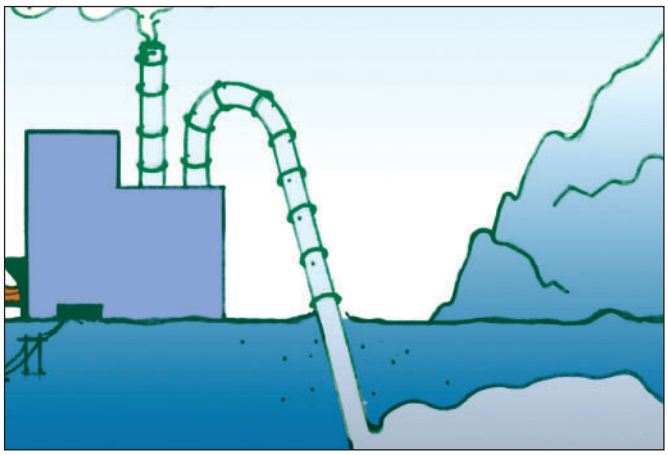
Carbon Capture and Storage (CCS)

Description and purpose of the technology

Carbon Capture and Storage (CCS) was originally developed by the oil industry to recover difficult-to-access deep oil reserves, and was therefore called Enhanced Oil Recovery (EOR) technique. It involves pumping pressurized CO_2 into oil reservoirs to extract remaining deposits from aging oil fields as well as recovering otherwise inaccessible oil, significantly boosting production. It has been available to use for more than 45 years, particularly in the United States, but it hasn't been used extensively because of high costs.

Renamed as Carbon Capture and Storage (CCS) it is now proposed as a carbon dioxide removal (CDR) technology that aims to capture and bury CO_2 emitted by fossil-fuel combustion, cement and steel production, refining and some other industrial processes. The captured CO_2 is compressed into a liquid form and transported by pipeline to a site where it can be pumped underground into geological formations, such as oil or gas reservoirs, saline aquifers, or below the seabed - theoretically for long-term storage.

Post-combustion technology, a method to remove CO_2 from the exhaust gas after the combustion process, is the most commonly proposed option. All CO_2 removal approaches involve a substance able to act as a selective CO_2 filter: CO_2 dissolves in or sticks to a filter. The most frequent type are liquid solvents. Further filter options include solid sorbents and membranes. However, to allow their repetitive use, the filters must be able to release the captured CO_2.



CCS technology aims to capture carbon and bury it underground.

This regeneration process typically requires high temperature, which in turn requires high energy inputs and impairs the efficiency on the facility where it is used. To power CO_2 capture, transport and storage, the consumption of fossil fuels increases by up to 40 percent, making it a costly process energetically as well as financially.

The highest share is held by the CO_2 capture process, causing an increase by up to 30 percent. This means that for a coal-fired power station, even more coal would need to be mined and burned in order to produce the same amount of energy with CCS.[1]

The International Energy Agency's (IEA) CCS Unit now describes "Advanced EOR+" as a way to "'co-exploit' two business activities": oil recovery and CO_2 storage for profit.[2] The CCS process leads to the extraction and combustion of more fossil fuels, carries significant environmental risks, such as CO_2 escaping through leaks, is costly and technologically challenging, therefore it is now presented as a "climate technology", to capture climate funds. The "capture" and gas compression phases in particular account for as much as 90% of the total monetary cost of CCS.[3]

Point of Intervention:

Reality Check:

Actors involved

Oil companies are the most interested in developing CCS because it provides a source of subsidised CO_2 for EOR and allows the companies to extract more oil. Decades of research and billions spent by governments and companies, such as Shell, Statoil and ExxonMobil have resulted in only a few commercial-scale CCS operations, highlighting the extent to which CCS is only commercially viable when used for EOR. This additional exploitation of fossil fuels contradicts its alleged purpose.

The Global CCS Institute lists 21 operational, so-called commercial-scale CCS facilities worldwide, but most of them employ EOR and shouldn't be called CCS.

Of the 21 listed, two are power generation facilities (both coal), in sixteen facilities the captured CO_2 is used for EOR, and the two facilities listed as being under construction are for EOR too.[4]

These statistics clearly show that the motivation for CCS is further oil production, which will increase emissions. The United States Department of Energy, the largest public funding body of CCS projects, claims that additional 200 billion barrels of oil could be recovered in the United States by utilizing CO_2 - EOR, doubling the amount of recoverable oil.[5]

Governments and the fossil fuel industry have for many years presented CCS as a silver bullet for climate change, with the promise of the technology being a consistent excuse for delaying serious reductions in fossil fuel use.

Impacts of the technology

The main impact of CCS is that it extends the life of dirty energy in poor communities around the world, with acute environmental justice, health and economic impacts, while having little evidence it can address the climate crisis at the scale required.

The symbiotic relationship between CCS and EOR undercuts its (theoretical) potential as a climate-change response. In North America, carbon captured from the only large-scale CCS-equipped power plants – Petra Nova in Texas, and SaskPower in Saskatchewan (both coal-fired) – is transported via pipeline to oil fields where it is injected for EOR.

"The main impact of CCS is that it extends the life of dirty energy in poor communities around the world, with acute environmental justice, health and economic impacts, while having little evidence it can address the climate crisis at the scale required."

Beyond the extra emissions from the recovered oil, oil industry estimates indicate that about 30 percent of the CO_2 piped to an EOR site will be directly emitted back into the atmosphere.[6]

CCS (and Bioenergy with CCS, see BECCS briefing) proponents claim that storing CO_2 in old oil and gas reservoirs, deep saline aquifers or below the seabed will be effective and reliable. But real-world experience suggests otherwise: the captured carbon could leak out for many reasons, including faulty construction, earthquakes or other underground movements. This means that even meticulous preparation cannot prevent leaks. At such high concentrations, leaked CO_2 is highly toxic to animal and plant life. The injected CO_2 may also displace pollutants as well as saline groundwater, which could lead to the deterioration of the quality of surface waters. At offshore sites, CCS may increase ocean acidification and adversely affect marine ecosystems, while well-established measurement approaches to identify leakages do not exist.[7]

The following examples highlight the uncertainties of underground storage:

- In 2000, Cenovus Energy began injecting CO_2 into the Weyburn oil field in Canada from a coal gasification plant.[8] Residents became concerned after unexplained farm animal deaths and observations of bubbling and oily film on their ponds. Years later, a trail of studies, both proving and disproving the leakage, leave the truth about Weyburn shrouded.[9]
- The Sleipner project in the North Sea, operated by ExxonMobil, Statoil, Lotos Norge and Total, has been injecting up to 1 million tonnes of CO_2 a year from a natural gas processing facility into a sub-seabed saline aquifer. Observations have been reported of oily water, unexplained cracking and damage to the formation related to injections, an oil leak, and unanticipated movement of injected CO_2 through the formation. These observations are coupled with a significant discrepancy between the amount of CO_2 injected and what has been detected in seismic surveys.[10]

- A joint venture between BP and Statoil in Algeria injected CO_2 from gas production into three wells between 2004 and 2011. A seismic study indicated that injection had activated a deep fracture zone,[11] and leakage was found from a nearby well head.[12]
- Leakage, either small amounts over a long time, or an abrupt, potentially catastrophic release, would undermine any "sequestration" gains. Leaks are hard to avoid. In the USA, over 3 million old oil and gas wells have been abandoned and remain unplugged,[13] and many of those penetrate the deeper formations currently in use or considered for CCS.[14]
- Plans for onshore CO_2 storage, particularly in Europe, have been met with strong protest over safety concerns, leading to a number of projects being cancelled.[15]

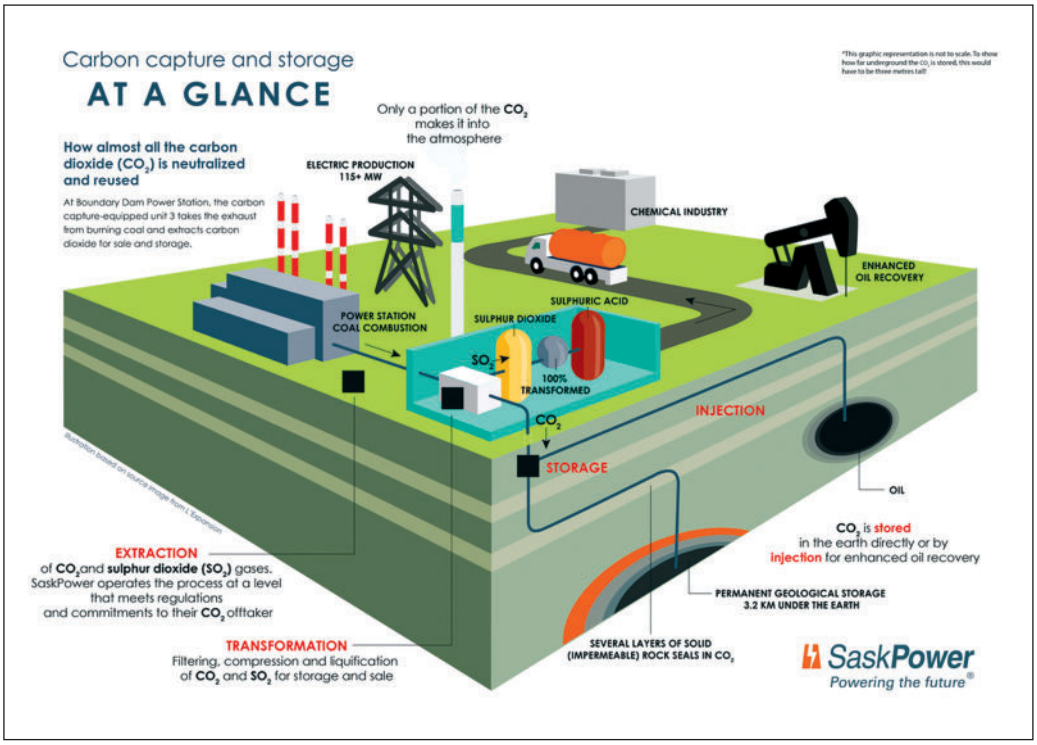


Diagram explaining the key processes of CCS from SaskPower

Reality check

CCS is largely aspirational, extremely expensive and there is little evidence that it is effective. It is mainly of interest to oil producing countries and the oil industry to get carbon credits or subsidies, with limited implementation. High costs and technical issues have led to a wave of high-profile project cancellations in recent years; the suspension of the CCS project at Petra Nova in 2020 is among the most recent examples. Even projects that have managed to achieve operation, and been heralded as successful, are plagued with problems.[16] The fact that several CDR technologies rely on CCS, such as BECCS and Direct Air Capture, should also be a serious cause for concern, as CCS may either not be developed or shown to be ineffective for carbon removal, so reliance on it is highly speculative and dangerous.

Further reading

CIEL (2019), ***Fuel to the Fire: How Geoengineering Threatens to Entrench Fossil Fuels and Accelerate the Climate Crisis***, https://www.ciel.org/reports/fuel-to-the-fire-how-geoengineering-threatens-to-entrench-fossil-fuels-and-accelerate-the-climate-crisis-feb-2019/

Geoengineering Monitor (2020), ***Carbon capture is the fossil fuel giants' plant to keep extracting***, http://www.geoengineeringmonitor.org/2020/03/carbon-capture-is-the-fossil-fuel-giants-plan-to-keep-extracting/

Greenpeace (2015), "***Carbon Capture SCAM***," http://www.greenpeace.org/usa/research/carbon-capture-scam/

Biofuelwatch, "***BECCS: Last ditch climate option or wishful thinking?***", http://www.biofuelwatch.org.uk/2015/beccs-report/

ETC Group and Heinrich Böll Foundation, "***Geoengineering Map***", https://map.geoengineeringmonitor.org/

Endnotes

1 ETC Group and Heinrich Böll Foundation (2020) Geoengineering Map, https://map.geoengineeringmonitor.org/; German Federal Environmental Agency (2018) Carbon Capture and Storage, published online: April 18, 2018, https://www.umweltbundesamt.de/themen/wasser/gewaesser/grundwasser/nutzung-belastungen/carbon-capture-storage#grundlegende-informationen;
House, et al. (2009) The energy penalty of post-combustion CO2 capture & storage and its implications for retrofitting the U.S. installed base, in Energy & Environmental Science, Issue 2, https://pubs.rsc.org/en/content/articlelanding/2009/ee/b811608c#!divAbstract

2 Heidug, et al. (2015) Storing CO2 through Enhanced Oil Recovery: Combining EOR with CO2 storage (EOR+) for profit, International Energy Agency, Insights Series 2015, p.6, https://nachhaltigwirtschaften.at/resources/iea_pdf/reports/iea_ghg_storing_co2_trough_enhanced_oil_recovery.pdf

3 Folger (2017) Carbon Capture and Sequestration (CCS) in the United States, Congressional Research Service, published: November 14, 2017, p. 12, https://www.ourenergypolicy.org/wp-content/uploads/2017/11/R44902-1.pdf; House, et al. (2009); German Federal Environmental Agency (2018)

4 Global CCS Institute (2019) Global Status Of CCS 2019, https://www.globalccsinstitute.com/wp-content/uploads/2019/12/GCC_GLOBAL_STATUS_REPORT_2019.pdf; Global CCS Institute (2020) Global CCS Institute welcomes the 20th and 21st large-scale CCS facilities into operation, published: June 3, 2020, https://www.globalccsinstitute.com/news-media/press-room/media-releases/global-ccs-institute-welcomes-the-20th-and-21st-large-scale-ccs-facilities-into-operation/

5 National Energy Technology Laboratory (2020) Commercial Carbon Dioxide Uses: Carbon Dioxide Enhanced Oil Recovery, US-DOE, accessed: June 2020, https://netl.doe.gov/research/coal/energy-systems/gasification/gasifipedia/eor;
ETC Group and Heinrich Böll Foundation (2020)

6 Ernsting and Munnion (2015) Last ditch climate option of wishful thinking? Bioenergy with carbon capture and storage, Biofuelwatch, http://www.biofuelwatch.org.uk/2015/beccs-report/

7 Gross, et al. (2019) Simulating and Quantifying Multiple Natural Subsea CO2 Seeps at Panarea Island (Aeolian Islands, Italy) as a Proxy for Potential Leakage from Subseabed Carbon Storage Sites, in Environ. Sci. Technol., Vol. 53(17): 10258 - 10268, https://pubs.acs.org/doi/abs/10.1021/acs.est.9b02131;
German Federal Environmental Agency (2018); Skuce (2016) 'We'd have to finish one new facility every working day for the next 70 years'—Why carbon capture is no panacea, in: Bulletin of the Atomic Scientists, published: October 4, 2016, https://thebulletin.org/2016/10/wed-have-to-finish-one-new-facility-every-working-day-for-the-next-70-years-why-carbon-capture-is-no-panacea/

8 Whittaker, et al. (2011) A decade of CO2 injection into depleting oil fields: Monitoring and research activities of the IEA GHG Weyburn-Midale CO2 Monitoring and Storage Project," in Energy Procedia, Vol. 4: 6069 - 6076, https://www.sciencedirect.com/science/article/pii/S1876610211008915

9 Ernsting and Munnion (2015)

10 Ernsting and Munnion (2015)

11 Stork, et al. (2015) The microseismic response at the In Salah Carbon Capture and Storage (CCS) site, in: International Journal of Greenhouse Gas Control, Vol. 32: 159 - 171, https://doi.org/10.1016/j.ijggc.2014.11.014

12 Wright, et al. (2010) In Salah CO2 Storage JIP: Site Selection, Management, Field Development Plan and Monitoring Overview, in: Energy Procedia: 614 - 1000

13 Gale (2014) IEAGHG Information Paper 2014-27; The Trouble with Abandoned Wells, IEA Greenhouse Gas R&D Programme, December 23, 2014; Weingarten, et al. (2015) High-rate injection is associated with the increase in U.S. mid-continent seismicity, in Science, Vol. 348(6241): 1336 - 1340, https://science.sciencemag.org/content/348/6241/1336

14 Ide, et al. (2006) CO2 leakage through existing wells: current technology and regulations, in: Proceedings of the 8th International Conference on Greenhouse Gas Control Technologies, International Energy Agency Greenhouse Gas Programme: Elsevier, Netherlands (2006)

15 Neslen (2015) Europe's carbon capture dream beset by delays, fears and doubt, in: The Guardian, published: April 9, 2015, https://www.theguardian.com/environment/2015/apr/09/carbon-capture-dream-norway-beset-by-delays-fears-doubt-europe

16 Greenpeace (2016) Carbon capture and storage a costly, risky distraction, published: July 1, 2016, http://www.greenpeace.org/international/en/campaigns/climate-change/Solutions/Reject-false-solutions/Reject-carbon-capture—storage/; Anchondo and Klump (2020) Petra Nova is closed: What it means for carbon capture, in: E&E News, September 22, 2020, https://www.eenews.net/stories/1063714297; ETC Group and Heinrich Böll Foundation (2020)