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Assessing the Risks and Opportunities of Dual-purpose CO_2 Injection for Enhanced Oil Recovery (EOR) and Long-term Storage: Implications for U.S. Energy Security and Economic Growth

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Abstract

This study assesses the risks, opportunities, and economic implications of dual-purpose carbon dioxide (CO_2) injection for Enhanced Oil Recovery (EOR) and long-term carbon storage in the U.S. energy sector. Through a comprehensive review of Carbon Capture Utilization and Sequestration (CCUS) technologies, policy frameworks, and case studies such as the Petra Nova and Illinois Industrial Carbon Capture projects, the analysis evaluates how this approach can enhance energy security, stimulate economic growth, and support climate goals. Key findings reveal that dual-purpose CO_2 injection extends the lifespan of oil fields, reduces net carbon emissions through permanent sequestration, and generates economic benefits via job creation and revenue generation. However, its success depends on overcoming technical challenges (e.g., leakage risks), financial barriers (e.g., high capital costs), and regulatory uncertainties. Policy incentives like the 45Q tax credit and advancements in monitoring technologies are critical for scaling deployment. The study concludes that dual-purpose CO_2 injection offers a transitional pathway to balance fossil fuel dependency with decarbonization, contingent on robust policy support, stakeholder engagement, and technological innovation.

Keywords: Dual-purpose; Sequestration; Enhanced Oil Recovery (EOR); Carbon Capture

1 Introduction

The recycling and utilization of carbon dioxide (CO_2) are gaining interest as decarbonization strategies [1]. Carbon Capture (CC) is vital for combating climate change through two key mechanisms: safely sequestering CO_2 and transforming it into useful products. Despite its importance in reducing greenhouse gas emissions, widespread CC adoption faces significant challenges related to economics, regulations, and technology. To successfully incorporate CC into global energy systems, increased policy backing and financial investment are essential. Whilst Carbon Capture Utilization and Sequestration (CCUS) focus on reusing CO_2 by converting it into products such as concrete or biofuel, Carbon Capture Sequestration (CCS) primarily stores CO_2 in geological formations.

According to Latif et al. [2], significant global CC implementations demonstrate the effectiveness of carbon capture in curbing emissions while bolstering energy security worldwide. These include CCS-EOR operations across North America, Norway's major storage initiatives, and China's progress in both Direct Air Capture and CO_2 utilization technologies. Despite these successes, broader CCUS deployment remains constrained by economic barriers, insufficient infrastructure, and complex regulations. They further reiterated that advancing CCUS at the scale needed for a successful energy transition will require ongoing technological breakthroughs and supportive policy frameworks.

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The concept of dual-purpose CO_2 injection combines Enhanced Oil Recovery (EOR) with carbon sequestration to achieve both economic and environmental benefits. In this process, CO_2 is injected into depleted oil reservoirs where it serves two functions simultaneously, first as an EOR agent and second, as permanent storage.

Li et al. [3] demonstrated that CO_2 injection serves dual purposes: enhancing oil recovery by reducing viscosity, swelling oil, and lowering interfacial tension, while enabling carbon sequestration through structural and residual trapping. Their comparison of injection methods revealed cyclic CO_2 injection as superior to continuous and water-alternating gas (WAG) approaches for both maximizing oil recovery and ensuring effective carbon storage in tight reservoirs.

Overall, while dual-purpose CO_2 injection presents a promising opportunity for both enhancing oil recovery and mitigating emissions, its success depends on technological advancements, cost-effectiveness, and robust regulatory frameworks to manage associated risks. This study aims to evaluate the risks, opportunities, and economic implications of dual-purpose CO_2 injection for Enhanced Oil Recovery (EOR) and long-term carbon sequestration in the U.S. energy sector. By analyzing its potential to enhance energy security, support job creation, and contribute to national climate goals, the study provides insights into its viability as a transitional technology for sustainable fossil fuel utilization.

2 Literature review

2.1 Overview of CCUS Technologies:

Carbon capture technologies play a crucial role in reducing CO_2 emissions from industrial and power generation processes. Post-combustion capture is widely used for retrofitting existing power plants, extracting CO_2 from flue gas after combustion. In contrast, pre-combustion capture removes CO_2 before combustion by converting fuel into a hydrogen-rich gas stream, making it suitable for integrated gasification combined cycle (IGCC) plants. Another approach, oxyfuel combustion, burns fuel in pure oxygen to produce an exhaust stream rich in CO_2, simplifying the capture process [4, 5].

Advanced methods such as chemical looping combustion eliminate the need for direct air separation by using metal oxides to transfer oxygen, while absorption remains the most mature technique, utilizing liquid solvents like amines to extract CO_2 from flue gas. Adsorption, on the other hand, relies on solid sorbents such as zeolites and activated carbon for CO_2 capture. Membrane separation uses selective filtering to isolate CO_2 from gas mixtures, offering a compact and efficient alternative. Emerging technologies like hydrate-based separation, which forms CO_2 hydrates under high pressure, and cryogenic distillation, which employs ultra-low temperatures to separate and liquefy CO_2, provide additional options for industrial applications. These technologies, when effectively deployed, contribute significantly to carbon capture and storage (CCS) efforts, supporting global climate goals and sustainable energy transitions [5].

CCS is applicable to large CO_2 point emission sources. It can reduce vast amounts of CO_2 with a capture efficiency of over 80%. However, CCS full-chain technologies have not yet been proven at full commercial scale [4]. In their comparative analysis, Leung & Maroto listed the Advantages and disadvantages of the different CO_2 capture technologies in the table below.

Table 1 Advantages and disadvantages of different CO_2 capture technologies [4]

Capture process	application area	advantages	disadvantages
Post-Combustion	Coal-fired and gas-fired plants	Technology more mature than other alternatives; can easily retrofit into existing plants;	Low CO_2 concentration affects the capture efficiency;
Pre-Combustion	Coal-gasification plants	High CO_2 concentration enhances sorption efficiency; fully developed technology, commercially deployed at the required scale in some industrial sectors;	Temperature-associated heat transfer problem and efficiency decay issues associated with the use of hydrogen-rich gas turbine fuel; high parasitic power requirement for sorbent regeneration; inadequate experience due to few gasification plants currently operated in the

		Opportunity for retrofit to existing plant;	market; high capital and operating costs for current sorption systems;
Oxyfuel Combustion	Coal-fired and gas-fired plants	Very high CO_2 concentration that enhances absorption efficiency; mature air separation technologies available; reduced volume of gas to be treated, hence required smaller boiler and other equipment;	High efficiency drop and energy penalty; cryogenic O_2 production is costly; corrosion problems may arise;
Chemical Looping Combustion	Coal-gasification plants	CO_2 is the main combustion product, which remains unmixed with N_2, thus avoiding energy intensive air separation	Process is still under development and inadequate large scale operation experience;

2.2 EOR and CO_2 Storage

The economic benefits of dual-purpose CO_2 injection for Enhanced Oil Recovery (EOR) and storage include high financial returns due to the increased oil recovery rates and cost offsets from CO_2 capture and storage. Many past and current CO_2 EOR projects have used low-cost CO_2 sources, achieving gas utilization efficiencies of 167-227 sm^3 CO_2 per STB of oil, with approximately 60% of injected CO_2 permanently retained in reservoirs, making it a commercially viable approach [6]. During EOR operations, the additional oil production offsets the high costs of CO_2 capture and injection, making the process financially viable [7].

2.3 Risk Management in CCUS

Environmentally, while CO_2-EOR reduces emissions compared to conventional oil extraction, its effectiveness in mitigating climate change depends on whether CO_2 is permanently stored after EOR, as scenarios without long-term storage result in significantly higher greenhouse gas emissions [7]. A study by Jill Wilday et al. [8] provides a critical analysis of the safety hazards linked to carbon capture, transport, and storage (CCS), focusing on risks such as CO_2 leakage, pipeline fractures, and explosive decompression. Using hazard identification (HAZID) methodologies, it evaluates these risks and suggests mitigation strategies through bow-tie diagrams, stressing the necessity of strong safety protocols and effective emergency response measures. Although the study reveals notable knowledge gaps, particularly in CO_2 pipeline fracture control and environmental impact assessment, it highlights the crucial role of integrated hazard management in enabling the safe implementation of CCS technology. In other research by Larkin et al. [9], they identified that robust site selection and characterization, iterative risk management through continuous monitoring and reassessment, and enhanced transparency and stakeholder communication are crucial strategies that ensure safe and effective CO_2 storage, helping to reduce leakage risks and addressing regulatory and public concerns.

2.4 Policy and Regulatory Landscape

Carbon capture technology in the United States has evolved significantly since the early 2000's, driven by policy initiatives, research investments, and large-scale demonstration projects following the 2005 Intergovernmental Panel on Climate Change (IPCC) report. The advancements have focused on improving capture efficiency, cost reduction, and integrating carbon utilization strategies, with increasing interest in direct air capture and geological storage solutions [10]. The Section 45Q tax credit provides financial incentives for carbon capture projects by offering tax credits for capturing and either securely storing or reusing carbon dioxide. The credit aims to reduce investment risks, encourage private capital in carbon management, and support decarbonization efforts across industries, including power generation, industrial facilities, and direct air capture. There is enormous economic feasibility of using carbon capture, utilization, and storage (CCUS) for enhanced oil recovery (EOR) in residual oil zones (ROZs) under the U.S. 45Q tax credit. Co-developing ROZs and main pay zones (MPZs) can maximize oil production, CO_2 storage, and net present value (NPV), making it a viable strategy for optimizing both financial and environmental outcomes [11]. Goddard A. [12] analyzes how the U.S. Inflation Reduction Act (IRA) and the enhanced 45Q tax credit impact the deployment of Carbon Capture and Storage (CCS) and Carbon Dioxide Removal (CDR) technologies. He argues that while the increased tax incentives improve project economics, challenges such as high capital costs, technology risks, and market uncertainties may still hinder private investment, making additional policy measures necessary to accelerate large-scale CCS and CDR adoption. Alongside these tax incentives, a complex regulatory framework has evolved. The Environmental Protection Agency's Underground Injection Control Program carefully manages the subsurface world where captured carbon finds its final home, distinguishing between wells used for enhanced oil recovery operations and those dedicated solely to permanent carbon sequestration [13].

3 Critical analysis

3.1 Opportunities of Dual-Purpose CO_2 Injection

The dual-purpose application of CO_2 injection for enhanced oil recovery (EOR) and geological sequestration presents a unique economic opportunity by simultaneously increasing oil production and providing a pathway for long-term CO_2 storage. Economic benefits include job creation, revenue generation, and investment attraction, particularly with incentives like the 45Q tax credit, which reduces financial risks and encourages private sector involvement in carbon management projects. Studies highlight that EOR operations significantly extend the economic life of oil fields while ensuring that captured CO_2 is effectively utilized, creating a financially viable model that aligns with both industry and environmental goals [7].

From an environmental perspective, CO_2-EOR contributes to climate change mitigation by reducing net carbon emissions when properly managed. Research indicates that utilizing anthropogenic CO_2 for EOR leads to lower emissions per barrel of oil produced compared to conventional extraction methods, supporting decarbonization targets [7]. Additionally, sequestration in depleted oil fields offers a long-term storage solution, reducing atmospheric CO_2 concentrations and enhancing the sustainability of fossil fuel use [3]. However, concerns remain regarding lifecycle emissions, as additional fossil fuel recovery can contribute to indirect emissions, necessitating stringent regulatory frameworks to ensure net-negative carbon outcomes [2].

Energy security is another critical advantage of dual-purpose CO_2 injection, as enhanced domestic oil production reduces reliance on imports and stabilizes supply chains. Studies emphasize that CO_2-EOR can boost domestic crude output, thereby strengthen national energy independence while facilitating a transition toward cleaner energy technologies [12]. The U.S. Inflation Reduction Act and expansions to the 45Q tax credit further support this model, providing financial certainty for long-term investments in CCS infrastructure. Nevertheless, high initial costs and infrastructure constraints remain barriers to widespread adoption, underscoring the need for continued policy support and innovation [4]. In conclusion, while dual-purpose CO_2 injection presents a compelling economic and environmental strategy, its success hinges on robust policy incentives, technological advancements, and sustainable implementation to balance fossil fuel dependency with climate goals.

3.2 Risks and Challenges

Carbon capture and storage (CCS) represent a potentially significant approach to greenhouse gas mitigation; however, its widespread deployment faces substantial technical, financial, regulatory, and social barriers. This analysis examines critical impediments to CCS implementation and identifies necessary interventions for enhanced viability.

The geological integrity of storage formations presents persistent technical challenges, with potential CO_2 leakage through subsurface discontinuities, geological faults, or abandoned wellbores threatening both storage permanence and environmental safety. As documented by Larkin et al. [9], current monitoring methodologies exhibit limitations in detection sensitivity across diverse geological contexts. Further refinement of injection protocols and geomechanical modeling remains essential to mitigate migration risks and ensure containment reliability.

Financial considerations significantly constrain investment in CCS infrastructure. Technology demands substantial capital expenditure with extended payback periods, creating unfavorable risk profiles for private capital allocation. Reliance on policy instruments such as the 45Q tax credit introduces regulatory uncertainty, as noted by Goddard [12], who demonstrates that policy volatility can fundamentally alter project economics. Extended development timelines further compound investment hesitancy, with multi-year intervals between capital commitment and operational status.

Table 2 Technology Readiness Levels of CO_2 Utilization Technologies [12]

Division	Application	Impact	Technology Readiness Level (TRL)	Breakeven Costs (US$/T)
Chemicals and Minerals Processing	Iron and Steelmaking; Steel slag carbonation, others	Medium	6-8	20-50
Oil and Gas	Enhanced Oil Recovery	Very High	10	40-60
Mineral Carbonation	Concrete Building Materials	Medium	7-8	30-81
Carbonation of Cement-Based Minerals	Cement Curing	Unknown	7-8	25-56
Fuels and Chemicals	Fuels (methanol, ethanol, syngas, methane); urea	High	5-6	Unknown
Geological Sequestration	CO_2 Storage	Extremely High	10	15

The social dimension introduces additional complexity. Public acceptance remains variable, with stakeholder opposition frequently emerging despite scientific consensus regarding environmental benefits. Concerns typically focus on safety parameters, land use modifications, and long-term liability frameworks. Effective stakeholder engagement strategies emphasizing transparency and substantive participation have demonstrated efficacy in addressing resistance, though implementation remains inconsistent across projects.

While CCS technology offers significant decarbonization potential, its effective deployment necessitates coordinated approaches to address these interconnected challenges. Strategic policy frameworks, enhanced monitoring technologies, and comprehensive stakeholder engagement represent critical elements in advancing CCS implementation beyond its current limited application.

4 Case studies

The Petra Nova Carbon Capture project stands as a pioneering initiative in carbon capture and storage technology. Located at the W.A. Parish Generating Station near Houston, Texas, it emerged as one of the world's largest post-combustion carbon capture systems, demonstrating the viability of CCS technology on a commercial scale.

The facility's impressive technical capabilities allowed it to capture approximately 90% of carbon dioxide from a 240 MW slipstream of flue gas, equivalent to about one-third of a single unit's emissions. Using a post-combustion chemical absorption process, Petra Nova effectively extracted CO_2 from the existing coal-fired power plant's exhaust.

After capture, the CO_2 underwent compression and traveled through an 80-mile pipeline to reach its destination at the West Ranch Oil Field. There, it served a dual purpose - enhancing oil recovery operations while simultaneously being sequestered underground. This innovative approach not only increased oil production but also prevented the captured carbon dioxide from entering the atmosphere, creating an environmentally beneficial cycle within an industrial context.

The Petra Nova project successfully demonstrated that carbon capture technology could be retrofitted to existing coal plants and operate effectively at a commercial scale, providing valuable insights for future carbon management strategies [14].

The U.S. Department of Energy announced that the Illinois Industrial Carbon Capture and Storage project in Decatur has begun operations, injecting carbon dioxide into a large saline reservoir. Led by Archer Daniels Midland Company, this $207 million project ($141M from DOE, $66M private funding) captures CO_2 from an ethanol production plant and stores it in the Mt. Simon Sandstone formation.

The underground storage site is approximately 7,000 feet deep with an annual capacity of one million tons of CO_2, though researchers estimate the formation could potentially store over 250 million tons yearly. Acting Assistant

Secretary Doug Hollett called this "a major step forward for industrial carbon capture and storage technologies," supporting the Office of Fossil Energy's mission to advance sustainable carbon management solutions [14].

Table 3 Some of the gasification projects that are operational/under construction/under evaluation globally which employ Pre-combustion (gasification) CO_2 capture & storage

Project Name	Location	Purpose	CO_2 Capture Start	Capture Capacity (Mtpa)	Transport Type	Primary Storage Type
Great Plains Synfuel Plant and Weyburn-Midale Project	Canada	Production Of Natural Gas and Other By-Products	2000	3.0	Pipeline	EOR
Kemper County Energy Facility	Mississippi, United States	Power Generation	2017	3.0	Pipeline	EOR
Yanchang Integrated Carbon Capture Demonstration Project	China	Chemical Production	2018	0.4	Pipeline	EOR
Texas Clean Energy Project	Texas, United States	Power Generation	2021	2.4	Pipeline	EOR
Huaneng GreenGen IGCC Project (Phase 3)	China	Power Generation	2020	2.0	Pipeline	EOR
Caledonia Clean Energy Project	United Kingdom	Power Generation	2022	3.8	Pipeline	Dedicated Geological Storage
Coffeyville Gasification Plant	Kansas, United States	Fertilizer production	2013	1.0	Pipeline	EOR

5 Implications for the U.S.

5.1 Energy Security

Dual-purpose CO_2 injection for EOR significantly enhances U.S. energy security by boosting domestic oil production from existing fields. As highlighted in the paper, CO_2-EOR can extend the economic life of oil fields while reducing reliance on imports. This review notes that enhanced domestic oil production reduces reliance on imports and stabilizes supply chains, with studies emphasizing that CO_2-EOR can boost domestic crude output, thereby strengthening national energy independence. This approach creates a more resilient energy supply chain by maximizing recovery from domestic reserves, reducing vulnerability to international market fluctuations, and geopolitical tensions.

5.2 Economic Growth

The implementation of dual-purpose CO_2 injection creates substantial economic benefits through multiple channels. The paper identifies job creation, revenue generation, and investment attraction as key economic advantages, particularly with incentives like the 45Q tax credit. Projects like Petra Nova and the Illinois Industrial Carbon Capture and Storage demonstrate the economic potential of this technology at a commercial scale. The dual-purpose approach creates jobs across multiple sectors, including energy, manufacturing, construction, and technical services. Regional economies benefit from extended production at existing oil fields, infrastructure development, and the creation of skilled positions in carbon management. This review emphasizes that this approach creates a financially viable model that aligns with both industry and environmental goals.

5.3 Climate Goals

Dual-purpose CO_2 injection supports U.S. climate commitments by providing a practical pathway for emissions reduction while maintaining economic productivity. The review indicates that utilizing anthropogenic CO_2 for EOR leads to lower emissions per barrel of oil produced compared to conventional extraction methods, directly supporting decarbonization targets. When properly managed, this approach contributes to climate change mitigation by permanently sequestering CO_2 in geological formations while enabling continued economic activity. The Petra Nova project demonstrated that captured carbon could be sequestered underground while simultaneously enhancing oil recovery, creating an environmentally beneficial cycle within an industrial context. This technology serves as a transitional solution that allows for continued fossil fuel use with significantly reduced climate impact.

5.4 Policy Recommendations To maximize the benefits of dual-purpose CO_2 injection, policy improvements should focus on

- Enhancing regulatory certainty through consistent long-term policies that reduce investment risk, addressing the concern that policy volatility can fundamentally alter project economics as noted by Goddard (2023).
- Expanding and stabilizing financial incentives beyond the 45Q tax credit to overcome the substantial capital expenditure with extended payback periods that currently create unfavorable risk profiles for private capital allocation.
- Investing in improved monitoring technologies to address the limitations in detection sensitivity across diverse geological contexts identified by Larkin et al. (2019).
- Developing comprehensive stakeholder engagement strategies emphasizing transparency and participation to address public concerns about safety parameters, land use modifications, and long-term liability frameworks.
- Creating integrated policies that balance energy security, economic growth, and emissions reduction goals in a coordinated framework.

These recommendations would help address the interconnected technical, financial, regulatory, and social barriers identified in the paper, enabling more widespread adoption of this promising technology.

6 Conclusion

Dual-purpose CO_2 injection presents a compelling strategy to harmonize energy security, economic growth, and climate objectives. By enhancing oil recovery and sequestering CO_2, this approach reduces reliance on foreign oil, bolsters domestic supply chains, and mitigates emissions. Case studies demonstrate its technical feasibility, while economic incentives like the 45Q tax credit improve financial viability. However, challenges such as geological risks, high costs, and public skepticism necessitate targeted interventions. Future research should prioritize advanced monitoring systems, lifecycle emission assessments, and public perception studies to address knowledge gaps. Policymakers must stabilize incentives, strengthen regulatory frameworks, and foster cross-sector collaboration to enable scalable deployment. As a transitional technology, dual-purpose CO_2 injection underscores the potential to sustainably leverage existing fossil fuel infrastructure while advancing U.S. energy and climate goals, provided its implementation aligns with rigorous environmental and economic safeguards.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

References

[1] Desport, L., & Selosse, S. (2022). An overview of CO2 capture and utilization in energy models. Resources, Conservation and Recycling, 180, 106150.

[2] Latif, W. M. S. M., Sabdullah, N. M., Aenun, S. N., & Bosamah, N. A. (2024). A review of global carbon capture and storage (CCS) and carbon capture, utilization, and storage (CCUS). In *E3S Web of Conferences* (Vol. 516, p. 01009). EDP Sciences.

[3] Li, D., Saraji, S., Jiao, Z., & Zhang, Y. (2021). CO2 injection strategies for enhanced oil recovery and geological sequestration in a tight reservoir: An experimental study. *Fuel*, *284*, 119013.

[4] Leung, D. Y., Caramanna, G., & Maroto-Valer, M. M. (2014). An overview of current status of carbon dioxide capture and storage technologies. Renewable and sustainable energy reviews, 39, 426-443.

[5] Gibbins, J., & Chalmers, H. (2008). Carbon capture and storage. Energy policy, 36(12), 4317-4322.

[6] Ettehadtavakkol, A., Lake, L. W., & Bryant, S. L. (2014). CO2-EOR and storage design optimization. International Journal of Greenhouse Gas Control, 25, 79-92.

[7] Roefs, P., Moretti, M., Welkenhuysen, K., Piessens, K., & Compernolle, T. (2019). CO2-enhanced oil recovery and CO2 capture and storage: An environmental economic trade-off analysis. Journal of environmental management, 239, 167-177.

[8] Jill Wilday, Mike Wardman, Michael Johnson, Mike Haines, Hazards from carbon dioxide capture, transport and storage, Process Safety and Environmental Protection, Volume 89, Issue 6, 2011, Pages 482-491, ISSN 0957-5820, https://doi.org/10.1016/j.psep.2011.09.002.
(https://www.sciencedirect.com/science/article/pii/S0957582011000978)

[9] Larkin, P., Leiss, W., & Krewski, D. (2019). Risk assessment and management frameworks for carbon capture and geological storage: a global perspective. International Journal of Risk Assessment and Management, 22(3-4), 254-285.

[10] Qiu, H. H., & Liu, L. G. (2018). A study on the evolution of carbon capture and storage technology based on knowledge mapping. Energies, 11(5), 1103.

[11] Ren, B., Male, F., & Duncan, I. J. (2022). Economic analysis of CCUS: Accelerated development for CO2 EOR and storage in residual oil zones under the context of 45Q tax credit. Applied Energy, 321, 119393.

[12] Goddard, A. (2023). Deal or no deal: Will the US Inflation Reduction Act (IRA) push Carbon Capture and Storage (CCS) and Carbon Dioxide Removal (CDR) technologies over the line? (No. 05). OIES Paper: CM.

[13] EPA, Class, I. V. (2012). Underground Injection Control Program.

[14] *Petra Nova - W.A. Parish Project | Department of Energy*. (n.d.). Retrieved March 12, 2025, from https://www.energy.gov/fecm/petra-nova-wa-parish-project