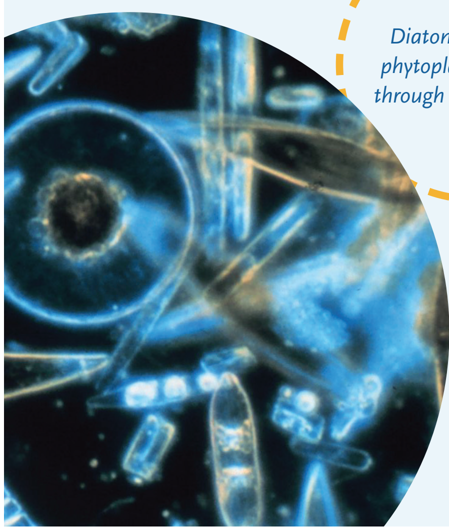
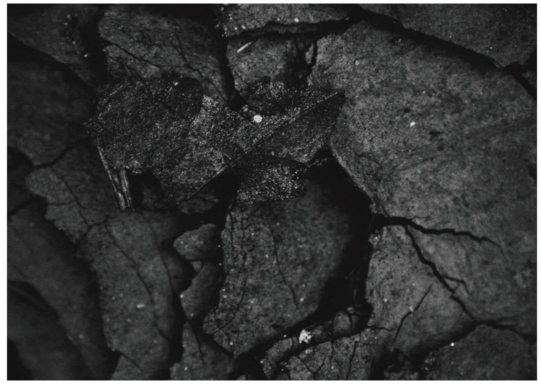
Ocean Fertilization

At the ocean's surface, tiny marine plants called phytoplankton take in carbon dioxide for photosynthesis. Phytoplankton are the base of the marine food web. When they die or are eaten by other organisms that die or release fecal material, carbon-rich matter sinks to the bottom of the ocean. Bacteria in the deep ocean consume most of this organic matter and rerelease CO_2 through respiration. As the ocean circulates, this carbon is eventually brought back to the surface and released, but this can take thousands of years. This process effectively takes carbon from the atmosphere and stores it deep in the ocean for a long time.

Scientists have proposed enhancing this process by "fertilizing" the ocean: adding nitrogen, phosphate, or iron to seawater to boost phytoplankton growth near the surface. Estimates are that global-scale iron fertilization of the oceans would remove less than 1 billion tons of carbon per year from the atmosphere. By comparison, in 2018, fossil fuel burning worldwide released over 10 billion tons of carbon into the atmosphere. As with any large-scale intervention in Earth's systems, iron fertilization may harm ecosystems. It could alter the marine food web, and lead to changes in nutrient supplies and oxygen levels.



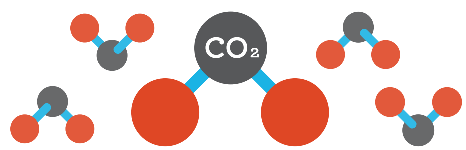
Diatoms (a type of phytoplankton) seen through a microscope.



Biochar is carbon-rich organic material that's been heated without oxygen.

Biochar

Biochar is a very stable, carbon-rich material made from burning plant wastes without oxygen. It is similar to charcoal, and people have used it in the Amazon basin to enrich soil for thousands of years. Making biochar from plant wastes and then adding this biochar to soil traps carbon that would normally be released to the atmosphere much more rapidly through decomposition. In this way, using biochar is a CDR technique. One estimate suggests that widespread use of biochar could remove two to four billion tons of CO_2 from the atmosphere by the year 2050.



For More Information

Project Drawdown: drawdown.org

Climate Intervention: Carbon Dioxide Removal and Reliable Sequestration (2015), National Academies Press

Greene et al., Geoengineering, marine microalgae, and climate stabilization in the 21st century (2017), Earth's Future

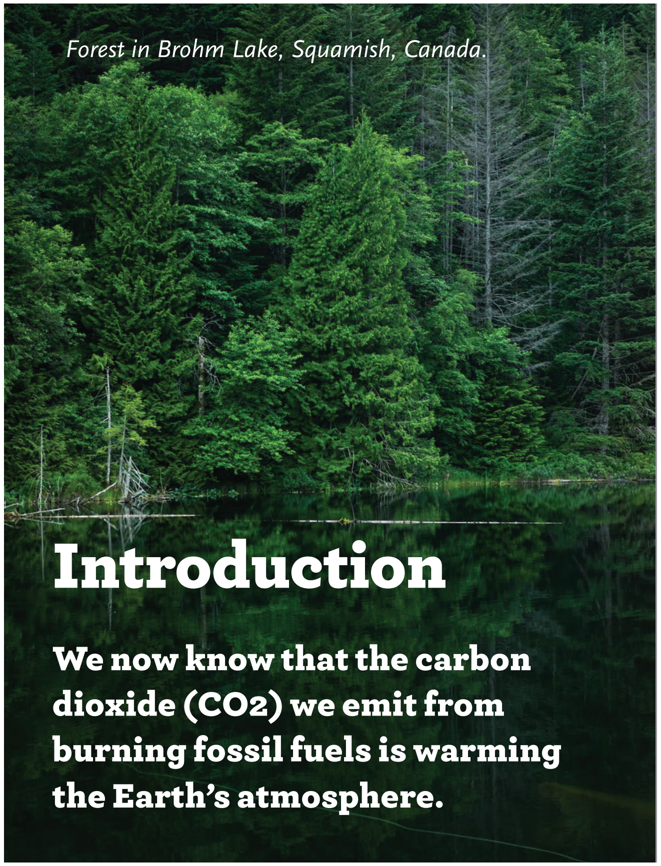
CHANGING CLIMATE

OUR FUTURE, OUR CHOICE

Carbon Dioxide Removal

MUSEUM OF THE EARTH

1259 Trumansburg Rd,
Ithaca, NY 14850
(607) 273-6623 priweb.org



Forest in Brohm Lake, Squamish, Canada.

Introduction

We now know that the carbon dioxide (CO_2) we emit from burning fossil fuels is warming the Earth's atmosphere.

While governments, communities, and individuals are working to reduce emissions of CO_2, these efforts may not be enough, and we may have to find ways to remove CO_2 from the atmosphere.

Carbon Dioxide Removal (CDR) is a type of geoengineering or climate intervention: a large-scale technological effort to change the Earth's climate.

Many scientists and policymakers are wary of CDR because they are concerned that climate intervention will be seen as an easy solution that allows us to go on with business as usual, releasing more and more carbon. CDR would be anything but easy, however, and could have tremendous financial and environmental cost. Intervening with Earth's climate systems also has great uncertainty at our current level of understanding, and could have harmful unintended consequences. This pamphlet provides a brief overview of several examples of CDR methods.

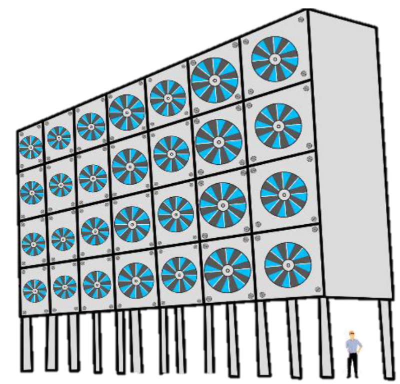
Land Sinks: Forests, Grasslands, & Soils

Plants take in carbon through photosynthesis, release some to the atmosphere through respiration, and some to the soil through their roots. They store the remainder—a tree's dry weight is almost half from carbon. Climate interventions involving trees include afforestation (planting trees where they did not previously grow), reforestation (restoring trees where they have been cut down), sustainable forest management, and reducing deforestation Tree planting efforts must be done thoughtfully in order to restore or preserve native ecosystems and provide healthy habitat. In addition, reducing food waste and increasing plants in our diets help prevent deforestation.

Land management practices can have a big impact on soil carbon storage. Human activity depletes soil carbon much faster than natural processes do; for example, most soils in the Midwest retain only 50 to 70% of the carbon they contained before large-scale farming began on the prairie. Tilling the soil exposes organic matter to the air, releasing carbon. Carbon is lost through wind erosion, leaching, and water runoff, processes that can be accelerated by agriculture. Crop and grazing land management and soil restoration projects can play a role in returning carbon to the soil.

Direct Air Capture

Direct Air Capture uses machinery to remove carbon dioxide directly from the air, pulling in air with fans and chemically absorbing CO_2 in a filter. The CO_2-depleted air is then released and the CO_2 is compressed for storage or use. Direct Air Capture technology is still under development and not operating at the large scales that would be needed to remove significant amounts of CO_2 from the atmosphere. It also potentially requires a lot of energy.



A DAC machine can be up to 300 ft tall!

Coastal wetlands in Massachusetts

Blue Carbon

Blue carbon is carbon stored in coastal ecosystems such as mangroves, salt marshes, and kelp forests.These ecosystems can hold three to five times more carbon than a terrestrial tropical forest of the same area can, and they can take in carbon almost ten times as fast.

Coastal ecosystems can also help protect coastal regions from storm damage, by breaking up wave action, filtering runoff, and absorbing stormwater. Examples in the U.S. are red mangroves in southern Florida, and the Staten Island Bluebelt, a network of streams, ponds, and wetlands in New York City. These Blue Carbon costal ecosystems are vital and need to be protected and supported.