U.S. unveils plans for large facilities to capture carbon directly from air

$1.2 billion program marks a global first for a controversial strategy for fighting climate change

Climeworks, which operates this Orca carbon capture and storage plant in Hellisheidi, Iceland, was selected as a team member for a new facility in Louisiana that will be capable of capturing 1 million tons of carbon dioxide annually. ARNALDUR HALLDORSSON/BLOOMBERG VIA GETTY IMAGES

The U.S. Department of Energy (DOE) today announced it will spend $1.2 billion for two pioneering facilities—one in Texas, the other in Louisiana—that will remove millions of tons of carbon dioxide (CO_2) annually from the atmosphere using a technology known as direct air capture (DAC). Part of a controversial effort to combat global warming, the awards represent the first phase of $3.5 billion in funding for DAC hubs set aside in last year's Bipartisan Infrastructure Law and mark the first major governmental backing in the world for the emerging carbon capture technology.

The program aims to create four DAC hubs over the next 10 years, each capable of removing and storing at least 1 million tons of CO2 each year. As part of the program's rollout, DOE officials also announced funding for an additional 19 conceptual and engineering studies of potential future DAC plants.

"This is a bold investment in a technology we think will be needed down the road," says Sally Benson, a geochemist at Stanford University.

But critics of the strategy are plentiful as well. Benson's Stanford colleague Mark Jacobson, an atmospheric scientist, calls the program "a boondoggle" and "a complete waste of money." He argues that because DAC requires so much energy to capture CO2, purify it, and pump it underground for permanent storage, it is one of the most expensive and inefficient ways to sequester carbon. A better climate strategy, Jacobson says, would be to simply spend the money on building out renewable energy faster, so that coal and natural gas electricity plants can be retired more quickly.

But DAC proponents counter that even though the world is spending more than $1 trillion a year on clean energy technologies, that won't be enough for countries to meet their carbon reduction goals. According to the Intergovernmental Panel on Climate Change, DAC and other so-called negative emissions technologies will need to sequester some 1 billion tons (or 1 gigaton, GT) of carbon every year by 2030 for countries to have a shot at limiting climate warming to the target 1.5°C rise above preindustrial levels. By 2050, the annual figure could reach as high as 20 GT.

Currently, human activity pumps some 38 GT of CO2 into the atmosphere annually. "We need an enormous amount of carbon removal," says Julio Friedmann, chief scientist at Carbon Direct, a company that aims to help other companies and organizations reduce their climate impacts. "We can't achieve our targets without it."

Much of that carbon removal will undoubtedly come from managing natural systems, such as forests and agricultural lands, so that they absorb more carbon, an option widely considered among the most affordable. But limits on land availability and growth rates of natural systems constrain how much carbon they can store. “DAC is a backstop technology,” Friedmann says.

Katie Lebling, a carbon removal expert at the World Resources Institute, adds that compared with natural carbon removal strategies, DAC plants require little land, make it easy to measure how much CO2 is captured, and are more likely to sequester carbon permanently.

To date, 130 DAC plants are under development worldwide, with 27 commissioned and 18 completed, according to the International Energy Agency. All of these are small-scale facilities, with a current collective CO2 removal capacity of about 11,000 tons annually.

Fans at Iceland’s Orca plant are powered by local geothermal power. ARNALDUR HALLDORSSON/ BLOOMBERG VIA GETTY IMAGES

The two newly announced plants are on a different scale entirely. The Texas plant, which will be built by Occidental Petroleum, will use a technology developed by the company Carbon Engineering that uses solar energy to power fans that push air past liquid sorbents. These fluids soak up CO2 and are later heated to release concentrated CO2 and free the sorbents for more removal. The concentrated CO2 can then either be used commercially to make concrete or other products or pumped underground for permanent storage. Vicki Hollub, Occidental Petroleum's president, says the plant will initially be able to capture and sequester 1 million tons of CO2 per year, which should eventually rise to 30 million tons annually.

The Louisiana plant will store another 1 million tons of carbon annually. Operated by Battelle, the plant will apply technology from two other companies, Climeworks and Heirloom, that uses solid sorbents to capture CO2 and later release it and pump it underground. Both versions of the technology have been tested in pilot plants and are considered "mature," Benson says. But the scale up should reveal opportunities for new cost savings. "The hubs are going to help us prove out this potential game changing technology," said DOE Secretary Jennifer Granholm at a press conference announcing the new facilities.

Friedmann and other carbon capture proponents acknowledge that the cost of DAC is currently high. Though prices range considerably, most estimates suggest the approach currently costs "north of $1000 per ton" of CO2 removed, says Sean McCoy, a carbon life cycle expert at the University of Calgary. DOE's Carbon Shot program, which aims to reduce the cost of all forms of carbon capture, has set a goal for the price of carbon sequestration to drop to $100 per ton within 10 years.

To get to that mark, Friedmann says, DOE's current $3.5 billion investment in DAC hubs is exactly what is needed to begin scaling up the technology from the R&D stage to eventual full commercial deployment. "This is what drives you down the cost curve," he says. He adds that it helps that last year Congress upped a U.S tax credit, called 45Q, to $180 per ton of CO2 sequestered underground, providing an incentive for companies to

use the technology. Canada, the European Commission, and the United Kingdom also have recently announced financial incentives for DAC and other carbon storage options.

But although scaling up technologies has dropped prices for everything from flat screen TVs to solar panels, Robert Howarth, a biogeochemist at Cornell University, says he doubts the same will apply to DAC plants. The low concentration of CO2 in air makes the physics difficult, he says. “I’m skeptical that direct air capture is really going to take us anywhere,” he says.

However, McCoy argues that money spent on DAC now could still pay off in the future. “It’s clear that removing carbon after the fact is a whole lot more expensive than mitigating it today. But we need to understand if there is a learning curve here.” If so, he adds, now is the time to get it started.