

U.S. Department of Energy's Carbon Negative Shot – An Introduction

Overview

The U.S. Department of Energy's (DOE's) [Energy Earthshots Initiative](#) aims to accelerate breakthroughs of more abundant, affordable and reliable clean energy and climate solutions within the decade.

Achieving the Energy Earthshots will help America tackle the toughest remaining barriers to addressing the climate crisis and reach the U.S. Government's goal of net-zero carbon emissions by 2050 while creating good-paying jobs and growing the economy.

Summary

Carbon dioxide removal (CDR) has a critical role in helping the United States address the climate crisis and achieve net-zero emissions by 2050. CDR refers to approaches that capture carbon dioxide (CO₂) directly from the atmosphere and durably store it in geological, biobased and ocean reservoirs or in value-added products to create negative emissions. To reach our global climate goals, gigatons of atmospheric CO₂ must be removed every year by mid-century, alongside aggressive decarbonization.

To advance the development of this emerging and necessary industry, DOE launched **Carbon Negative Shot**—the U.S. Government's first major effort in CDR.

Carbon Negative Shot is the all-hands-on-deck call for innovation in technologies and approaches that will remove CO₂ from the atmosphere and durably store it at meaningful scales for **less than \$100/net metric ton of CO₂-equivalent (CO₂e)**. This effort is being deployed to achieve a net-zero carbon economy and eventually remove legacy carbon pollution to help address the climate crisis, with a dedicated focus on doing so in a just and sustainable manner.

Four performance elements will define the technologies DOE will advance through this initiative:

1. Less than **\$100/net metric ton CO₂e** for both capture and storage.
2. Robust **accounting of full lifecycle emissions** (i.e., ensures emissions created when running and building the removal technology are accounted for).
3. **High-quality, durable storage** with costs demonstrated for monitoring, reporting and verification for at least 100 years.
4. Enables necessary **gigaton-scale removal**. To put this into perspective, one gigaton of CO₂ 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.

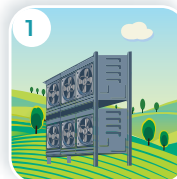
CDR Pathways

CDR is a wide array of approaches that capture and durably store the CO₂ that is already in the atmosphere. CDR can address emissions from the hardest to decarbonize sectors (e.g., agriculture, aviation and shipping) and eventually remove legacy CO₂ emissions from the atmosphere.

Carbon Negative Shot requires that multiple CDR approaches be enabled at scale to address place-based requirements and support the U.S. Government in meeting its net-zero emissions goal by 2050.

A few of these approaches include, but are not limited to, the following:

1. Direct Air Capture with Durable Storage
2. Soil Carbon Sequestration
3. Biomass Carbon Removal and Storage
4. Enhanced Mineralization
5. Ocean-Based CDR
6. Afforestation/Reforestation



CDR is distinct from point-source carbon capture and storage (CCS) for fossil fuel power plants and heavy industry.

Impact

To achieve climate goals, the nascent carbon removal industry must reach a scale similar in size to the global steel industry in terms of tons of material handled. The deployment of new approaches will also transform existing industries, like agriculture and forestry. Achieving the Carbon Negative Shot target will help spur innovation and position U.S. enterprises as leaders in research, manufacturing and deployment in a CDR industry that must have rapid, global ramp-up by mid-century.

It will also position America to lead the way to net-zero on a global scale, eventually remove legacy greenhouse gas emissions from the atmosphere, create good-paying job opportunities that build on the skillsets of the fossil fuel workforce and ensure that climate justice and environmental protection for local communities remain a priority.

Stakeholder Engagement

In alignment with the U.S. Government's numerous efforts around equity, justice and communities, Carbon Negative Shot will center justice and equity and support a CDR industry that accounts for diverse place requirements. As a driver for this necessary and emerging industry, Carbon Negative Shot prioritizes information sharing and engagement with communities that could participate in or be affected by CDR, including environmental and climate justice organizations, tribal nations, labor groups, industry and academia. Carbon Negative Shot also supports a whole-of-government approach and seeks alignment in federal, state and local areas.

Alignment of Resources

CDR is a crosscutting research, development and demonstration area for DOE. The Offices of Fossil Energy and Carbon Management, Energy Efficiency and Renewable Energy, Science and the Advanced-Projects Research Agency-Energy have existing efforts in CDR that contribute to Carbon Negative Shot.

Achieving Net-Zero by 2050 Calls for Multiple Strategies

In addition to Carbon Negative Shot, which focuses on *CO₂ removal* strategies, DOE is investing in the following approaches to help achieve the nation's net-zero goals:

- *CO₂-avoidance* technologies and practices, such as renewable energy, energy efficiency and land use conservation.
- *CO₂-reduction* technologies and practices, such as point-source CCS for power plants and industry.

The Carbon Negative Shot target is durable and scalable CO₂ removal under \$100/net metric ton CO₂e within a decade.



<100 Dollars



1 Ton



1 Decade