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Carbon Capture and Decarbonisation Strategies in the Petroleum Industry: A Qualitative Analysis

Abhinav Patil

I. INTRODUCTION

The global energy system is undergoing an unprecedented transformation because governments, industries, and international organizations across the globe are responding to the escalating threat of climate change. If we look closely, we can see that the combustion of fossil fuels remains the largest contributor to anthropogenic greenhouse gas emissions, and with this comes the petroleum industry that is accounting for a significant share of global carbon dioxide (CO_2) output. According to the Intergovernmental Panel on Climate Change, limiting global warming to well below 2°C, at this moment, requires rapid and sustained reductions in the emissions across all sectors, but particularly amongst energy production and heavy industry (IPCC, 2023). As a result of this, the petroleum companies worldwide are increasingly facing regulatory pressure and investor scrutiny, alongside being held accountable for the societal expectations in order to adopt strategies that reduce their carbon footprint while also sufficiently maintaining energy supply.

Within this context, decarbonisation strategies have become central to the long-term sustainability of the petroleum sector and among these strategies, Carbon Capture, Utilisation and Storage (CCUS) has emerged as a prominent technological pathway for mitigating emissions from fossil fuel extraction, refining, and combustion processes. The thing is, CCUS technologies capture carbon dioxide from industrial sources and either store it in geological formations or repurpose it for industrial applications, which helps in thereby preventing its release into the atmosphere. Based on the same, international energy policy bodies suggest that large-scale deployment of carbon capture will be essential for achieving global climate targets, particularly in sectors where emissions are difficult to eliminate entirely (IEA, 2022). On the global scale, even though there is growing interest and investment, the actual role of carbon capture in the petroleum industry remains widely debated because while proponents view it as a pragmatic transition tool that allows for emission reductions while preserving energy security, critics argue that it may prolong dependence on fossil fuels. Thus, this paper qualitatively examines the decarbonisation strategies adopted within the petroleum industry, with a particular focus on carbon capture technologies. Through a thematic review of academic literature, policy reports, and industry initiatives, the study aims to look at how these strategies are being implemented, as well as the challenges and implications associated with their adoption.

II. LITERATURE REVIEW

The growing urgency of climate change mitigation has placed the global energy sector under intense scrutiny, particularly industries that are heavily reliant on fossil fuels. One needs to note that the petroleum industry has historically been a major contributor to global greenhouse gas emissions due to the extraction, processing, and combustion of oil and gas resources. This is why scholars and policy institutions increasingly shed light on the fact that achieving global climate goals requires structural transformation within this sector. It also needs to be taken into serious consideration that the reports by the Intergovernmental Panel on Climate Change highlight that limiting global warming to internationally agreed thresholds will require rapid decarbonisation of energy systems alongside the furtherance and global adoption of technological innovations that reduce emissions from existing fossil-fuel-based infrastructure (IPCC, 2023). As a result, the existing research and its subsequent literature has increasingly focused on pathways through which the petroleum industry can reduce its environmental impact while continuing to meet global energy demand.

A. Climate Change and the Energy Sector

A substantial amount of the existing body of literature sees the energy sector as the primary driver of anthropogenic carbon emissions, where fossil fuels currently account for the majority of global energy consumption, which further makes the decarbonisation of this sector central to climate mitigation strategies. The international climate framework established through the Paris Agreement requires countries to partake in efforts that result in the limiting of global temperature rise to well below 2°C above pre-industrial levels (UNFCCC, 2015).

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Achieving this target commands significant emission reductions from oil and gas operations, including improvements in energy efficiency, reductions in methane leakage, and the adoption of carbon mitigation technologies, and as a result, the research in energy policy suggests that decarbonisation in fossil fuel industries will likely occur through a combination of regulatory interventions, technological innovations, and market-based mechanisms such as carbon pricing (Sovacool, 2016). Nowadays, governments are increasingly introducing climate policies that incentivize low-carbon technologies and penalize high-emission activities and these policy shifts have prompted petroleum companies to explore alternative operational models and technological solutions aimed at reducing their environmental footprint.

B. Decarbonisation Pressures on the Petroleum Industry

The literature highlights multiple drivers pushing the petroleum industry toward decarbonisation. Regulatory frameworks, investor expectations, and growing environmental awareness among consumers have significantly influenced corporate sustainability strategies. Major multinational oil companies such as Shell plc, BP, and ExxonMobil have begun incorporating emissions reduction targets and climate commitments into their corporate strategies (Fattouh, Poudineh, & Sen, 2018). Academic analyses also suggest that these commitments are partly driven by increasing financial and reputational risks associated with carbon-intensive operations because of how institutional investors and financial regulators are increasingly demanding climate disclosures and environmental risk assessments from energy companies. Consequently, petroleum firms are investing in low-carbon technologies, renewable energy ventures, and emissions management strategies in order to maintain long-term competitiveness in a transitioning energy market, but at the same time, the literature also presents a critical perspective regarding the pace and depth of these commitments. Some researchers argue that industry-led decarbonisation initiatives remain incremental and may not be sufficient to meet global climate targets (Newell & Simms, 2020). Thus, this tension between economic interests and environmental responsibility continues to shape debates within both academic and policy circles.

C. Carbon Capture, Utilisation and Storage (CCUS)

Out of the various technological approaches proposed for reducing emissions from fossil fuel industries, Carbon Capture, Utilisation and Storage (CCUS) has received significant attention in both academic-cum-policy literature. CCUS involves capturing carbon dioxide emissions from industrial processes and either storing them in geological formations or using them in other industrial applications, which is why the International Energy Agency identifies CCUS as a critical technology for achieving net-zero emissions, particularly in sectors where emissions are difficult to eliminate through renewable energy alone (IEA, 2022). Scholars highlight several potential benefits of CCUS. First, it allows continued use of existing energy infrastructure while significantly reducing emissions. Secondly, it offers potential applications in industries such as cement, steel, and chemical production, where decarbonisation options are limited. Within the petroleum sector, captured carbon dioxide can also be used for enhanced oil recovery, where CO_2 is injected into depleted reservoirs to increase extraction efficiency (Bui et al., 2018).

However, even though there are these potential advantages, the literature also identifies several limitations and controversies surrounding CCUS, where critics argue that high implementation costs, technological uncertainties, and limited large-scale deployment pose significant barriers to widespread adoption. Additionally, some environmental scholars contend that reliance on carbon capture technologies may delay the transition away from fossil fuels by enabling continued hydrocarbon production (Markusson et al., 2017). These debates highlight the complex role of CCUS within broader decarbonisation strategies, but overall, existing literature demonstrates that while carbon capture technologies offer promising opportunities for emission reduction, their effectiveness and long-term role in the petroleum industry remain subjects of ongoing academic and policy discussion. Thus, this paper builds upon these debates by qualitatively examining the evolving decarbonisation strategies adopted by petroleum companies and evaluating the role of carbon capture within these approaches.

III. METHODOLOGY

This study makes use of a qualitative research design based on a literature-based analytical approach in order to examine decarbonisation strategies within the petroleum industry. The research relies on a systematic review of secondary sources, including academic journal articles, policy reports, and industry publications related to carbon mitigation and energy transition, alongside relying on key data sources include energy policy reports from international institutions such as the International Energy Agency and climate assessments published by the Intergovernmental Panel on Climate Change. Furthermore, it also makes use of sustainability and transition reports released by major petroleum companies. The collected literature was examined using thematic analysis to identify recurring patterns and strategic approaches related to carbon capture and decarbonisation.

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Additionally, a comparative review of strategies adopted by different firms and regions was conducted to understand variations in implementation and policy influence. This qualitative methodology has allowed the researcher to identify key strategic themes shaping decarbonisation efforts in the petroleum sector.

IV. DECARBONISATION STRATEGIES IN THE PETROLEUM INDUSTRY

The petroleum industry has increasingly made use of a wide range of technological and operational strategies in order to reduce greenhouse gas emissions while also working on continuing to meet global energy demand. These strategies largely focus on carbon management technologies, improvements in operational efficiency, and gradual diversification into low-carbon energy systems.

A. Carbon Capture and Storage (CCS)

Carbon Capture and Storage (CCS) is widely regarded as one of the most significant technological approaches for reducing emissions from fossil fuel operations. CCS involves capturing carbon dioxide (CO_2) produced during industrial processes, compressing it, and transporting it to geological formations such as depleted oil and gas reservoirs or deep saline aquifers for long-term storage (Bui et al., 2018). International energy policy bodies, including the International Energy Agency, highlight how the large-scale deployment of CCS will be essential towards achieving the goal of having global net-zero emissions (IEA, 2022). One notable example is the Northern Lights CCS Project in Norway, which aims to create an open-access infrastructure for transporting and storing captured carbon from multiple industrial sources. While such projects demonstrate the potential effectiveness of CCS, challenges remain regarding scalability and economic feasibility since high capital investment, transportation infrastructure, and long-term monitoring requirements significantly increase operational costs, limiting widespread adoption in the short term (Global CCS Institute, 2023).

B. Carbon Capture Utilisation (CCU)

Carbon Capture Utilisation (CCU) represents another strategy in which captured CO_2 is reused rather than permanently stored. In the petroleum industry, one common application is enhanced oil recovery (EOR), where CO_2 is injected into mature oil reservoirs to increase extraction efficiency. Captured carbon can also be used in the production of synthetic fuels, building materials, and chemical products (IEA, 2022). However, this approach presents a notable paradox because while CCU can reduce emissions from industrial sources, its use in enhanced oil recovery ultimately contributes to the production of additional fossil fuels. Scholars, therefore, debate whether CCU represents a genuine decarbonisation strategy or a transitional mechanism that prolongs reliance on petroleum resources (Markusson et al., 2017).

C. Operational Decarbonisation

In addition to carbon capture technologies, petroleum companies are increasingly focusing on reducing emissions within their own operations. In this case, operational decarbonisation strategies include methane leak detection and reduction, electrification of drilling and production facilities, and the integration of renewable energy sources into refinery operations (Fattouh et al., 2018). Several multinational oil companies have begun implementing such initiatives as part of their sustainability commitments, like how TotalEnergies has introduced programs aimed at reducing methane emissions and increasing the use of renewable electricity in its operations. These measures contribute to lowering the overall carbon intensity of oil and gas production while aligning corporate strategies with changing climate policies.

D. Diversification into Low-Carbon Energy

Another emerging trend in the petroleum industry is the diversification of energy portfolios toward low-carbon technologies since many major oil companies are investing in renewable energy, hydrogen production, and biofuels as part of broader energy transition strategies. Such diversification allows companies to reduce reliance on traditional fossil fuel revenues while positioning themselves within future energy markets. For example, Equinor has expanded its investments in offshore wind energy and hydrogen projects, which is signaling a strategic shift toward sustainable energy systems (IEA, 2021). These initiatives reflect a rather positively growing corporate approach in which petroleum companies seek to balance continued hydrocarbon production with increasing participation in the low-carbon economy.

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V. CHALLENGES AND CRITIQUES

Even though there is a growing investment in decarbonisation strategies, significant challenges still remain in the large-scale adoption and effectiveness of carbon mitigation technologies within the petroleum industry. These challenges include economic barriers, technological limitations, and broader political and ethical concerns regarding the role of fossil fuels in a sustainable energy future.

A. Economic Barriers

One of the most significant obstacles to implementing carbon capture technologies is the high cost associated with their deployment because carbon capture facilities require substantial capital investment, specialized infrastructure for transporting CO_2, and long-term monitoring of storage sites. According to the International Energy Agency, the financial viability of CCS projects often depends heavily on government subsidies, carbon pricing mechanisms, and supportive regulatory frameworks (IEA, 2022). Without such incentives, many petroleum companies may find it economically challenging to make use of carbon capture technologies at a large scale.

B. Technological Limitations

In addition to economic constraints, technological challenges also hinder the rapid expansion of CCS and CCU systems. Long-term storage of CO_2 in geological formations raises concerns about potential leakage, environmental risks, and monitoring requirements. Furthermore, carbon capture processes are energy-intensive, meaning that additional energy inputs are required to capture, compress, and transport carbon dioxide (Bui et al., 2018). These factors, thus, reduce the overall efficiency of carbon mitigation technologies and complicate their implementation within existing petroleum infrastructure.

C. Political and Ethical Concerns

Apart from technical and economic challenges, decarbonisation strategies within the petroleum sector also face substantial political and ethical criticism. Environmental organizations, including Greenpeace, argue that heavy reliance on carbon capture technologies may enable continued fossil fuel extraction rather than encouraging a full transition toward renewable energy systems, and critics majorly contend that such approaches risk delaying structural changes required to achieve long-term climate goals (Newell & Simms, 2020). This debate reflects a broader tension between maintaining global energy security and pursuing aggressive climate mitigation policies because while petroleum companies emphasize the importance of gradual transition strategies that incorporate carbon capture and operational efficiency improvements, critics argue that more rapid reductions in fossil fuel production are necessary to meet international climate targets. As a result, the role of the petroleum industry in global decarbonisation efforts remains a subject of ongoing debate within both academic and policy communities.

VI. FUTURE OUTLOOK FOR DECARBONISATION

The future course of decarbonisation in the petroleum industry will likely be shaped by a combination of technological innovation, policy interventions, and collaborative industry initiatives because one of the most significant policy instruments expected to influence this transition is the expansion of carbon pricing mechanisms. Carbon pricing systems, including carbon taxes and emissions trading schemes, are designed to internalize the environmental cost of carbon emissions and incentivize companies to adopt cleaner technologies (World Bank, 2023). By placing a financial value on carbon emissions, these mechanisms encourage petroleum companies to invest in emission reduction strategies such as carbon capture and storage. Government subsidies and financial incentives for Carbon Capture, Utilisation and Storage (CCUS) technologies are also expected to play a critical role in accelerating their adoption since many CCUS projects remain economically unviable without public financial support due to high infrastructure and operational costs. Policy frameworks promoted by international organizations such as the International Energy Agency highlight that large-scale deployment of CCUS will require coordinated government policies, long-term investment, and regulatory support (IEA, 2022).

Another emerging trend is the development of carbon capture hubs, where multiple industrial facilities share common infrastructure for carbon transportation and storage. These hubs reduce costs by allowing for collective investment and improving economies of scale. In addition, collaborative partnerships between governments, research institutions, and petroleum companies are becoming increasingly common in order to accelerate technological innovation and project implementation (Global CCS Institute, 2023). Together, these developments indicate that the decarbonisation of the petroleum sector will depend not only on corporate initiatives but also on strong policy frameworks and international cooperation that are aimed at facilitating a broader transition toward low-carbon energy systems.

VII. CONCLUSION

The petroleum industry is currently undergoing a significant transformation as global efforts to address climate change intensify, and increasing regulatory pressure, investor expectations, and international climate commitments have compelled petroleum companies to explore strategies aimed at reducing greenhouse gas emissions. Among these strategies, carbon capture technologies have emerged as a central component of industry-led decarbonisation efforts because by capturing and storing or reusing carbon dioxide emissions, these technologies offer a potential pathway for mitigating the environmental impact of fossil fuel production while maintaining energy supply. However, the role of carbon capture remains contested as while proponents view CCUS as a necessary transitional technology for achieving climate targets, critics argue that it may delay the broader shift away from fossil fuels. The effectiveness of decarbonisation strategies within the petroleum industry, therefore, depends on the balance between technological innovation and bigger structural changes within global energy systems. Ultimately, meaningful decarbonisation will require a combination of advanced technologies, supportive policy frameworks, and sustained collaboration between governments, industry stakeholders, and international institutions. As the global energy transition progresses, petroleum companies will play a crucial role in determining whether or not the sector moves toward a more sustainable and low-carbon future.

REFERENCES

[1] Bui, M., Adjiman, C. S., Bardow, A., Anthony, E. J., Boston, A., Brown, S., ... Mac Dowell, N. (2018). Carbon capture and storage (CCS): The way forward. Energy & Environmental Science, 11(5), 1062–1176.
[2] Fattouh, B., Poudineh, R., & Sen, A. (2018). The rise of renewables and energy transition: What adaptation strategy exists for oil companies and oil-exporting countries? Energy Transitions, 2(1–2), 45–58.
[3] Global CCS Institute. (2023). Global status of CCS 2023 report. Global CCS Institute.
[4] Intergovernmental Panel on Climate Change. (2023). Climate change 2023: Synthesis report. IPCC.
[5] International Energy Agency. (2021). Net zero by 2050: A roadmap for the global energy sector. IEA.
[6] International Energy Agency. (2022). Carbon capture, utilisation and storage: Technology report. IEA.
[7] Markusson, N., Dahl Gjefsen, M., Stephens, J., & Tyfield, D. (2017). The political economy of technical fixes: The (mis)alignment of clean fossil and political regimes. Energy Research & Social Science, 23, 1–10.
[8] Newell, P., & Simms, A. (2020). Towards a fossil fuel non-proliferation treaty. Climate Policy, 20(8), 1043–1054.
[9] Rogelj, J., Shindell, D., Jiang, K., et al. (2018). Mitigation pathways compatible with 1.5°C in the context of sustainable development. In Global warming of 1.5°C. IPCC.
[10] Sovacool, B. K. (2016). How long will it take? Conceptualizing the temporal dynamics of energy transitions. Energy Research & Social Science, 13, 202–215.
[11] United Nations Framework Convention on Climate Change. (2015). The Paris Agreement. UNFCCC.
[12] World Bank. (2023). State and trends of carbon pricing 2023. World Bank.

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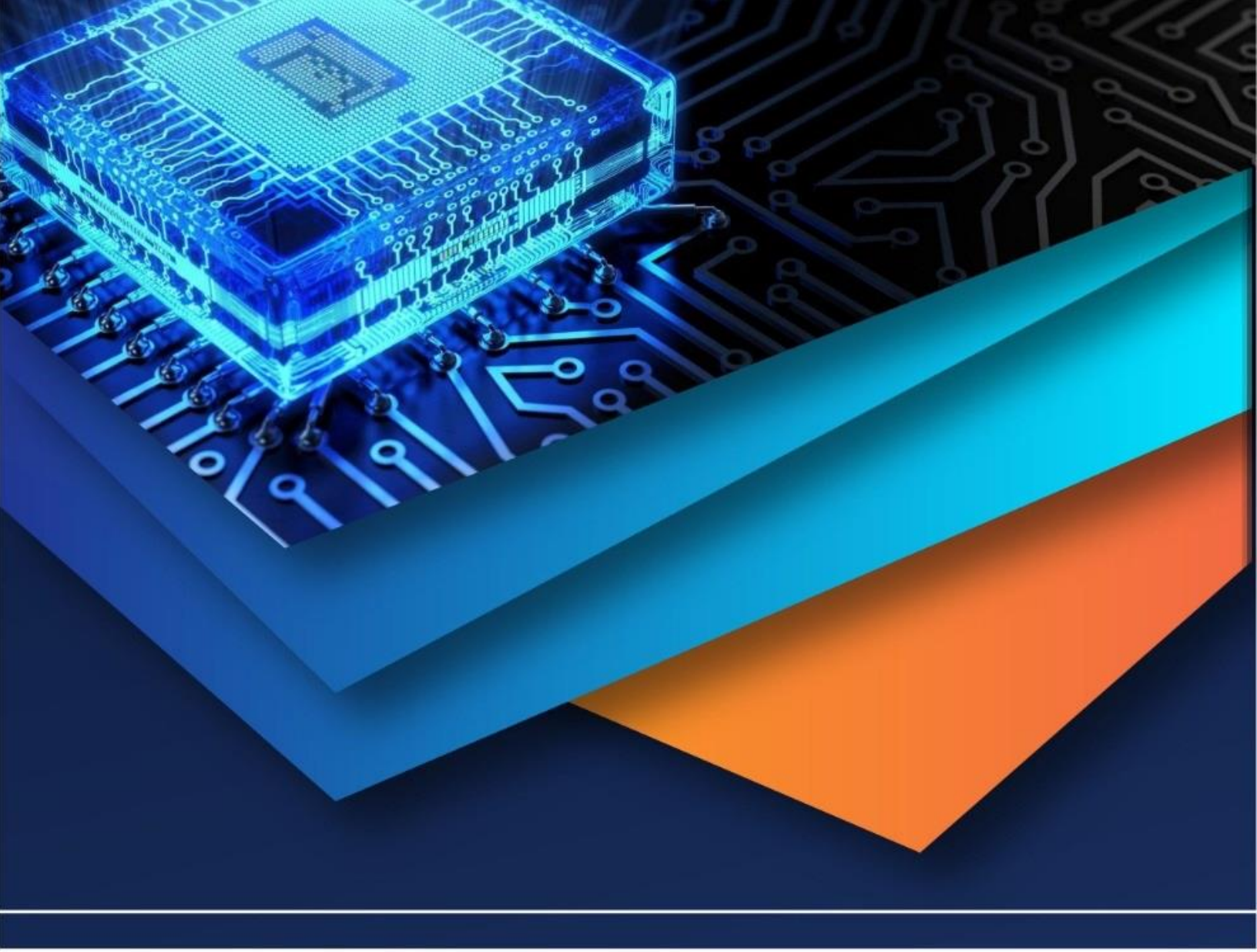

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