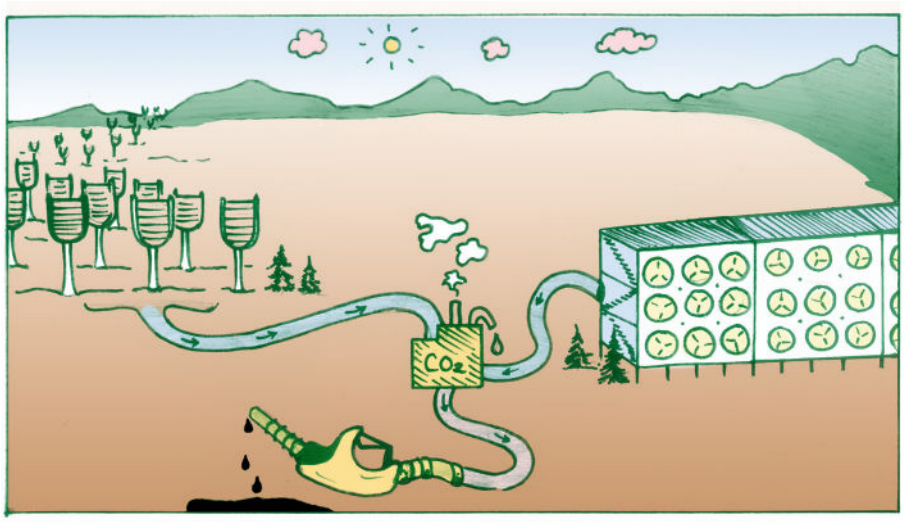
Direct Air Capture

POINT OF INTERVENTION

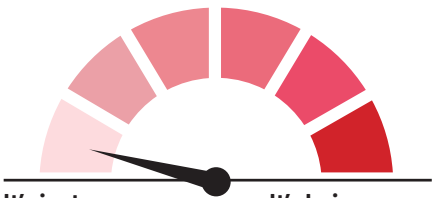
OVERVIEW

Direct Air Capture (DAC) is a largely theoretical technique in which CO2 (and potentially other greenhouse gases) are removed directly from the atmosphere. The current technique uses large fans that move ambient air through a filter, using a chemical adsorbent to produce a pure CO2 stream that could be stored. To have any significant effect on global CO2 concentrations, DAC would need to be rolled out on a vast scale, raising serious questions about the energy it requires, the levels of water usage for particular technologies, and the toxicity impacts from the chemical sorbents used. In addition, safe and long-term CO2 storage cannot be guaranteed, either in geological formations where leakage is a risk (see CCS factsheet[1]) or in products using CO2, where carbon is likely to end up back in the atmosphere one way or another (see CCUS factsheet[2]). The fossil fuel industry is attracted to DAC because the captured CO2 can be used to for Enhanced Oil Recovery (EOR), especially where there is not enough commercial CO2 available locally.



Direct Air Capture's high cost means close ties with the oil industry are its most likely path to adoption.

REALITY CHECK

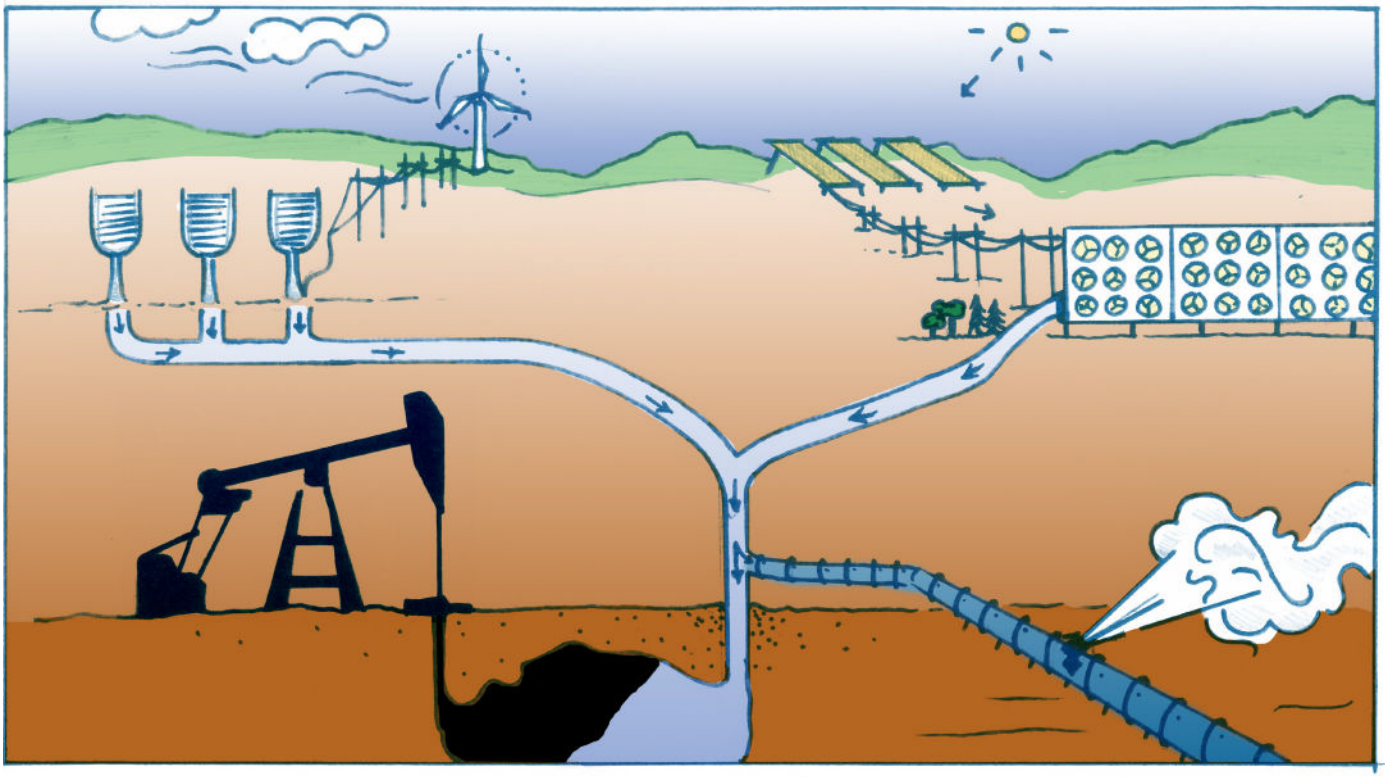


It's just a theory — **It's being implemented**

ACTORS INVOLVED

DAC is a commercially active geoengineering technology. David Keith's company Carbon Engineering is funded by private investors including Bill Gates and Murray Edwards, the billionaire tar sands magnate who runs Canadian Natural Resources Ltd (Keith is a prominent US-based geoengineering researcher and proponent). Carbon Engineering opened an CAD$ 8 million pilot plant in Squamish, British Columbia in 2015, where they claim to extract about a tonne of carbon dioxide a day.[3] Carbon Engineering also plans to turn captured CO2 into transport fuels, which then re-emit CO2 into the atmosphere when they are burned.[4]

Swiss company Climeworks says they have created the "first commercial plant to capture CO2 from air" in Zurich.[5] They claim the US$ 23 million plant is supplying 900 tonnes of CO2 annually to a nearby greenhouse to help grow vegetables. They have partnered in Iceland with Reykjavik



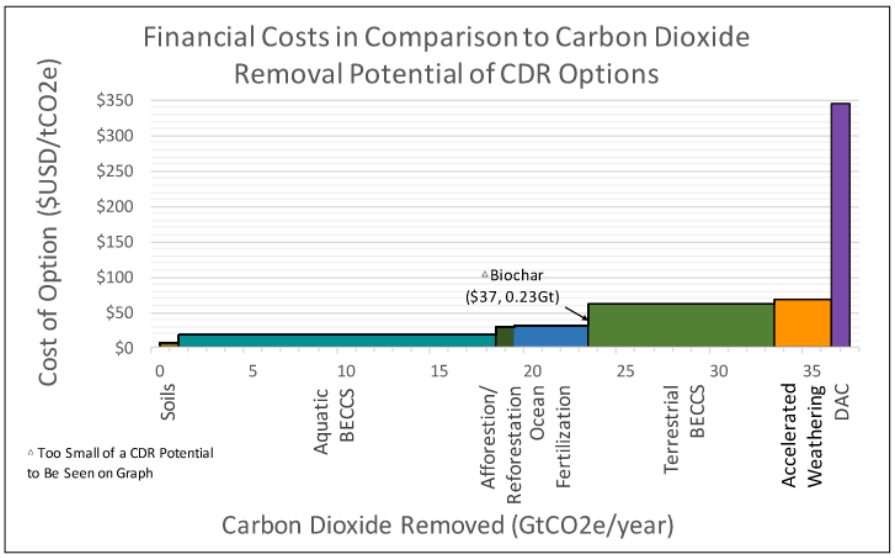
Direct Air Capture would be likely be used for Enhanced Oil Recovery, and would incur significant energy costs and divert resources from alternative energy sources. There would also be a significant risk of the CO2 leaking back into the atmosphere, potentially causing ecological damage.

Energy at the Hellisheidi geothermal plant to run one of their air capture units (with capacity to capture 50 tonnes of CO2 per year) and inject CO2 into basalt formations. This project, CarbFix2, has received funding from the European Union's Horizon 2020 research and innovation programme.[6] Reykjavik Energy, and in particular the Hellisheidi geothermal plant, have been the focus of large-scale environmental protests in Iceland for causing serious harm in what is Europe's last remaining area of wilderness.[7]

> ***At a DAC summit in Calgary in 2012 there were a number of oil companies in attendance, including Suncor, BP, Husky Oil, and Nexen***

Other companies developing DAC include Global Thermostat, bankrolled by Goldman Sachs, and partnered with Algae Systems,[8] as well as Skytree in the Netherlands and Infinitree (formerly Kilimanjaro) in the US.[9]

David Keith and other developers have pitched DAC as a means to use captured CO2 to massively scale up the EOR industry in the US and elsewhere. At a DAC summit in Calgary in 2012 there were a number of oil companies in attendance, including Suncor, BP, Husky Oil, and Nexen.[10] However, optimism for DAC's business case is belied by the reality that it is not economically feasible due to high costs,[11] which are likely to be more than 4 times greater than other Carbon Dioxide Removal approaches.[12] Moreover, using DAC to enable EOR would obviously cancel



Cost comparison of Carbon Dioxide Removal options (Martin, Johnson, Stolberg, Zhang and De Young, 2017)

any supposed climate mitigation benefits.[13]

DAC technology has attracted the attention of venture capitalists like Ned David, who is keen on EOR and runs an algae synthetic biology company. He hopes to create biofuels by feeding captured carbon to algae produced in giant vats outdoors and has sought funding from Monsanto.[14]

IMPACTS

DAC requires considerable energy input. When including energy inputs for mining, processing, transport and injection, energy requirements are greater still, perhaps as much as 45 gigajoules per tonne of CO2 extracted.[15] For David Keith's pilot DAC unit, this is the equivalent of running it off a constant 0.5 megawatt power supply.[16] Neither Climateworks nor Carbon Engineering publish the energy requirements of their units, and in the case of Carbon Engineering, it is not known how the electricity powering the unit is produced. Because of the huge demand for energy that DAC implies, some geoengineering promoters have proposed to use "small nuclear power plants" connected to DAC installations, [17] potentially introducing a whole new set of environmental impacts.

DAC also requires substantial water input. One study estimates that at implementation levels that would remove 3.3 gigatonnes of carbon per year, DAC could expect to use around 300 km3 of water per year (assuming current amine technology, which is what Climeworks uses). This is equivalent to 4% of the water used for crop cultivation each year. DAC technologies using sodium hydroxide (Carbon Engineering) would use far less,[18] but this in turn is a highly caustic and dangerous substance.

A modelling exercise looking at the impact of DAC on climate stabilization efforts predicted that it would postpone the timing of mitigation (emissions reductions) and allow for a prolonged use of oil, impacting positively on energy exporting countries.[19] This is of course similar for many geoengineering technologies and one of their most dangerous aspects.

REALITY CHECK

There is one demonstration facility near Zurich owned by Climeworks,[20] and another by the same company in Iceland.[21] Carbon Engineering also operates a pilot plant in British Columbia.[22] In addition there are several companies that have developed small-scale capture units, with numerous research projects also underway.

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

Washington State Governor Jay Inslee inspects a Climeworks DAC unit in Switzerland (Jay Inslee/Creative Commons)

SOURCES

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10. Marc Gunther, "The business of cooling the planet," *Fortune*, 2011, http://fortune.com/2011/10/07/the-business-of-cooling-the-planet/

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14. Katie Fehrenbacher, "Algae startup Sapphire Energy raising $144M," Gigaom, 2012, https://gigaom.com/2012/04/02/algae-startup-sapphire-energy-raising-144m/

15. Pete Smith et al., "Biophysical and economic limits to negative CO2 emissions," *Nature Climate Change*, 2015

16. W=J/t, therefore 45GJ / 1 day in seconds = roughly 500,000W

17. Proposed by David Sevier, Carbon Cycle Limited, UK; communication in a geoengineering electronic discussion group, September 2017

18. Pete Smith et al., 2015

19. Chen Chen and Massimo Tavoni, "Direct air capture of CO2 and climate stabilization: A model based assessment," *Climatic Change*, Vol. 118, 2013, pp. 59–72

20. Christa Marshall, "In Switzerland, a giant new machine is sucking carbon directly from the air," *Science*, 2017, http://www.sciencemag.org/news/2017/06/switzerland-giant-new-machine-sucking-carbon-directly-air

21. ClimeWorks, "Public Update on CarbFix," 2017, http://www.climeworks.com/public-update-on-carbfix/

22. John Lehmann, 2017