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Carbon180

Direct air capture

Direct air capture (DAC) is a leading technological carbon removal solution with the capacity to remove existing carbon emissions from the atmosphere — an important addition to ongoing emissions reductions efforts. Using large fans and chemical processes, DAC plants remove atmospheric CO_2, which is then either permanently stored in underground rock formations (a process known as dedicated geologic storage), utilized in enhanced oil recovery (EOR), or used to produce a range of commercial products (known as carbontech).

DAC has significant potential as a carbon removal solution, with estimates suggesting that it could remove up to 5 gigatons of CO_2 per year by 2050.[1] In addition to mitigating climate change, DAC offers benefits such as flexibility in facility siting, new market opportunities for repurposed carbon products, and jobs in developing, deploying, and operating DAC plants.

KEY TERMS

Gigaton
1 billion tons.

Induced seismicity
Minor earthquakes and tremors (of a low magnitude) caused by human activity.

Enhanced oil recovery (EOR)
A form of oil production that involves injecting captured CO_2 into depleted oil wells to aid in recovery and then permanently storing the injected CO_2 in the depleted well.

Read more about EOR.

Carbon use
The breadth of ways removed or captured CO2 can be used to produce economically valuable products or services (includes EOR).

Carbontech
The wide variety of commercial products that can be made with CO_2 (does not include EOR).

Siting, infrastructure, and ecosystem impacts

DAC plants require less land than other prominent carbon removal solutions like forestation and bioenergy with carbon capture and storage (BECCS). A DAC plant can capture the same amount of CO_2 as a tropical forest that takes up 40 times more land. However, land requirements for the energy used to power a DAC plant can significantly increase its physical footprint.[2] DAC plants are energy intensive, but siting flexibility makes it relatively easy for DAC plants to be located near renewable energy sources.[3]

DAC deployment may also give rise to concerns about geologic storage of CO_2. These include groundwater contamination, induced seismicity, and potentially high concentrations of CO_2 in the air and soils due to carbon dioxide leakage from storage sites.[4]

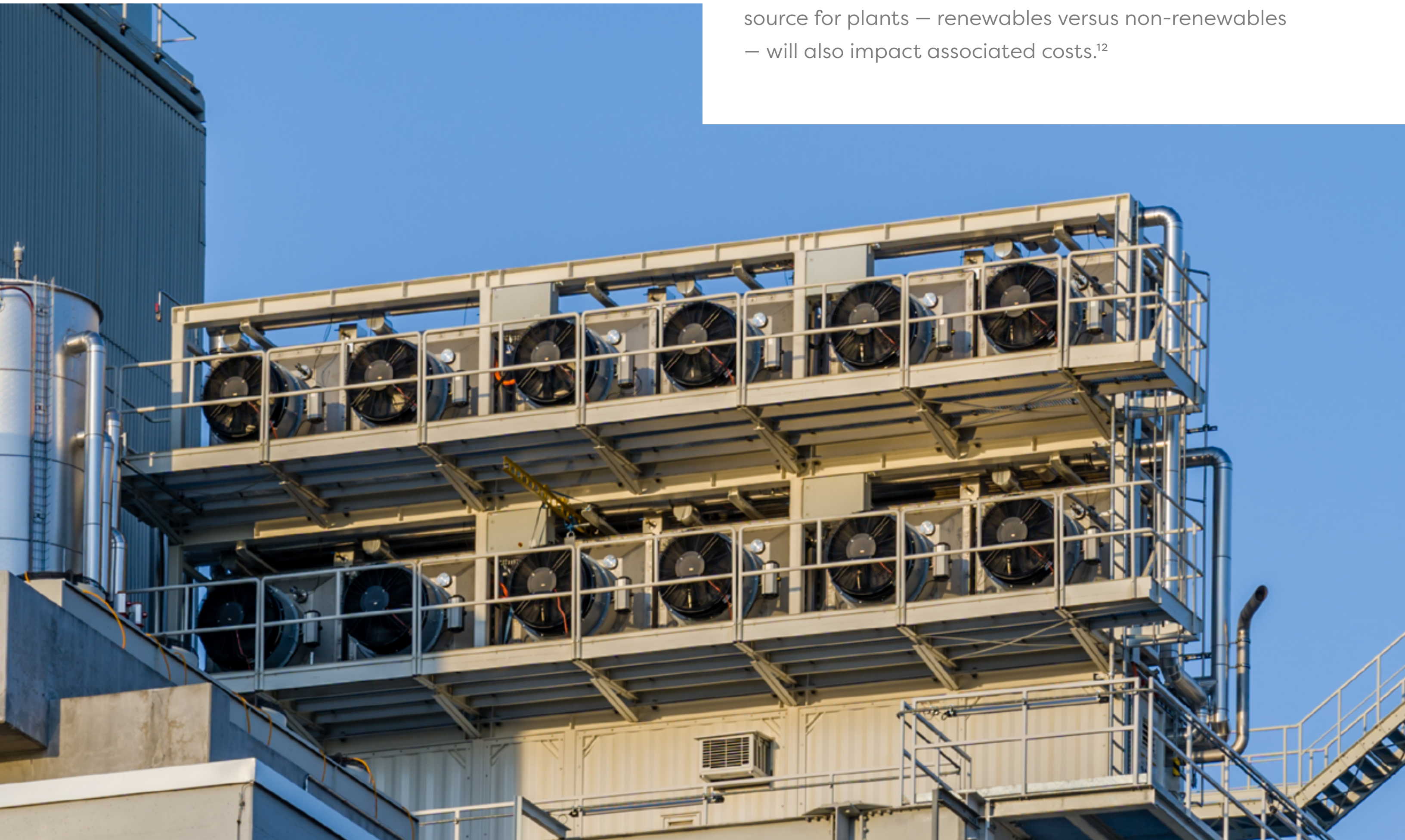
However, these concerns are unlikely to occur and can be easily mitigated.[5] Future DAC facilities could be sited near dedicated geologic storage sites in order to minimize the need for carbon transportation infrastructure, as well as near renewable energy sources to reduce the use of fossil fuels.

Job creation and economic impacts

Large-scale DAC deployment can contribute to economic growth and create 300,000 jobs over the next 30 years.[6] The deployment of each DAC plant is estimated to provide around 1,500 jobs in plant construction, maintenance, and transportation of necessary materials. After construction, a typical DAC plant is expected to require close to 300 workers to maintain and operate it.[7] Many of these are high-quality jobs that can support historically fossil-dependent communities and other communities with disproportionately high underemployed or unemployed populations. Additionally, DAC can help unlock an estimated $1 trillion total available market within the US for carbontech.[8]

Costs

Current cost estimates for DAC have fluctuated across studies, typically ranging from $200 to $600 per ton of CO_2.[9] However, recent studies suggest that the future cost of plants could drop below $100 per ton relatively quickly, and the growing carbon use market can help further offset costs.[10] The largest operational costs of DAC facilities are associated with the energy consumption of the plant.[11] Almost all DAC processes require large amounts of energy to operate the facility. The power source for plants — renewables versus non-renewables — will also impact associated costs.[12]



Deployment

There are currently 15 small-scale DAC plants in operation in the United States, Europe, and Canada, which have successfully removed thousands of tons of CO_2 per year.[13] Construction planning is underway for a DAC plant in the US that would remove 1 million metric tons per year and make it the largest plant globally.[14] However, wide-scale deployment must address financial limitations, proximity of DAC plants to communities, availability of necessary resources like land and water, and access to clean power sources. Additional federal investment to bolster post-deployment monitoring, reporting, and verification (MRV) of CO2 is necessary to ensure the carbon dioxide these plants are removing is measured accurately and, where applicable, stored effectively and permanently.

Government engagement

The Department of Energy (DOE) is the primary federal agency driving DAC advancement in the US. Last year, DOE launched its landmark Carbon Negative Shot to advance carbon removal solutions with durable storage to gigaton scale for less than $100 per ton CO_2. DOE also does research, development, demonstration, and deployment (RDD&D) for critical enabling technologies for DAC such as carbontech and geologic storage.

The Environmental Protection Agency issues geologic storage permits through the Underground Injection Control program, and the Department of the Interior makes decisions around constructing DAC facilities on federal lands.

Recent federal funding for DAC has skyrocketed, particularly through the Bipartisan Infrastructure Law (BID) and fiscal year (FY) 2022 appropriations. The BID includes $700 million for the Regional DAC Hubs program and $115 million for the DAC Technology Prize Competitions authorized in the 2020 Energy Act. Congress also appropriated $100 million for coordinated RD&D of DAC technologies and facilities at DOE's Office of Fossil Energy and Carbon Management, Office of Energy Efficiency and Renewable Energy, and Office of Science through the FY22 omnibus bill. These developments, among others, lay critical groundwork for advancements in DAC technologies and infrastructure in the coming years.

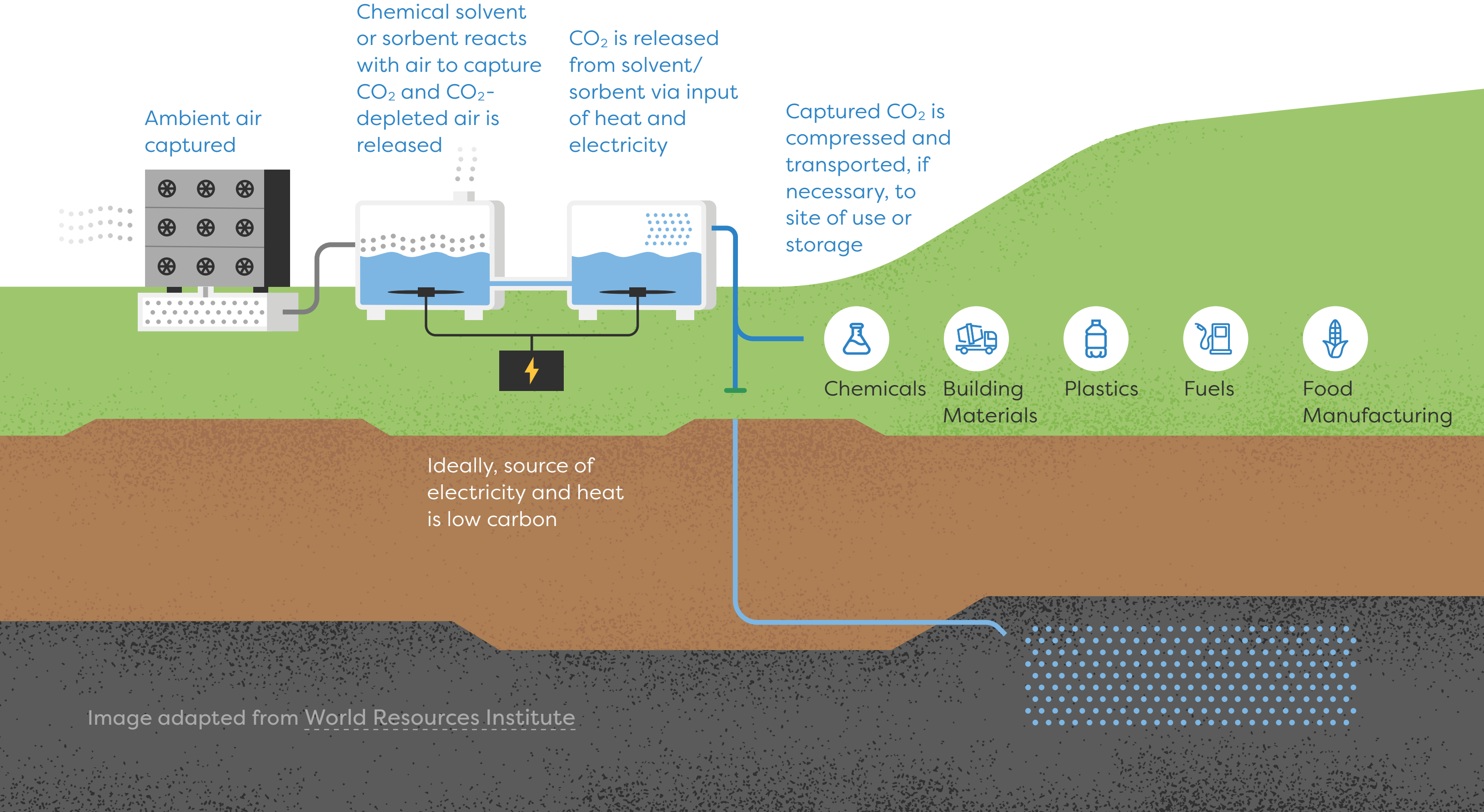


Image adapted from World Resources Institute

Endnotes

1 Capturing Leadership, Rhodium Group

2 Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, The National Academies of Sciences

3 Ibid.

4 Geologic Storage of Carbon Dioxide: Risk Analyses and Implications for Public Acceptance, Gregory R. Singleton

5 Assessing induced seismicity risk at CO_2 storage projects: Recent progress and remaining challenges, Joshua A.White and William Foxall

6 Capturing New Jobs, Rhodium Group

7 Ibid.

8 Carbon Conversion to Valuable Products, New Carbon Economy Consortium

9 Fact Sheet: Direct Air Capture, Carbon180

10 Carbon Conversion to Valuable Products, New Carbon Economy Consortium

11 Techno-economic assessment of CO_2 direct air capture plants, Mahdi Fasihi, Olga Efimova, and Christian Breyer

12 Negative Emissions Technologies and Reliable Sequestration: A Research Agenda, The National Academies of Sciences

13 Direct Air Capture, International Energy Agency

14 Ibid.

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