Global Academic and Scientific Journal of Multidisciplinary Studies (GASJMS)

Volume 4 | Issue 7, 2026 Homepage: https://gaspublishers.com/gasjms/ ISSN: 2583-8970

Analysis of Economic Influencing Factors of Oilfield CCUS-EOR Projects under the Dual Carbon Goals

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Received: *11.06.2026* | ***Accepted:*** *06.07.2026* | ***Published:*** *07.07.2026*

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DOI: *10.5281/zenodo.21237088*

Abstract **Original Research Article**

Under the dual carbon goals, carbon capture, utilization and storage combined with enhanced oil recovery (CCUS-EOR) has become an important pathway for petroleum enterprises to coordinate oilfield development and emission reduction. However, the economic feasibility of oilfield CCUS-EOR projects is affected by high capital expenditure, long operation cycles, uncertain oil and carbon prices, CO2 supply costs, transportation distance, reservoir adaptability and monitoring rules. This paper analyzes the economic composition of CCUS-EOR projects from the perspectives of revenue, cost and risk, and identifies the main influencing factors from four dimensions: reservoir engineering, market price, cost investment and policy institution. It further discusses the applicability of discounted cash flow analysis, break-even analysis, sensitivity analysis and uncertainty analysis. The study finds that incremental oil revenue remains the main economic support for most projects, while carbon reduction revenue mainly plays a supplementary and incentive role at the current stage. Improving reservoir screening, source-sink matching, monitoring and verification, carbon market rules and dynamic investment decision-making can enhance project feasibility.

Keywords: Dual Carbon Goals, CCUS-EOR, Economic Feasibility, Influencing Factors, Oilfield Development, Carbon Price, Oil Price.

1. INTRODUCTION

Climate change and carbon emission reduction have become central issues in global energy governance. Under the carbon peak and carbon neutrality goals, petroleum enterprises are required to maintain energy supply security while reducing carbon emission intensity. Oilfield development, production, transportation and processing activities still depend on fossil energy and are accompanied by direct and indirect emissions. Therefore, the low-carbon transformation of petroleum enterprises is not only a policy requirement, but also an important condition for improving long-term competitiveness [1-3].

Carbon capture, utilization and storage (CCUS) is widely regarded as a key technology for hard-to-abate fossil energy systems. Among different CCUS pathways, carbon capture, utilization and storage combined with enhanced oil recovery, namely CCUS-EOR, is directly related to oilfield enterprises. CO2 injection can improve displacement efficiency, increase crude oil production and retain part of the injected CO2 underground. This dual value structure gives the project both enhanced oil recovery value and carbon emission reduction value [2,4].

However, CCUS-EOR is not automatically economical. Compared with conventional oilfield development, it involves additional links, including CO_2 capture or purchase, purification, compression, transportation, injection, production adjustment, recycling, monitoring, reporting and verification. Each link may generate extra capital expenditure or operating cost. At the same time, project revenue is exposed to oil price and carbon price uncertainty. Oil price determines the value of incremental crude oil production, while carbon price affects the potential value of verified CO_2 storage. If oil prices decline or carbon market rules are unclear, the profitability of a project may be weakened [12,13].

Existing studies have discussed CCUS technology, CO_2-EOR mechanisms, carbon trading, policy support and low-carbon transformation of petroleum enterprises. These studies provide useful references for understanding the technical and institutional background of CCUS-EOR. From the perspective of project economic analysis, it remains necessary to clarify how reservoir conditions, market prices, cost structure and policy mechanisms jointly affect economic feasibility. Based on this logic, this paper analyzes the economic composition, major influencing factors, applicable evaluation methods and optimization pathways of oilfield CCUS-EOR projects under the dual carbon goals.

2. ECONOMIC COMPOSITION OF OILFIELD CCUS-EOR PROJECTS

2.1 Basic Concept of Oilfield CCUS-EOR Projects

Oilfield CCUS-EOR projects are comprehensive engineering projects combining carbon utilization with enhanced oil recovery. The basic process includes CO_2 source acquisition, purification and compression, transportation to the oilfield, reservoir injection, crude oil displacement, oil production, produced-gas recycling and geological storage monitoring. Compared with conventional enhanced oil recovery methods, CCUS-EOR not only aims to increase crude oil production, but also has the function of CO_2 utilization and storage.

From a technical perspective, injected CO_2 can dissolve in crude oil, reduce oil viscosity, expand oil volume and improve fluid mobility. Under suitable reservoir pressure and crude oil conditions, CO_2 may achieve miscible or near-miscible displacement, thereby improving recovery. From an environmental perspective, part of the injected CO_2 can remain underground through structural trapping, residual trapping and solubility trapping. Therefore, the project has both oilfield development value and carbon reduction value [14].

2.2 Revenue Composition

The first source of revenue is incremental crude oil revenue. After CO_2 is injected into the reservoir, displacement efficiency may be improved and additional crude oil production can be obtained. This revenue is mainly determined by incremental oil production and crude oil price. When oil price remains at a relatively high level and incremental oil production is stable, the project can obtain stronger cash flow. However, incremental production is affected by permeability, heterogeneity, crude oil properties, miscibility conditions, injection-production well pattern and development stage. If reservoir adaptability is poor or gas channeling occurs, actual oil increment may be lower than expected.

The second source of revenue is carbon reduction revenue. When CO_2 is injected and stored underground, the verified storage amount may generate carbon asset value under compliance or voluntary carbon market mechanisms. The scale of carbon revenue depends on storage amount, verification ratio, carbon price and trading rules. CO_2 injection amount cannot be simply regarded as permanent storage amount, because part of the injected CO_2 may be produced back, recycled or reinjected. Only monitored and verified storage can provide a reliable basis for carbon revenue [4,6].

2.3 Cost Composition

The cost of oilfield CCUS-EOR projects mainly includes initial investment, CO_2 acquisition cost, transportation cost, injection and operation cost, recycling cost and monitoring cost. Initial investment covers injection systems, pipelines, compressors, metering facilities, monitoring devices and supporting infrastructure. If existing oilfield facilities can be reused, capital expenditure may be reduced. If new source-sink infrastructure is required, investment pressure will increase significantly.

Operating cost is closely related to CO_2 supply and project scale. If CO_2 is purchased from industrial emission sources, purchase price, purity and supply stability become key factors. If self-built capture facilities are used, capture and compression costs may be high. Transportation cost is affected by distance, scale and transportation mode. Pipeline transportation is suitable for large-scale and long-term projects, while truck transportation is more flexible but usually has higher unit cost. Monitoring, reporting and verification costs should also be included in whole-cycle evaluation; otherwise, the economic result may be overly optimistic.

3. MAIN ECONOMIC INFLUENCING FACTORS

3.1 Reservoir Engineering Factors

Reservoir engineering conditions form the technical foundation of project economics. Reservoir permeability and heterogeneity directly affect CO_2 sweep efficiency and breakthrough risk. Low-permeability reservoirs may have potential for CO_2 flooding because water flooding efficiency is often limited and remaining oil is difficult to produce. However, low permeability alone does not guarantee economic feasibility. Strong heterogeneity may cause early gas breakthrough along high-permeability channels, reduce sweep efficiency and weaken incremental oil revenue.

Crude oil properties and miscibility conditions also affect economic results. CO_2 can reduce oil viscosity and improve flow capacity, but the effect depends on reservoir pressure and crude oil composition. When reservoir pressure reaches or approaches the minimum miscibility pressure, displacement efficiency may be higher. If miscibility conditions are poor, the project may require higher injection pressure or larger CO_2 injection volume, which will increase costs. Injection-production well pattern, remaining oil distribution and development stage further determine whether incremental production can support investment recovery.

3.2 Market Price Factors

Oil price is one of the most important market variables affecting CCUS-EOR economics. Incremental oil revenue is directly related to crude oil price. Since CCUS-EOR projects usually have high fixed costs and long operation periods, oil price fluctuation has a strong influence on discounted cash flow and payback period. When oil price rises, the value of incremental crude oil production increases and project profitability improves. When oil price declines, project cash flow may deteriorate rapidly.

Carbon price affects the potential revenue from CO_2 storage and emission reduction. A higher carbon price can increase the value of verified storage and improve the overall revenue structure. However, the role of carbon price depends on whether CCUS-EOR storage can be recognized by carbon market rules. Under high oil price and high carbon price, the project has the most favorable revenue condition. Under high oil price and low carbon price, it mainly relies on incremental oil revenue. Under low oil price and high carbon price, carbon revenue may partly offset the negative impact of low oil price, but it may not fully compensate for the decline in oil revenue [12,15].

3.3 Cost and Investment Factors

Cost and investment factors form the economic constraints of CCUS-EOR projects. Initial investment scale directly affects capital pressure, net present value and investment payback period. The project may require injection systems, CO_2 pipelines, compressors, monitoring equipment and surface engineering facilities. For small-scale demonstration projects, unit cost may be high because fixed costs cannot be fully shared. For large-scale projects, economies of scale may reduce unit cost, but financing pressure and construction risk may increase.

CO2 supply cost is another key factor. It is affected by source type, capture technology, purification requirements, compression cost and supply stability. High-concentration industrial CO2 sources may reduce capture and purification costs, but their geographical distribution may not match oilfield locations. If the source is far from the sink, transportation cost may erode project profitability. Therefore, source-sink matching is essential for reducing overall cost and improving commercial feasibility [7].

3.4 Policy and Institutional Factors

Policy and institutional factors determine whether carbon reduction value can be transformed into economic revenue. Carbon trading mechanisms are especially important. If verified CO2 storage can enter carbon markets or voluntary emission reduction mechanisms, CCUS-EOR projects may obtain additional cash flow. If there is no clear trading channel, carbon reduction value may remain an environmental benefit rather than a realizable financial return.

Emission reduction verification is also necessary. CCUS-EOR projects have both utilization and storage attributes, so the accounting relationship among CO2 injection, production, recycling and permanent storage should be clearly defined. Fiscal subsidies, tax incentives, green credit and transition finance may reduce capital cost and improve investment attractiveness. However, policy support should not be overestimated. If a project is feasible only under very high subsidies, its commercial sustainability may be weak [6,17].

4. APPLICABILITY OF ECONOMIC EVALUATION METHODS

4.1 Discounted Cash Flow Method

The discounted cash flow method is widely used in project economic evaluation because it considers the time value of money and measures profitability through cash inflows and outflows over the whole life cycle. For CCUS-EOR projects, this method can include incremental oil revenue, carbon reduction revenue, initial investment, CO2 supply cost, transportation cost, injection cost and monitoring cost in a unified framework. Net present value, internal rate of return and payback period can be used to judge whether the project has investment value.

The limitation of this method is that the result is sensitive to parameter assumptions. Oil price, carbon price, incremental oil production, CO2 cost, storage verification ratio and discount rate may all change over time. Therefore, discounted cash flow analysis should not be used as a purely deterministic calculation. It should be combined with break-even analysis, sensitivity analysis and uncertainty analysis to avoid overstating project feasibility.

4.2 Break-Even and Sensitivity Analysis

Break-even analysis can identify critical conditions for project feasibility. For CCUS-EOR projects, break-even indicators may include oil price, carbon price, incremental oil production, CO2 supply cost and investment scale. The value of break-even analysis lies not only in obtaining a critical value, but also in revealing the relationship between oil revenue and carbon revenue. When carbon revenue increases, the required break-even oil price may decline; when oil price is high, the project may be less dependent on carbon revenue.

Sensitivity analysis can compare the influence degree of key variables by changing one variable while keeping others unchanged. For oilfield CCUS-EOR projects, oil price, incremental oil production, CO2 supply cost, initial investment, carbon price and storage verification ratio are usually important variables. Sensitivity results can help enterprises identify the main risk sources and prioritize management measures.

4.3 Uncertainty Analysis

Uncertainty analysis is necessary because oil price, carbon price, reservoir response and cost levels may fluctuate during the project life cycle. Scenario analysis can compare optimistic, base and conservative cases. For projects with sufficient data, probability simulation can further describe the distribution of economic results, such as expected net present value, downside risk and probability of loss. The key point is to avoid treating uncertain factors as fixed values and to match the evaluation method with the available data quality.

5. OPTIMIZATION PATHWAYS

5.1 Optimizing Reservoir Screening

Improving reservoir screening is the first step to enhance project economic feasibility. Before implementation, petroleum enterprises should evaluate permeability, heterogeneity, crude oil properties, miscibility conditions, remaining oil distribution, well pattern and storage security. Projects should be prioritized in reservoirs with suitable geological conditions, sufficient remaining oil potential and controllable gas channeling risk. Technical evaluation should be combined with economic evaluation, because technical potential does not necessarily mean commercial feasibility.

5.2 Reducing CO2 Supply and Transportation Costs

CO2 supply and transportation costs are major constraints on project economics. Enterprises should strengthen source-sink matching and choose stable industrial emission sources near oilfields. High-concentration and stable CO2 sources should be prioritized because they can reduce capture and purification costs. Shared pipelines and regional CCUS clusters can reduce transportation costs through economies of scale. For long-term commercial projects, stable and low-cost CO2 supply systems are essential [7,18].

5.3 Improving Monitoring and Verification Mechanisms

Monitoring, reporting and verification mechanisms are the basis for realizing carbon revenue. Oilfield CCUS-EOR projects should establish whole-process monitoring systems covering CO2 injection, migration, recycling and storage. Accurate monitoring data can improve storage safety and support carbon reduction verification. A sound MRV mechanism can also enhance market confidence and promote the transformation of environmental value into economic value.

5.4 Strengthening Carbon Market and Policy Support

Carbon market support is important for improving the low-carbon value of CCUS-EOR projects. Relevant authorities may further clarify whether and how verified CO2 storage can enter carbon markets or voluntary emission reduction mechanisms. Clear rules can improve enterprise expectations and encourage investment. In addition, green finance and transition finance can provide support through green bonds, low-interest loans and special funds.

5.5 Establishing Dynamic Investment Decision-Making Mechanisms

Since CCUS-EOR projects have both oil revenue and carbon revenue, investment decisions should consider the linkage between oil price and carbon price. If enterprises focus only on oil price, they may ignore carbon reduction value. If they emphasize only carbon price, they may overestimate the role of carbon revenue. A reasonable decision-making mechanism should consider oil price, carbon price, incremental oil production, CO2 cost and investment scale together. Phased investment and risk warning mechanisms can reduce one-time investment risk and improve project flexibility.

6. CONCLUSION AND OUTLOOK

Oilfield CCUS-EOR projects are important technical options for petroleum enterprises under the dual carbon goals. They combine enhanced oil recovery with geological CO2 storage and therefore have both economic and environmental attributes. The economic feasibility of such projects is not determined by a single factor. It depends on the coordination of reservoir adaptability, market prices, cost control and institutional support.

The analysis shows that project revenue mainly comes from incremental oil revenue and carbon reduction revenue. At the current stage, incremental oil revenue remains the main economic support, while carbon revenue mainly plays a supplementary and incentive role. Reservoir conditions determine the technical basis of incremental oil production and storage efficiency. Oil price and carbon price determine the external revenue environment. Initial investment, CO2 supply cost, transportation cost, injection cost and monitoring cost determine whole-cycle cash flow. Policy and verification mechanisms determine whether carbon reduction value can be converted into realizable revenue.

In the future, the commercial development of oilfield CCUS-EOR projects should focus on scientific reservoir screening, source-sink matching, cost reduction, MRV system construction, carbon market improvement and dynamic investment decisions. With technological progress, lower CO2 supply costs and more mature carbon market rules, CCUS-EOR may gradually become an important component of low-carbon oilfield development.

REFERENCES

[1] International Energy Agency. The Oil and Gas Industry in Net Zero Transitions[R]. Paris: IEA, 2023.

[2] International Energy Agency. CCUS in Clean Energy Transitions[R]. Paris: IEA, 2020.

[3] International Energy Agency. Carbon Capture, Utilisation and Storage: Tracking Clean Energy Progress[R]. Paris: IEA, 2024.

[4] Global CCS Institute. Global Status of CCS 2024[R]. Melbourne: Global CCS Institute, 2024.

[5] Global CCS Institute. Global Status of CCS 2023[R]. Melbourne: Global CCS Institute, 2023.

[6] Ministry of Ecology and Environment of the People's Republic of China. Progress Report of China's National Carbon Market 2024[R]. Beijing: Ministry of Ecology and Environment, 2024.

[7] National Petroleum Council. Meeting the Dual Challenge: A Roadmap to At-Scale Deployment of Carbon Capture, Use, and Storage[R]. Washington, DC: National Petroleum Council, 2019.

[8] Intergovernmental Panel on Climate Change. Climate Change 2022: Mitigation of Climate Change[R]. Cambridge: Cambridge University Press, 2022.

[9] Energy Transitions Commission. Carbon Capture, Utilisation and Storage in the Energy Transition: Vital but Limited[R]. London: Energy Transitions Commission, 2022.

[10] Abuov, Y., Seisenbayev, N., & Lee, W. Techno-economic assessment and life cycle assessment of CO2-EOR[J]. Environmental Science & Technology, 2022, 56(12): 8571-8580.

[11] McLaughlin, H., Littlefield, A. A., Menefee, M., Kinzer, A., Hull, T., Sovacool, B. K., & Bazilian, M. D. Carbon capture utilization and storage in review: Sociotechnical implications for a carbon reliant world[J]. Renewable and Sustainable Energy Reviews, 2023, 177: 113215.

[12] Liu, J., Wei, Y. M., Xu, Y., et al. Investment decision on carbon capture and utilization under uncertainty: The role of oil price and carbon price[J]. Applied Energy, 2022, 322: 119470.

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

[14] Dai, Z., Viswanathan, H., Fessenden-Rahn, J., Middleton, R., Pan, F., Jia, W., Lee, S. Y., McPherson, B., & Grigg, R. Uncertainty quantification for CO2 sequestration and enhanced oil recovery[J]. International Journal of Greenhouse Gas Control, 2014, 27: 155-162.

[15] Gao, S., Hartley, P., & Sickles, R. C. On the economics of CO2 contracts in the enhanced oil recovery industry[J]. The Energy Journal, 2022, 43(6): 1-26.

[16] Liu, G., Larson, E. D., Williams, R. H., Guo, X., & Chen, H. China's pathways of CO2 capture, utilization and storage under carbon neutrality goals[J]. Carbon Management, 2022, 13(1): 435-449.

[17] Song, D., Zhang, J., Fan, J. L., & Wei, Y. M. Review of policy framework for the development of carbon capture, utilization and storage in China[J]. International Journal of Environmental Research and Public Health, 2022, 19(24): 16853.

[18] Asian Development Bank. Road Map Update for Carbon Capture, Utilization, and Storage Demonstration and Deployment in the People's Republic of China[R]. Manila: Asian Development Bank, 2022.