



## Overview

To tackle the world's climate crisis and achieve net-zero emissions by 2050, we need a dual strategy: we must significantly reduce the emissions going into the atmosphere and permanently remove carbon dioxide (CO<sub>2</sub>) from the atmosphere.

**Carbon dioxide removal (CDR)** is a key part of this strategy. In fact, nearly all climate model scenarios that achieve international climate goals indicate the need for a near-term focus on CDR development and deployment.

CDR encompasses a wide array of approaches that capture the CO<sub>2</sub> that has accumulated in the atmosphere and then store it in geological, biobased and ocean reservoirs or value-added products like low-carbon concrete. CDR is distinct from point-source carbon capture from the fossil power sector and heavy-duty industry. CDR approaches can address emissions from the hardest to decarbonize sectors (e.g., agriculture, aviation and shipping) and eventually remove legacy CO<sub>2</sub> emissions from the atmosphere.

## CDR's Role in the Climate Crisis

To keep global warming below international targets, gigatons of atmospheric CO<sub>2</sub> must be removed every year by mid-century, alongside aggressive decarbonization. To put this task into perspective, one gigaton of CO<sub>2</sub> is equivalent to the annual emissions from the U.S. light-duty vehicle fleet. This is equal to approximately 250 million vehicles driven in one year.



Advancing the emerging CDR industry will help spur innovation and position the United States as a leader in research, manufacturing and demonstration. It will also support the deployment of approaches that transform existing industries, like agriculture and forestry, to enable reliable carbon removal strategies.

## Justice Considerations in CDR

The nascent nature of CDR provides an opportunity to integrate equity and justice considerations throughout the development of this new industry.

As the United States pursues CDR research, development, demonstration and deployment, we must understand the resources required for CDR and prioritize investments that make meaningful progress on achieving net-zero emissions while supporting place-based solutions tuned to specific community needs. We must also operate in a justice-based framework to ensure an equitable industry and advancements that benefit vulnerable climate populations locally

and globally. This framework will include a focus on the following areas:

- **Measurement of CDR investments** against robust environmental justice criteria to avoid harm and provide equitably distributed benefits.
- **Early, frequent and meaningful engagement** with communities that could participate in or be affected by CDR, such as environmental and climate justice organizations, tribal nations, labor groups, industry and academia.
- **A whole-of-government approach** that seeks alignment in federal, state and local areas.
- **Engagement with global partners** to facilitate the use of CDR as a tool to address global climate justice.

## Research and Development

The U.S. Department of Energy (DOE) is already investing in several CDR pathways. DOE is also seeking to expand carbon storage demonstration and is leading an interagency CDR task force pursuing the advancement of many CDR approaches, including:

- **Direct Air Capture with Storage** – removal of CO<sub>2</sub> directly out of the atmosphere, using scrubbers and chemical processes, and storage underground or in products.

- **Soil Carbon Sequestration** – practices and crops that increase the amount of carbon stored in soils.
- **Biomass Carbon Removal and Storage** – processes that use plants and algae to remove CO<sub>2</sub> from the atmosphere and store it underground or in long-lived products.
- **Enhanced Mineralization** – removal of CO<sub>2</sub> through reaction with alkaline materials such as crushed rocks spread over the ground.
- **Ocean-Based CDR** – amplification of the ocean's biological and abiotic carbon pumps, which pull CO<sub>2</sub> from the atmosphere and transport the carbon into the deep ocean and marine sediments.
- **Afforestation/Reforestation** – storage of CO<sub>2</sub> in newly grown or regrown forests.

In advancing any given approach to CDR, we will need to examine how much climate-warming pollution is removed and whether net-negative emissions are achieved by applying rigorous analytical approaches, such as life cycle assessment. This array of options allows for diverse place-based approaches, enabling CDR technology deployment in many different localities that will be uniquely targeted to each setting and its community.