The U.S. can help lead on understanding the potential for ocean-based carbon dioxide removal

The ocean covers 70% of the earth's surface and holds 42 times more carbon than the atmosphere. Proposed ocean carbon dioxide removal (CDR) approaches seek to leverage this space and demonstrated capacity to safely remove and store more carbon dioxide (CO_2). These methods can help diversify the range of carbon removal approaches the U.S. will rely on in the future and increase the total amount of CO_2 removed.

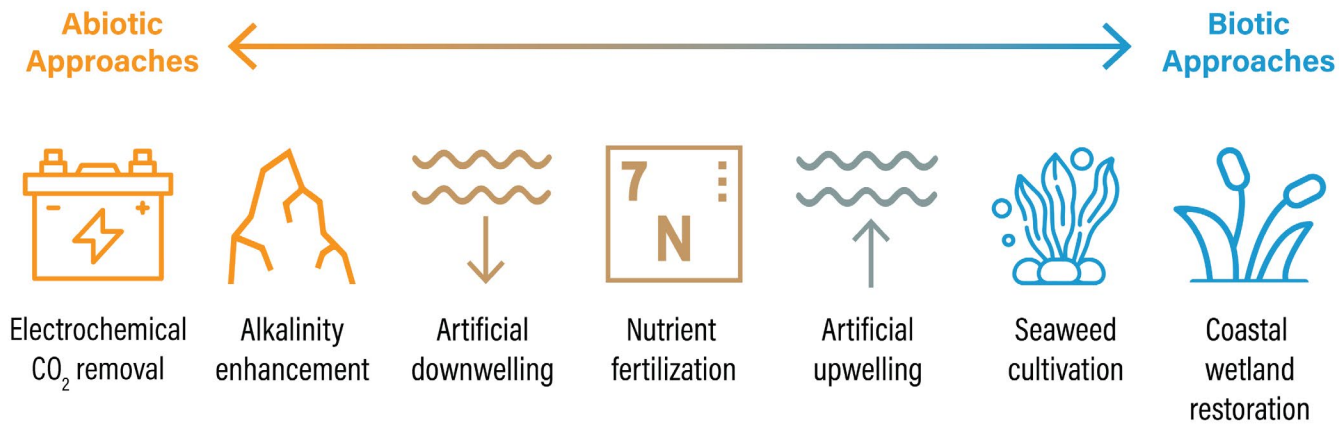
Ocean CDR approaches could potentially remove up to billions of tons of CO_2 per year. But this potential is paired with uncertainty. We need to better understand how effective ocean CDR approaches are at removing carbon and storing it over time and what impacts they could have on people and the environment. More federal funding is needed for research and at-sea testing to resolve these uncertainties and determine which approaches may be appropriate for larger-scale deployment.

TYPES OF OCEAN-BASED CARBON DIOXIDE REMOVAL

Just as on land, there is a range of ways the ocean could be used to increase carbon removal. Ocean CDR approaches can be grouped into two general categories: those that leverage biological ("biotic") processes and those that leverage chemical ("abiotic") processes.

One example of a biological approach involves intentionally cultivating and sinking seaweed to remove carbon. Seaweed takes up dissolved carbon dioxide from surface waters as it grows and transforms that CO_2 into its carbon tissues. That embodied carbon is sequestered when the seaweed is sunk. The seawater depleted of CO_2 then re-equilibrates with the atmosphere by taking up some of its carbon dioxide, resulting in atmospheric carbon removal.

General types of ocean CDR approaches



Source: WRI based on taxonomy in NASEM 2021.

One type of abiotic process is ocean alkalinity enhancement. This involves adding ground-up alkaline rock to seawater, where it reacts with dissolved CO_2 to form solids that lock away carbon. As with seaweed cultivation, ocean alkalinity enhancement seeks to reduce the amount of dissolved CO_2 in surface waters so that they can remove more CO_2 from the air.

These and other ocean CDR approaches are generally in the early stages of research and development. Like other climate mitigation strategies, each ocean CDR approach involves different potential risks to the environment and neighboring communities as well as potential benefits. These must be better understood in order to make sound decisions around deployment.

U.S. GOVERNMENT ACTION ON OCEAN CDR TO DATE

Federal funding for land-based CDR approaches has increased dramatically in the past several years through the direct air capture (DAC) hubs program, expansion of the 45Q tax credit and many other efforts. By contrast, there has been comparatively little funding for ocean CDR. Given the growing interest and private sector activity in this topic, there is an opportunity and need for greater federal funding to help resolve uncertainties in the field. More research funding can help determine which approaches are appropriate for scale up and establish U.S. leadership in ocean CDR technology and innovation.

Government agencies and Congress have already taken several important steps in this direction, including on research strategy:

- In 2021, the National Academies of Science, Engineering, and Medicine released a landmark report on ocean carbon dioxide removal outlining the state of knowledge across approaches and recommending more than $1 billion in federal funding to be invested over 10 years to address knowledge gaps.
- In 2023, the National Oceanographic and Atmospheric Administration (NOAA) outlined its research strategy to help assess the efficacy and risks of different approaches.
- Also in 2023, the White House released its Ocean Climate Action Plan. This put forth a whole-of-government approach to ocean CDR, including building a sufficient knowledge base around efficacy and tradeoffs and developing a robust regulatory framework.
- In late 2023, a Fast-Track Action Committee on Marine Carbon Dioxide Removal was created with members from more than a dozen agencies to evaluate the tradeoffs of different types of marine CDR to help shape policy and research decisions.

A few agencies have begun to fund ocean CDR research:

- In 2023, the National Oceanic Partnership Program provided $24 million for 17 project teams working on ocean CDR research.
- The Department of Energy will direct $10 million in 2024 for research and development of biological ocean CDR, $250,000 for clarifying regulatory processes and $20 million to continue a CDR purchase pilot prize. This pilot prize is the first government initiative to directly purchase CDR credits, and ocean CDR is eligible.
- DOE's ARPA-E has also funded work on macroalgal cultivation since 2017 (though with a focus on utilization rather than removal).

Finally, Congress has introduced, but not yet passed, several bills that would broadly support the scale-up of carbon dioxide removal approaches, including ocean CDR:

- The Carbon Dioxide Removal Research and Development Act of 2023 lays out a comprehensive, 10-year research and development agenda for CDR, including more than $1 billion over 10 years specifically for ocean CDR.
- The bipartisan CREST Act of 2023 and the Federal Carbon Dioxide Removal Leadership Act of 2024 both aim to increase government procurement of CDR from various approaches.
- The bipartisan CREATE Act would set up inter-agency working groups to support CDR research and development across agencies.

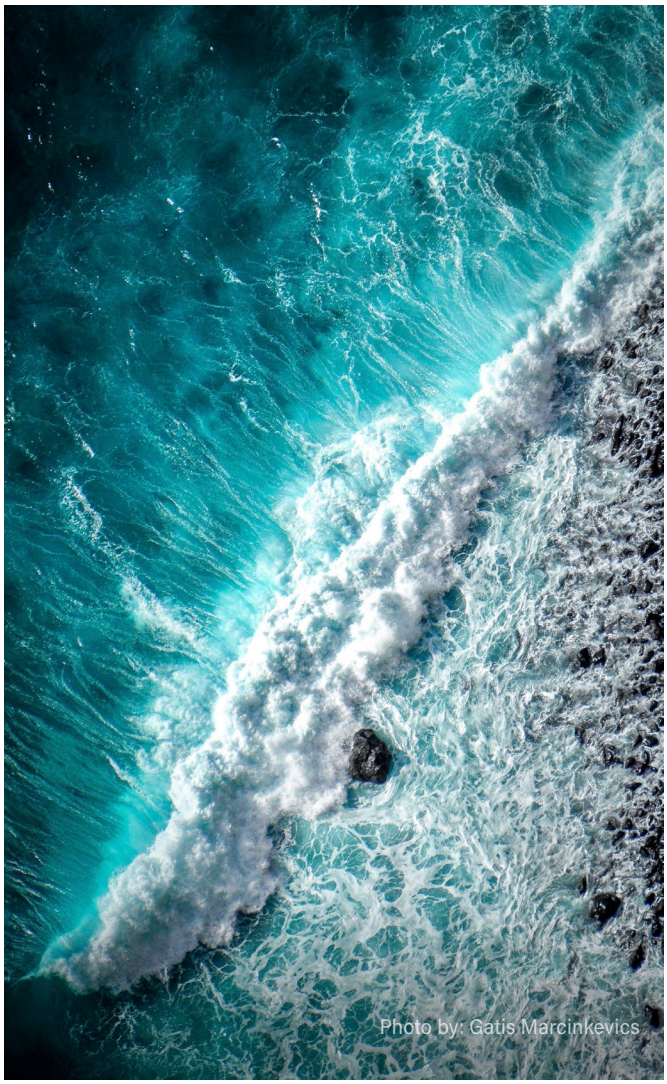


Photo by: Gatis Marcinkevics

Actors Outside of the Government are also Taking Steps to Advance Ocean CDR

Some U.S.-based companies are already beginning development, including at sea, of their ocean CDR approaches and technologies:

- Running Tide combines biomass sinking and ocean alkalinity enhancement.
- Captura, Ebb Carbon and Equatic use electricity to strip CO_2 out of the water directly or to create alkalinity, which is then added to seawater to indirectly remove carbon.
- Vesta applies alkaline material to coastlines for ocean alkalinity enhancement.

Companies like Shopify and Microsoft as well as the coalition of companies that make up Frontier are purchasing tons of ocean-based carbon removal to support the industry and help meet their climate commitments. Frontier has committed to purchasing $1 billion of durable carbon removal by 2030 and is already purchasing from several ocean CDR companies.

Nonprofits are also working to address the knowledge and research gaps associated with ocean CDR:

- Carbon to Sea Initiative is evaluating ocean alkalinity enhancement.
- Ocean Visions has compiled a database of known at-sea trials for ocean CDR among other resources.
- [C]Worthy is developing modeling and data resources to support ocean CDR.

NEXT STEPS FOR RESPONSIBLY DEVELOPING OCEAN CDR

Increased government funding will be key to safely developing ocean carbon removal by supporting research and testing to understand which approaches can be responsibly developed and deployed. Funding can come from either annual Congressional Appropriations or through standalone laws that guide research and testing.

Just as federal funding for CDR approaches on land went from almost nothing five years ago to billions today, a similar increase for ocean CDR approaches can help ensure there is a solid foundation of scientific understanding from which to operate.

For more information, see WRI research:

- Report: Toward Responsible and Informed Ocean-Based Carbon Dioxide Removal: Research and Governance Priorities
- Article: Ocean-based Carbon Dioxide Removal: 6 Key Questions, Answered

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