Philanthropy Briefs

CARBON MANAGEMENT

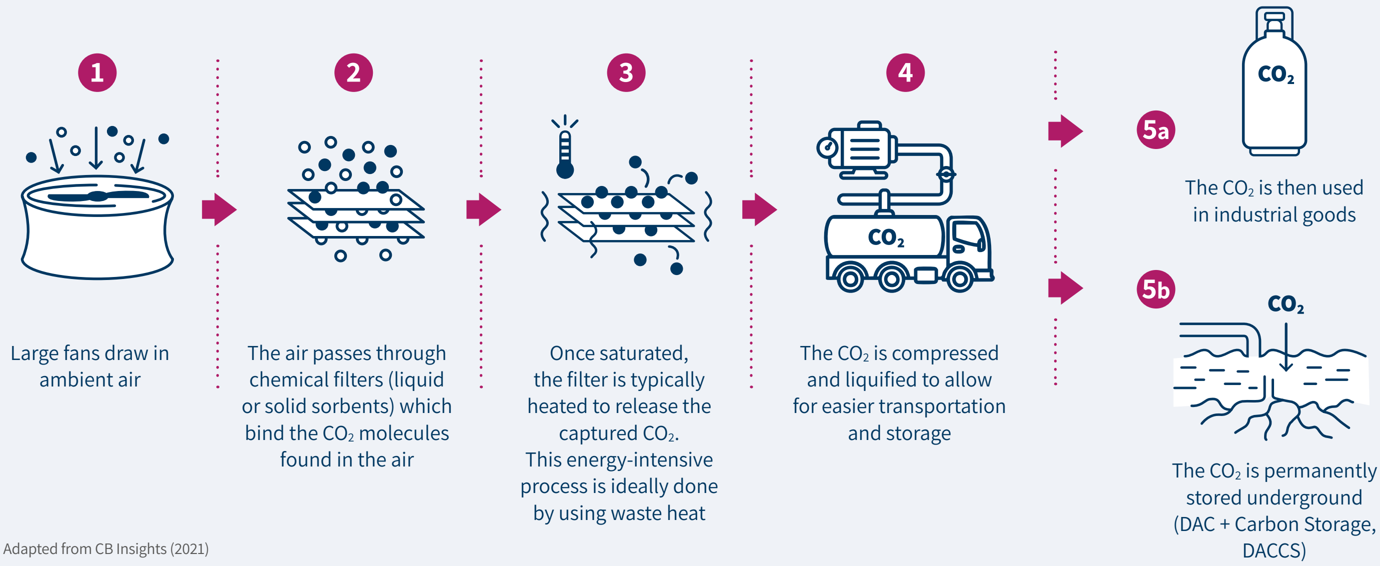
Direct Air Capture

a series by Active Philanthropy

WHAT IS IT ABOUT?

Direct Air Capture (DAC) is a technological approach to carbon dioxide removal – one of the three building blocks of carbon management. Unlike CCS, which aims to capture emissions from a point source (like a cement factory), DAC aims to remove emissions that have been emitted in the past and have accumulated in the atmosphere.

Current DAC technologies differ in detail, but largely follow a five-step process:[1]



Adapted from CB Insights (2021)

For DAC to remove more CO_2 than it produces, it must use waste heat or renewable energy. Why? Because ambient air only contains 0.04 % of CO_2. Filtering it out is technically demanding and requires substantial amounts of energy. Compared to other CDR approaches, DAC can be employed across geographies. However, optimal deployment requires nearby CO_2 transport and storage infrastructure (like pipelines or geological storage sites).

WHY IS DIRECT AIR CAPTURE IMPORTANT FOR OUR CLIMATE?

Reducing emissions is undoubtedly the most important and urgent climate action to achieve net-zero. Yet, to limit global warming well under 2°C depends on large-scale carbon dioxide removal (CDR) to offset past emissions and residual emissions from hard-to-abate sectors (see our Primer on Carbon Management). Put simply, the less carbon we emit today, the more effective DAC becomes in targeting these residual emissions.

Among the portfolio of CDR approaches, DAC has received significant attention because it promises permanent and precisely measurable removals. The International Energy Agency has projected that DAC will contribute 13 % of all CO_2 captured by mid-century.[2]

However, today's global capacity represents only a fraction of what would be required to move the needle. While the first commercial DAC plants are now operating, current costs remain high and scaling faces significant technical, and regulatory challenges.[3]

[1] Lebling et al. 2025, [2] IEA 2022, [3] Breitschopf et al. 2023

WHAT FUNDERS CAN DO

Shape guardrails early: With much of its deployment ahead, DAC technology can be developed responsibly. Philanthropy's role is critical in funding research about risks and co-benefits, supporting watchdog groups and establishing standards. Funding strategies abound. For example, policymakers need to be engaged so that emission cuts and carbon removals are treated separately[4]. Moreover, oil companies, who are currently the biggest investors in DAC[5], need to be scrutinised so that DAC is not misused for enhanced oil recovery, a practice already banned in California[6].

Advance principles of justice: As DAC moves from pilot stage to commercialisation, garnering the social license for large-scale deployment is crucial[7]. Philanthropy can help by fostering community participation and transparent decision-making in potential host regions, particularly where frontline communities bear the risks of siting and resource use.

Foster public debate: DAC is one of the most mature CDR approaches with high potential for future carbon removal. Yet, it remains costly, technologically complex and resource intensive. There is a need for an informed and honest public debate about DAC's role, limits and realistic cases for application. Funders can support fact-based communication and public engagement, ensuring the technology is neither dismissed prematurely nor overpraised as a silver bullet.

There are many different strategies to engage in climate philanthropy. See our Spotlight on Climate Funding Strategies to learn more.

3 FAST FACTS

700 TWh

the amount of energy needed to remove 1 Gt (= 1 billion tonnes) of CO_2 with todays' DAC technologies, equivalent to 17% of the US' annual energy production.[8]

500-1,000 US$

the price for removing and safely storing 1 tonne of CO_2 via DAC today.[9]

36,000 tonnes

the annual CO_2-removal capacity of the world's largest DAC plant, located in Iceland and operated by Swiss company Climeworks.[10]

THINGS TO CONSIDER WHEN FOCUSING ON DAC

Urgency vs. future readiness: In the near term, renewable energy is more impactful when used to replace fossil fuels than when used to power DAC plants. Yet, DAC will be needed further down the net-zero pathways and thus needs to be scaled early. Funders can navigate this dilemma by reflecting on their goals: focusing on immediate impact by supporting proven mitigation pathways or investing in future readiness by supporting the responsible scaling up of DAC so it may become a viable tool.

Energy and storage as enabling factors: DAC is not a stand-alone solution. Its climate value hinges on two enabling factors: abundant low-carbon energy and secure storage options. For funders, this means that supporting these conditions can simultaneously advance near-term emission reductions while laying the foundations for potential large-scale DAC deployment in the future.

Assess DAC's full environmental footprint: Many climate scenarios count on DAC but, in the real world, the technology has trade-offs. For instance, while often touted as land-efficient, this changes when the land needed to generate the energy needed for DAC (e.g. solar or geothermal) is considered. DAC deployment and other land-use such as biodiversity conservation or agriculture can come to compete. Funders can address such trade-offs by supporting research on holistic life-cycle assessments to clarify DAC's true footprint, including land, water use, energy and material demand, and other environmental impacts.

Link to bibliography

[4]Lebling et al. 2024, [5]ClimateWorks Foundation 2024, [6]Lebling et al. 2025, [7]Scott-Buechler et al. 2024, [8]Sartor et al. 2024, [9]De Luna 2024, [10]Climeworks 2024