



Overview

The U.S. Department of Energy's (DOE's) [Office of Fossil Energy and Carbon Management](#) (FECM) is advancing a suite of carbon dioxide removal approaches to help the nation achieve net-zero greenhouse gas emissions by 2050 and support an equitable, decarbonized energy system of the future.

Advancing the carbon dioxide removal industry will help spur innovation and position the United States as a leader in the research and manufacturing of technologies that will be important in the global economy of the 21st century.

Carbon dioxide removal is needed to counterbalance emissions associated with the hardest-to-decarbonize sectors (e.g., agriculture, aviation, and shipping) to achieve our net-zero goals, and will ultimately remove legacy carbon dioxide (CO₂) emissions from the atmosphere.

It will also help to create hundreds of thousands of quality rural and industrial jobs across the nation.

Note: Nearly all climate model scenarios in the latest [United Nations Intergovernmental Panel on Climate Change report](#) that meet the [Paris Agreement climate goals](#) indicate the need for carbon dioxide removal.

Defining Carbon Dioxide Removal

Carbon dioxide removal encompasses a wide array of approaches that capture CO₂ emissions that are already in the atmosphere. The CO₂ can then be stored in geological, biobased, and ocean reservoirs or in value-added products. For example, it can be stored deep underground, in low-carbon concrete, oceans, and natural sinks such as forests, soils, and wetlands to create negative emissions (i.e., when more carbon is removed from the atmosphere than is generated).

While carbon dioxide removal can share some technology overlap with more conventional carbon capture technologies for stationary emissions sources, such as carbon capture and storage, it is important to understand the distinction between the two approaches.



Carbon capture and storage captures CO₂ at the source of emissions (e.g., from a cement plant or a natural gas fired power plant) to reduce the amount of CO₂ emissions that are entering the atmosphere. On the other hand, carbon dioxide removal addresses CO₂ emissions that are already in the atmosphere.

Some examples of carbon dioxide removal include the following:

- **Direct Air Capture with Storage** – Removing CO₂ directly from the atmosphere, using scrubbers and chemical processes, and storage underground or in products.
- **Soil Carbon Sequestration** – Improving practices and crops that increase the amount of carbon stored in soils.
- **Biomass Carbon Removal and Storage** – Using plants and algae to remove CO₂ from the atmosphere and storing it underground or in long-lived products.
- **Enhanced Mineralization** – Removing CO₂ through reaction with alkaline materials such as calcium- or magnesium-rich crushed rocks spread over the ground.
- **Ocean-Based Carbon Dioxide Removal** – Pulling CO₂ from the atmosphere and transporting the carbon into the deep ocean and marine sediments.
- **Afforestation/Reforestation** – Storing CO₂ in newly grown or regrown forests.

Research and Development

At the 2021 United Nations Climate Change Conference, DOE launched the [Carbon Negative Shot](#) initiative.

Carbon Negative Shot is an all-hands-on-deck call for innovation in carbon dioxide removal pathways that will capture CO₂ from the atmosphere and store it at gigaton scales for less than \$100/net metric ton of CO₂-equivalent.

To put this into perspective, one gigaton of CO₂ is equivalent to approximately one fifth of the United States' annual CO₂ emissions in 2022.

As a part of this initiative, DOE announced initial funding opportunities for four Bipartisan Infrastructure Law programs that will help build a commercially viable, and responsible carbon dioxide removal industry in the United States. For example, DOE's Office of Clean Energy Demonstrations, in partnership with FECM, will invest \$3.5 billion to [develop four regional direct air capture hubs](#). Each of these hubs will have the potential for capturing at least one million metric tons of CO₂ annually from the atmosphere and storing that CO₂ permanently in a geologic formation or through its conversion to long-lived products.

These efforts also contribute to the United States' commitment to the Carbon Dioxide Removal Launchpad, a coalition of countries that has committed to leveraging collective resources and best practices to accelerate innovation and cost reductions across a portfolio of carbon dioxide removal technologies. The Carbon Dioxide Removal Launchpad members which include Canada, the European Commission, Iceland, Japan, Norway, and the United Kingdom, each agreed to build at least one 1,000+ ton/year carbon dioxide removal project by 2025, contribute to cumulative investment of \$100 million collectively by 2025 to support demonstration projects and efforts to advance robust measurement, reporting, and verification.

DOE is also seeking to expand carbon storage demonstration and is leading an interagency carbon dioxide removal task force pursuing the advancement of many of the approaches mentioned above, including direct air capture with durable storage.

Since January 2021, the U.S. Department of Energy estimates an investment of approximately \$53 million in 24 research and development projects and front-end engineering design studies to advance carbon dioxide removal pathways.

Societal Considerations and Impacts in Carbon Dioxide Removal

The projects that build the clean energy economy will create infrastructure that can drive new regional economic development, technological innovation, and high-wage employment for communities across the United States.

As we advance these efforts, it is critical to understand and address the societal considerations and impacts of these projects at local, regional, and global levels. To that end, projects funded by FECM will develop the following plans to ensure that they provide tangible economic and environmental benefits to affected communities:

- Community, Tribal, and Stakeholder Engagement
- Diversity, Equity, Inclusion, and Accessibility
- Environmental Justice
- Quality Jobs

[Learn more about each of these project plan areas.](#)

To keep up to date with carbon dioxide removal updates and funding opportunity announcements, [visit FECM's website](#) and [sign up for news alerts](#).