CO_2–enhanced oil recovery with CCS: the basics

GLOBAL CCS INSTITUTE
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NOTE: This document is provided for information only. The viability and appropriateness of deploying CO_2-EOR with CCS depend heavily on location-specific physical characteristics, operational requirements, infrastructure availability, and policy and regulatory considerations. In some parts of the world, CO_2-EOR with CCS has helped to jump-start carbon management activities, while in other parts, it receives limited consideration for carbon management.

Traditional carbon dioxide enhanced oil recovery (CO_2-EOR) operations have been successfully ongoing for more than 50 years using both anthropogenic and naturally sourced CO_2. A variation on this approach, CO_2-EOR with carbon capture and storage (CO_2-EOR with CCS), is now being recognised as part of a comprehensive carbon management strategy in some parts of the world. When properly managed, this process can create commercial value that supports the development of broader capture, transport, and storage networks.

What is CO_2-EOR with CCS?

CO_2-EOR with CCS uses CO_2 captured from sources such as industrial facilities and power plants and transports it to mature oil fields for injection to recover additional oil. The CO_2 produced with the oil is separated and reinjected. Robust monitoring and accounting verify permanent CO_2 storage. Unlike traditional CO_2-EOR, it specifically accounts for stored CO_2, and unlike dedicated geologic storage, it produces oil.

How does CO_2-EOR work?

CO_2 is injected into underground rock layers (reservoirs) and moves through tiny pore spaces between the rock grains. A portion of the CO_2 dissolves into the oil and formation fluids, reducing the oil's viscosity (thickness), so it flows more easily toward production wells. Some of the CO_2 remains as a separate phase and becomes trapped in the pore spaces as disconnected droplets, a permanent storage mechanism known as residual trapping. The CO_2 that is dissolved in the oil travels up the wellbore to a surface facility, where it is separated from the oil, treated, and reinjected into the reservoir.

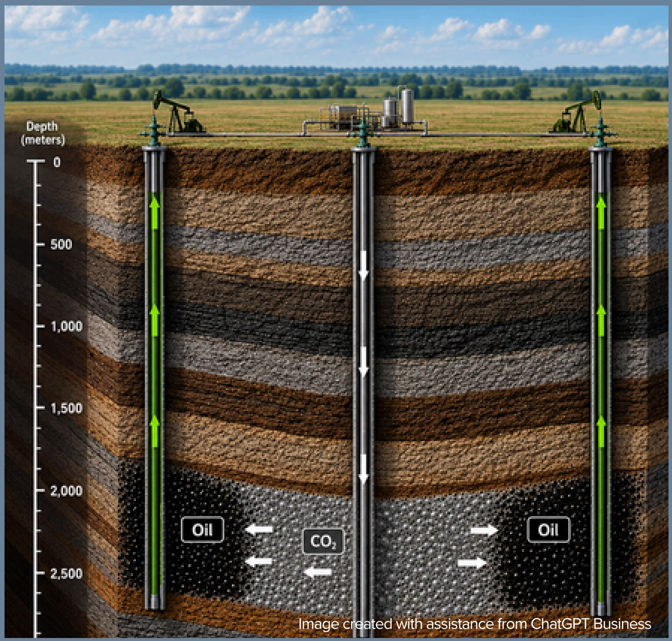


Figure 1. Cross-section of a CO_2-EOR with CCS operation, depicting CO_2 injection into a deep rock formation to mobilise oil towards production wells

Figure 2. Microscopic conceptualisation of CO_2 moving through rock pore spaces, dissolving into the oil, and reducing its viscosity to enable recovery

How do the three approaches differ?

Traditional CO_2-EOR, CO_2-EOR with CCS, and dedicated CO_2 storage all involve injecting CO_2 underground. They differ in their purpose, storage priorities, and how CO_2 storage is measured, accounted, and reported. While traditional CO_2-EOR focuses on maximising oil extraction, CO_2-EOR with CCS uses rigorous monitoring, reporting, and verification (MRV) to quantify permanent underground CO_2 storage alongside production, reducing carbon intensity in some fields compared to traditional CO_2-EOR.

Table 1. Comparison of the three approaches

Key feature	Traditional CO_2–EOR	CO_2–EOR with CCS	Dedicated CO_2 storage
Primary objective	Maximise oil production from mature fields using CO_2	Increase oil production while assuring and quantifying permanent CO_2 storage	Permanently store CO_2
CO_2 source	Historically naturally produced CO_2 in some regions. Captured CO_2 increasingly used	Captured CO_2	Captured CO_2
Storage priority	Optimise oil recovery. CO_2 storage occurs but is not the primary objective or formally quantified as storage	Optimise oil recovery while explicitly assuring, quantifying and documenting long-term CO_2 storage	Permanent storage is the sole objective
Monitoring & verification	Operational tracking focused on CO_2–EOR performance	Robust MRV to quantify and verify permanent storage	Robust MRV to quantify and verify permanent storage
International standards	No specific international standard	**ISO 27916** CO_2 capture, transport and storage: CO_2 storage using CO_2–EOR	**ISO 27914** CO_2 capture, transport and storage: geological storage
US injection well class & reporting frameworks	Class II injection wells. EPA GHGRP Subpart UU	Class II injection wells, which may transition to Class VI wells. EPA Subpart VV (ISO 27916) or EPA Subpart RR with approved MRV plan	Class VI injection wells. EPA Subpart RR with approved MRV plan
Public data accessibility	CO_2 injection/receipt volumes may be reported to regulators. Otherwise, they may remain commercially confidential	Injection and storage volumes have historically been publicly reported	Injection and storage volumes have historically been publicly reported
Oil production	Yes	Yes	No
Permanent CO_2 storage	Incidental/unclaimed	Significant and documented	Complete project purpose

EPA: United States Environmental Protection Agency. GHGRP: Greenhouse Gas Reporting Program.

Life cycle assessment (LCA) matters

Any climate benefit of CO_2–EOR with CCS depends on the life cycle assessment and accounting boundary applied. Transparent accounting, reporting, and robust monitoring are essential to demonstrate the net climate benefits.

How is CO_2 Transported?

CO_2 can be transported by pipeline, ship, barge, rail, or truck. The most practical option depends on distance, location, scale, and available infrastructure. Using different modes can connect sources where pipelines are not available. Pipeline networks used for traditional CO_2-EOR have been used safely for decades and can also transport captured CO_2 to dedicated storage sites.

What role can it play in carbon management?

When aligned with long-term storage objectives and regulatory requirements, CO_2-EOR with CCS can strengthen project economics, contribute to energy production, and enable broader CO_2 capture, transportation, and storage infrastructure development, potentially reducing future overall project costs.

Table 2. Benefits of CO_2-EOR with CCS deployment

Project economics	In the United States, CO_2–EOR with CCS qualifies for the Section 45Q federal tax credit at the same value as dedicated CO_2 storage projects.	Captured CO_2 can be sold for CO_2–EOR, creating additional revenue to offset capture costs.	Reliable CO_2 demand justifies pipeline investments and generates steady revenue from transit fees.	Shared infrastructure reduces costs by connecting multiple sources to common pipelines and storage facilities.
Resource efficiency	Utilising existing sites limits the environmental impact associated with new infrastructure development.	Repurposing suitable wells, pipelines, and facilities conserves materials and supports efficient project development.	Injecting CO_2 into mature reservoirs optimises the use of known formations for secure storage.	Decades of reservoir data and fluid management experience minimise operational risks.
Deeper decarbonisation	Increasing demand for CO_2 promotes capture at industrial, power, and carbon removal facilities.	This process enables carbon intensity reduction, in some fields, compared to conventional production when supported by robust emissions accounting and monitoring.	Early mover projects validate secure underground storage under established regulatory frameworks for monitoring, verification, reporting and accounting.	Near-term projects accelerate investment in CCS infrastructure, helping to lower costs and expand dedicated storage deployment.

In the US, the 2025 One Big Beautiful Bill Act updated the 45Q federal tax credit to include parity for the utilisation of CO_2 and dedicated geologic storage.

Are there regulations or standards?

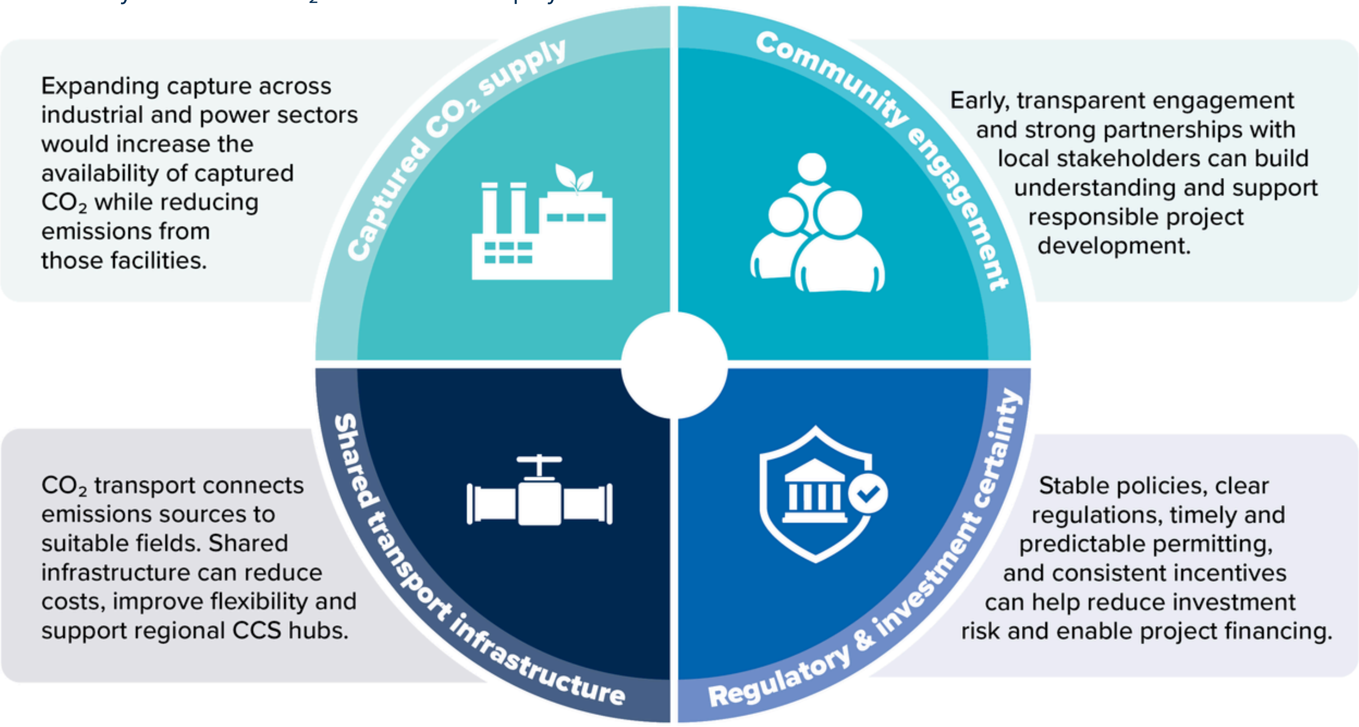
Regulations for CO_2 transport, injection, monitoring, and long-term storage, together with international standards, provide a framework for project design, operation, monitoring, accounting, and verification. Their goal is to ensure safety, effectiveness, and environmental integrity.

Existing permitting frameworks for CO_2-EOR with CCS projects require continuous monitoring throughout operations to track CO_2 within the intended reservoir. These frameworks distinguish CO_2-EOR with CCS from dedicated CO_2 storage by recognising oil recovery is a core project objective, while simultaneously requiring mechanisms to account, document, and demonstrate permanent CO_2 storage.

What will shape deployment?

CO_2-EOR with CCS faces logistical and structural challenges that will influence its wider deployment. Collaboration among industry, policymakers, and local communities is important for infrastructure development, environmental and workforce considerations, and understanding potential emissions benefits. Projects also need to consider local economic and workforce impacts, domestic energy supply, potential emissions reductions, and collaboration across stakeholders.

Table 3. Key enablers for CO_2-EOR with CCS deployment



United States: storage and market context

US conventional oil reservoirs could potentially store an estimated 39* billion tonnes of CO_2. Developing transport and storage infrastructure to and within these basins can support near-term operations while establishing shared networks for future dedicated geological storage sites.

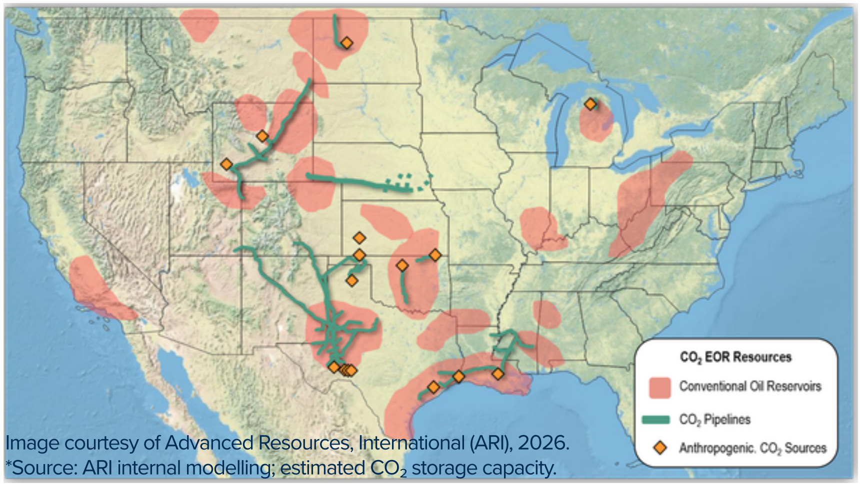


Image courtesy of Advanced Resources, International (ARI), 2026.
*Source: ARI internal modelling; estimated CO_2 storage capacity.

Figure 3. US current locations of CO_2 pipelines and conventional oil reservoirs

Oil production and market effects

Increasing the availability of CO_2 for CO_2-EOR does not automatically mean more oil on the market. Output from individual fields can increase, but global production depends on demand, prices, and investment decisions.

CO_2-EOR projects require significant upfront investment in transport infrastructure and field operations. Additional production will depend on project economics. Increased oil production in a mature field may offset new field development elsewhere, potentially avoiding local environmental and community impacts.