used to produce chemicals such as methane, methanol, syngas, urea and formic acid. CO2 can also be used as a feedstock to produce fuels (e.g. in the Fischer–Tropsch process[iv]).

> ***With the exception of EOR, which is a well-established process, companies involved tend to be start-ups aiming to profit on the back of hype around negative emissions, in an attempt to increase the value of captured CO2.***

However, using CO2 in this way is energy intensive since it is thermodynamically highly stable: a large energy input is required to make the reactions happen. Furthermore, chemicals and fuels are stored for less than six months before they are used and the CO2 is released back into the atmosphere very quickly.[v] As with EOR, this is CCU, but not Storage.

Creating biofuels from microalgae: CO2 help cultivate microalgae that are used to produce biofuels. In this case, microalgae would fix CO2 directly from waste streams such as power station flue gases. Microalgae are cultivated in giant open-air ponds that require a large land area.[vi] Concerns have been raised about plans to use genetically modified algae to produce biofuels: containment of the organisms would be next to impossible, and if organisms escape the consequences for human health and natural environments are unknown.[vii] The US-based Algae Biomass Organization promotes CCUS with microalgae, and many algae biofuel companies have already attempted to combine algae cultivation with industrial power plants that provide CO2. Canada-based Pond Technologies is one

Can captured CO2 be stored in concrete? Not without expending large amounts of energy on transportation and processing.

such company, which has three pilot facilities aimed at producing algae-derived bioproducts from the steel, cement, oil and gas, and power generation industries. Similarly, the Tata Steel manufacturing facility in Port Talbot, UK, has partnered with the UK EnAlgae program to test the use of flu gases for algae cultivation.[viii]

CARBON NEGATIVE PLASTICS

A company called Newlight Technologies has recently commercialized a process that captures methane from farming processes and converts it into plastic, at a factory in California.[ix] However, this carbon capture technology would only be effective if the plastics never degraded, or were never incinerated as waste.

MINERAL CARBONATION OF CO2 –CARBON NEGATIVE CONCRETE?

Mineral carbonation is a chemical process where CO2 reacts with a metal oxide such as magnesium or calcium to form carbonates. The idea is to use materials in concrete construction that lock in CO2 as a way of "greening" the significant emissions of the cement industry. It is similar to Enhanced Weathering (see factsheet) where silicate minerals found naturally in rocks react with CO2 in the atmosphere and turn into stable carbonates.

Companies such as Carbicrete claim to be producing carbon-negative concrete by using steel-slag, a waste product from steel manufacturing, instead of cement. CO2 is then injected into the wet concrete, which reacts with the slag and forms mineral carbonates.[x]

Another company, Calera, is hoping to scale up its method of concrete production using captured CO2 to create a form of calcium carbonate cement.[xi] These processes, in theory, could be capable of storing CO2 for long periods. However, as with Enhanced Weathering, the energy penalty and costs including the mining, transportation and preparation of the minerals, are massive and likely outweigh any benefits.[xii]

FOOD FROM CAPTURED CO2

Another example of CCU (but not storage!) is Climeworks' Direct Air Capture unit in Zurich (see Direct Air Capture factsheet). The facility pumps captured CO2 into nearby greenhouses, increasing the yield in the vegetables grown there by up to 20%.[xiii]

Of course, as soon as the food is digested or composted, a significant amount of the carbon will be re-released. And plants are already quite good at capturing CO2 from the atmosphere, without requiring large infrastructure developments and greenhouses.

REALITY CHECK

All of the aforementioned technologies are being commercialized to varying extents and levels of success. With the exception of EOR, which is a well-established process, companies involved tend to be start-ups aiming to profit on the back of hype around negative emissions, in an attempt to increase the value of captured CO2.

FURTHER READING

ETC Group and Heinrich Böll Foundation, "Geoengineering Map." map.geoengineeringmonitor.org

The Big Bad Fix: The Case Against Climate Geoengineering, http://etcgroup.org/content/big-bad-fix

SOURCES

i. Rosa Cuéllar-Franca and Adisa Azapagic, "Carbon capture, storage and utilisation technologies: A critical analysis and comparison of their life cycle environmental impacts", *Journal of CO2 Utilization*, Vol. 9, 2015

ii. Global CCS Institute, "Large-scale CCS facilities", 2017, https://www.globalccsinstitute.com/projects

iii. Rosa Cuéllar-Franca and Adisa Azapagic, 2015

iv. For more information see: https://en.wikipedia.org/wiki/Fischer%E2%80%93Tropsch_process

v. Ibid.

vi. Ibid.

vii. Biofuelwatch, "Solazyme: Synthetic Biology Company Claimed to be Capable of Replacing Palm Oil Struggles to Stay Afloat", 2016

viii. Biofuelwatch, "Microalgae Biofuels Myths and Risks," 2017

ix. Newlight Technologies, "Technology", https://www.newlight.com/technology/

x. Carbicretem http://carbicrete.com/

xi. Calera, http://www.calera.com/

xii. Rosa Cuéllar-Franca and Adisa Azapagic, 2015

xiii. Mark Harris, "The entrepreneurs turning carbon dioxide into fuels", The Guardian, 2017, https://www.theguardian.com/sustainable-business/2017/sep/14/entrepreneurs-turn-carbon-dioxide-into-fuels-artificial-photosynthesis