

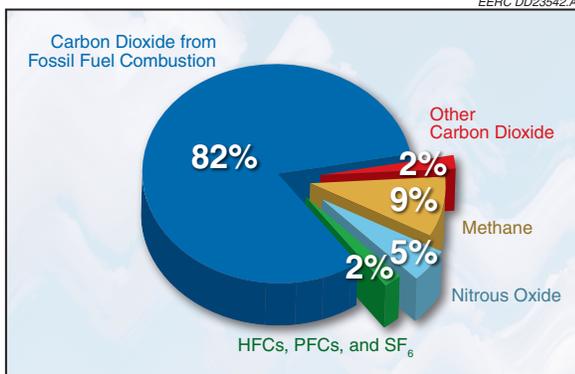
Carbon Dioxide (CO₂) Sequestration – Controlling CO₂ Emissions to the Atmosphere Through Capture and Long-Term Storage

What Is CO₂?

Carbon dioxide (CO₂) is a gas composed of one atom of carbon and two atoms of oxygen. CO₂ occurs naturally in the atmosphere, is essential to plant life and, as a greenhouse gas, helps create the greenhouse effect that keeps our planet livable.¹ CO₂ is exhaled by humans and is used to put the bubbles in soft drinks, as a coolant (dry ice), and in fire extinguishers.

Why Consider Carbon Management?

Greenhouse gases, including CO₂, trap a portion of the sun's energy in the Earth's atmosphere and make our planet warm enough to support life. Human (anthropogenic) activity, including the use of fossil fuel, generates a significant volume of greenhouse gases like CO₂. There is concern that the anthropogenic greenhouse gases entering the atmosphere are causing increased warming and that this warming will affect climate on a global scale. CO₂ sequestration—the capture and long-term storage of CO₂—is one of several actions that would help to control anthropogenic CO₂ emissions to the atmosphere.



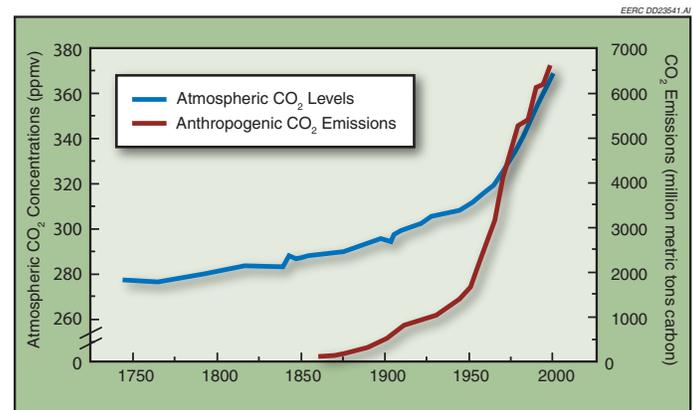
The diagram shows the contribution to global warming potential by gas type for the anthropogenic greenhouse gases emitted by the United States in 2001. Although a relatively weak greenhouse gas, CO₂ is emitted in such large quantities that it constitutes 84% of the global warming potential of the emissions.

What Is CO₂ Sequestration?

Sequestration is the capture and long-term storage of CO₂ either before or after it has entered the atmosphere. Sequestration is one of several actions aimed at controlling the release of anthropogenic CO₂. There are two types of sequestration: direct and indirect.³

Direct CO₂ Sequestration

Direct sequestration involves capturing CO₂ at a source before it can be emitted to the atmosphere.³⁻⁵ The most efficient concept would use specialized equipment to capture CO₂ at large stationary sources like factories or power plants and then inject the CO₂ into secure storage zones deep underground (geologic sequestration) or into the deep ocean.



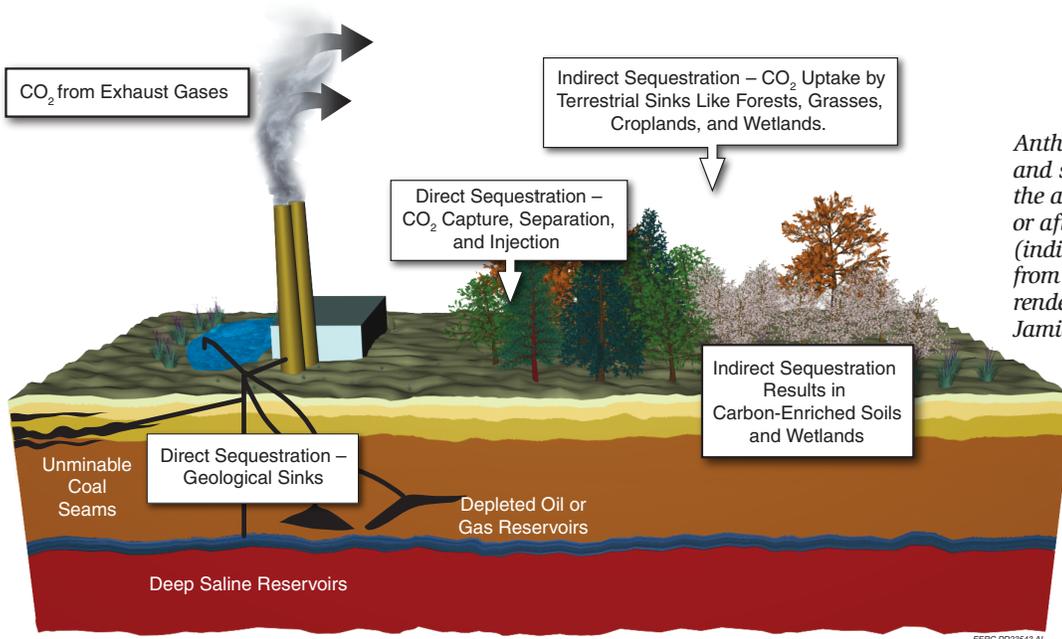
Since the beginning of large-scale industrialization about 150 years ago, the level of CO₂ in the atmosphere increased by about 25%.^{1,2}

Indirect CO₂ Sequestration

Indirect or terrestrial sequestration involves removing CO₂ from the atmosphere.^{3,5,6} Indirect sequestration uses land management practices that boost the ability of natural CO₂ sinks like plants and soils to remove carbon as CO₂ from the atmosphere, regardless of its source. Opportunities for indirect sequestration can be found in forests, grasslands, wetlands, and croplands.

What Is the Status of Direct Sequestration?

The injection and control of CO₂ in underground formations has been done safely for more than 30 years by oil companies.⁷ Issues currently being addressed for direct CO₂ sequestration include developing CO₂ capture systems, determining the best underground storage sites for long-term storage of CO₂, determining the best way to monitor sites to guard against CO₂ migration, and determining a workable regulatory framework for sequestration projects.



Anthropogenic CO₂ can be captured and sent to storage before it enters the atmosphere (direct sequestration) or after it has entered the atmosphere (indirect sequestration) (modified from Oak Ridge National Laboratory rendering by LeJean Hardin and Jamie Payne, 2000).

Direct Sequestration Projects in the Great Plains Region

The Weyburn oil field in Saskatchewan is currently the site of active CO₂ flooding to improve oil production.⁸ Weyburn is also the site of a major international effort, coordinated by the Petroleum Technology Research Centre, located in Regina, Saskatchewan, to assess geologic sequestration practices.⁹ Thus far, studies have demonstrated the site to be safe and secure for sequestration, and it is expected that more than 20 million metric tons of CO₂ will be successfully sequestered there by 2025.⁸⁻¹⁰

What Is the Status of Indirect Sequestration?

Land use practices can cause soils to trap carbon (sinks) or release carbon (sources). Agricultural practices like no-till and low-till keep more carbon in the soil than conventional practices. Current research activities in the Great Plains include determining the amount of CO₂ that can be taken up in different settings like forests, grasslands, croplands, or wetlands; developing monitoring practices to determine the amount of carbon staying in place; and determining optimal land management practices for carbon storage in different ecoregions and settings.^{11,12}

What Is the Role of the PCOR Partnership?

The Plains CO₂ Reduction Partnership is currently characterizing CO₂ sources and sequestration opportunities in the Great Plains region. This includes cataloging CO₂

sources, identifying sequestration opportunities, assessing monitoring technologies, and assessing regulatory needs for successful sequestration projects in the region. The PCOR Partnership is one of seven partnerships funded by the U.S. Department of Energy's National Energy Technology Laboratory that are working to complete this activity for much of North America by the fall of 2005.

References and Notes

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The Plains CO₂ Reduction (PCOR) Partnership is a group of public and private sector stakeholders working together to better understand the technical and economic feasibility of sequestering CO₂ emissions from stationary sources in the central interior of North America. The PCOR Partnership is managed by the Energy & Environmental Research Center (EERC) at the University of North Dakota and is one of seven regional partnerships under the U.S. Department of Energy's National Energy Technology Laboratory Regional Carbon Sequestration Partnership Program. To learn more, contact:

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Visit the PCOR Partnership Web site at www.undeerc.org/PCOR. New members are welcome.

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