

# Direct air capture

Direct air capture (DAC) technologies remove CO<sub>2</sub> from the atmosphere. This CO<sub>2</sub> is then securely stored underground or used to produce commercial products like construction materials and chemicals. Meeting global climate goals will require both reducing emissions and removing them through DAC and other means.

## Where in the world is DAC?

DAC is not entirely new. Similar systems have been installed in submarines and space applications for decades — it would be impossible to breathe in these closed environments without them. Over the past several years, progress on the large-scale versions has moved quickly, with a burgeoning field of commercial development efforts.

### CarbonCapture (California)

Designs modular DAC units that can use a range of sorbents (substances that grab onto CO<sub>2</sub> molecules because of their chemical or physical properties) for carbon removal.

### Carbon Engineering (British Columbia, Canada)

Owens a pilot plant that removes 1 metric ton of CO<sub>2</sub> per day. The company is also engineering a US facility that will remove 500,000 million metric tons per year and scale to 1 million yearly.

### Climeworks (Zürich, Switzerland)

Runs the world's first net-negative power plant and 15 DAC facilities across Europe, collaborating with permanent underground storage partners like Carbfix..

### Global Thermostat (New York)

Currently operates a 4,000 metric ton per year carbon removal plant in Alabama.

### Heirloom (California)

Uses chemical reactions between CO<sub>2</sub> and calcium minerals to remove CO<sub>2</sub> from the air, forming a product that is then heated to separate CO<sub>2</sub> for storage and return the mineral to its original state for more carbon removal.

### Noya (California)

Performs energy-efficient and cost-effective DAC by making use of modular designs and existing infrastructure (cooling towers) to reduce the amount of heat the process requires.

### Verdox (Massachusetts)

Uses electrochemistry to power DAC entirely on renewable electricity and reduce the amount of heat (energy) required.

### 1PointFive (California)

Uses liquid sorbents first pioneered in Switzerland by Carbon Engineering to remove carbon from the air, with projects in Louisiana and West Texas in planning stages.

## THE MARKET FOR DAC

### \$1 trillion

is the total available US market for use of CO<sub>2</sub> from DAC.

### \$200 to \$600 per ton

is the current cost estimate for DAC, though a recent study suggested the number may drop to less than \$100 per ton for future plants.

## ADVANTAGES OF DAC



### Economics

DAC has the potential to be a global business by mid-century, and at full scale could create at least 300,000 new jobs in construction, engineering, and manufacturing.



### Scalability

The modular design of many DAC plants means these facilities can be scaled up while keeping a small physical footprint compared to other forms of carbon removal.



### Storage

Entire sectors can move from net-zero to negative by storing the CO<sub>2</sub> from DAC in underground layers of rocks (dedicated geologic storage).

## REFERENCES

[Capturing Leadership: Policies for the US to Advance Direct Air Capture Technology](#), Rhodium Group

[Negative Emissions Technologies and Reliable Sequestration: A Research Agenda](#), The National Academies of Sciences



The Hellisheidi geothermal power plant in Iceland provides renewable energy to power the Climeworks DAC machines and facilitate the permanent storage of CO<sub>2</sub> through a process called mineralization. *Photo credit: Climeworks*

## Current policy support

Policy support for DAC is growing rapidly. One of the most pressing needs is a robust federal research, development, demonstration, and deployment (RDD&D) program. Fiscal year (FY) 2020 appropriations took steps to develop this program with \$68 million appropriated for RDD&D related to negative emissions technologies with specific carve outs for DAC, and FY21 appropriations bills have even higher levels of funding. Additionally, there are bills in the House and Senate to update the Department of Energy's Office of Fossil Energy and Carbon Management to establish the first-ever dedicated federal carbon removal RDD&D program.

Previous support includes the FUTURE Act, signed into law in 2018, which updated an existing tax credit to include DAC for the first time. As a result, a DAC project can now receive a tax credit worth \$35–\$50 per ton of removed CO<sub>2</sub>, depending on how it is used. California also allowed DAC combined with secure geologic storage to access their low-carbon fuel standard market — currently the most valuable carbon incentive globally at \$180 per ton.

There are also several other bills in Congress with provisions that would establish competitive DAC prizes, ensure cross-agency coordination on carbon removal, and much more.

Explore today's federal support for DAC with the [Carbon Removal Policy Tracker](#).