

SUSTAINABLE TRANSFORMATION OF THE UNITED ARAB EMIRATES OIL AND GAS SECTOR

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Summary

This paper critically examines the sustainable transformation of the United Arab Emirates (UAE) oil and gas sector in the context of global climate imperatives and economic diversification. The UAE, a major hydrocarbon exporter, faces the dual challenge of sustaining economic growth while achieving ambitious decarbonisation targets, as outlined in the Paris Agreement and the Net Zero 2050 Strategic Initiative. Drawing on transition management and comparative policy analysis, the study explores the UAE's adoption of advanced technologies—including Carbon Capture, Utilization and Storage (CCUS), Direct Air Capture (DAC), Artificial Intelligence (AI), and Leak Detection and Repair (LDAR)—and evaluates their potential to mitigate emissions and modernise the sector. The analysis benchmarks the UAE's strategies against global leaders such as Norway, Canada, and Saudi Arabia, highlighting the importance of policy innovation, regulatory frameworks, and stakeholder engagement in enabling a just energy transition. The findings reveal that while the UAE has made substantial investments in clean energy and technological innovation, further progress is needed in regulatory enforcement, carbon pricing, and regional cooperation. The paper concludes with policy recommendations for strengthening the UAE's decarbonisation roadmap, emphasising the integration of advanced technologies, green finance, and workforce reskilling to ensure long-term economic and environmental resilience.

Keywords: UAE, oil and gas, decarbonisation, energy transition, CCUS, policy, innovation, climate change

Word count: 2042

Introduction

The United Arab Emirates (UAE) occupies a pivotal position in global energy markets, underpinned by substantial oil and gas reserves and a GDP of \$504.17 billion (OPEC, 2024). Despite its economic reliance on hydrocarbons, the UAE has articulated ambitious sustainability targets, including the Net Zero 2050 Strategic Initiative and the Paris Agreement. However, the challenge lies in reconciling economic growth with decarbonisation imperatives. To critically examine the UAE's transition, this paper adopts the Multi-Level Perspective (MLP) on socio-technical transitions (Geels, 2002) and Transition Management Theory (Loorbach, 2010), which

provide conceptual lenses for understanding how technological innovation, institutional change, and policy frameworks interact to enable sustainability in resource-dependent economies.

Theoretical Framework

Transition Management Theory posits that complex socio-technical systems, such as national energy sectors, undergo transformation through coordinated policy, technological innovation, and stakeholder engagement (Loorbach, 2010). The MLP framework distinguishes between niche innovations (e.g., CCUS technologies), regime-level actors (e.g., state oil companies), and broader landscape pressures (e.g., global climate agreements) (Geels, 2002). By applying these frameworks, this paper situates the UAE's efforts within the broader literature on sustainability transitions (Markard et al., 2012), offering a theoretically grounded analysis that moves beyond descriptive policy synthesis

Research Question and Objectives

Research Question

How do the UAE's technological and policy strategies for decarbonising the oil and gas sector compare with global benchmarks, and what theoretical insights do these comparisons offer for managing sustainability transitions in resource-dependent economies?

Objectives

1. To analyse the UAE's decarbonisation strategies through the lens of transition management and the multi-level perspective.
2. To benchmark the UAE's policies and technological innovations against leading international cases (Norway, Canada, Saudi Arabia).
3. To identify institutional barriers and enablers for scaling low-carbon technologies in the UAE oil and gas sector.

Methodology

This paper employs a qualitative comparative policy analysis. Data sources include peer-reviewed academic literature, policy documents, and industry reports published between 2015 and 2025. The selection of international benchmark cases (Norway, Canada, Saudi Arabia) is based on their recognized leadership in oil and gas sector decarbonization and relevance to the UAE's context. Thematic coding was conducted to identify patterns in policy design, technological adoption, and institutional arrangements. The analysis is structured using the MLP and transition management frameworks to ensure conceptual coherence.

Literature Review

The literature on energy transitions highlights the importance of aligning technological innovation, policy frameworks, and stakeholder engagement to achieve decarbonisation (Markard et al., 2012; Cherp et al., 2018). The MLP framework has been widely used to analyse how niche technologies (such as CCUS and AI-enabled monitoring) can disrupt established energy regimes under landscape pressures like international climate agreements (Geels, 2002). Transition Management Theory emphasises the role of coordinated policy interventions and multi-actor governance in steering complex systems toward sustainability (Loorbach, 2010). Studies on the Gulf region underscore the unique challenges faced by hydrocarbon-dependent economies in balancing economic and environmental objectives (Al-Saidi & Elagib, 2017).

Advancing Sustainability in the UAE Oil and Gas Sector

Carbon Footprint and Environmental Challenges

Like the 166 other countries, the UAE's total annual emissions are less than 1% (~0.55%) of global emissions. In 2019, 36% CO₂ emissions were generated by the power industry, 33% by the transport sector, 17% by Buildings and 13% by non-combustion sources. Other industrial combustion had the smallest share (1%). To address this, it aims to increase its renewable energy contribution under its Energy Strategy 2050 by investing \$54 billion in next seven years. A sustainable energy transition is vital for both environmental and economic security, with GHG emissions as the key success measure (Al-Ragom, 2024).

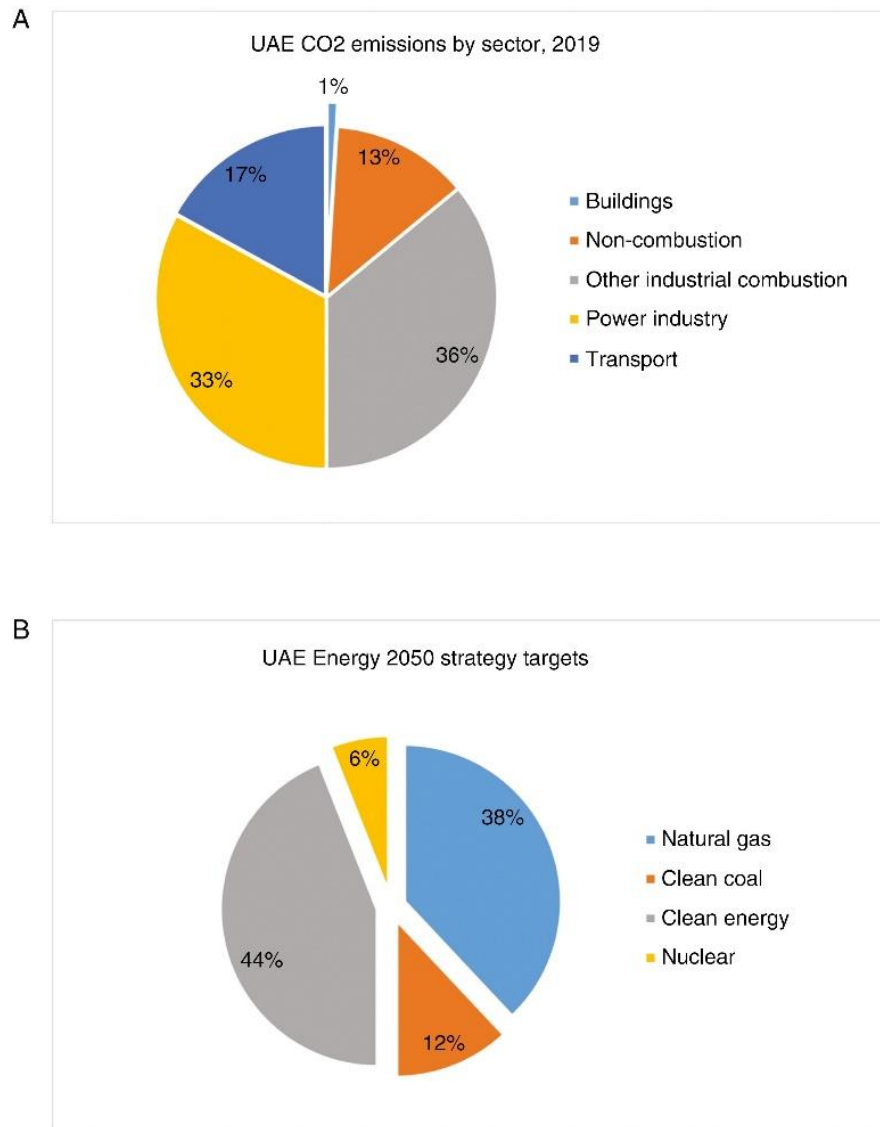


Figure 1(Sector wise emissions and Energy 2050 targets - (Al-Ragom, 2024))

The UAE GHG Emissions System comprises of two main sectors: power generation and energy-intensive industries. In power generation, emissions come from gas and clean coal, with yearly and cumulative emissions determined by emission factors and activity levels (Figure 2).

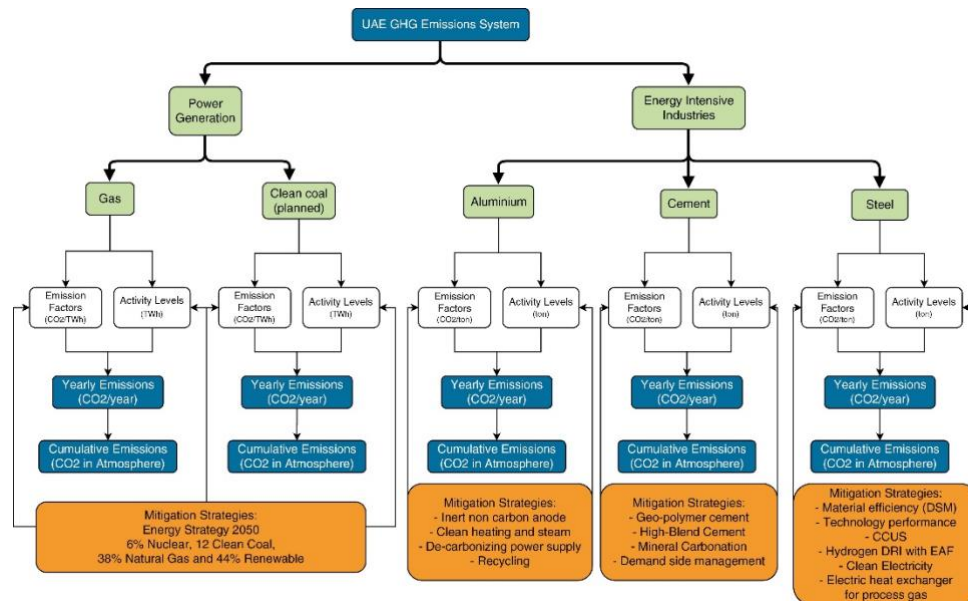


Figure 2(UAE Emission System - (Al-Ragom, 2024))

Beyond Existing Sustainability Strategies: New Frontiers

Carbon Capture, Utilization, and Storage (CCUS) Technologies efficiently reduce emissions from oil and gas sector. They involve capturing CO₂ from the sources, using it for various applications, and storing it in geological formations. The captured CO₂ is stored in deep saline aquifers, depleted oil fields, and coal seams. These sites are selected based on extensive geological surveys.

Enhanced Oil Recovery (EOR): The captured CO₂ has very important application in increasing the output from the depleting oil fields. The captured CO₂ is introduced in the oil fields to increase oil production. Subsequently, this phenomenon provides a storage solution for captured CO₂. This enables fossil fuel extraction and contributes to long-term CO₂ sequestration.

Leak Detection and Repair (LDAR): The oil and gas industry use LDAR system to oversee GHG emissions using advanced sensors and cameras (infrared cameras, drones, and continuous monitoring sensors). This system detects leakages and suggests timely repairs to minimize leakages efficiently subsequently preventing greenhouse gas emissions.

Direct Air Capture (DAC): This technology captures CO₂ directly from the atmosphere. This has significantly improved efficiency of the energy systems.

Artificial Intelligence (AI) in CCUS and plant operations: AI is useful technology in reducing human labor time and finances. It optimizes the operations using large datasets, detect discrepancies and help addressing the short comings and improve overall efficiency and effectiveness of the system. In Oil and Gas sector, AI helps in optimizing the carbon capture, determine storage site stability based on geological factors, and monitor emissions. Machine learning techniques employed in oil and gas sector improve real-time monitoring and detection of CO₂ leakages, optimizes plant operations, chemical conversion processes, and enhances logistics for CO₂ transport and storage (Saxena et al., 2024).

Lessons from Global Best Practices

There are best practices available which are adopted by the countries rich in oil reserves. UAE, by following these practices can bring concrete interventions in its overall oil and gas sector. For example, Norway has electrified its offshore oil platforms which has helped it in significantly reducing emissions from upstream operations (Gravdal, 2022), Canada has incentivized development of CCUS projects (Cortinovis, 2023) and Saudi Arabia's has taken NEOM hydrogen initiative. Its circular carbon economy model enables sustainable hydrocarbon use and renewable energy development (Islam & Ali, 2024).

Geopolitical and Market Implications

The UAE's oil and gas transformation encounters a complex geopolitical and economic environment. Being OPEC+ member, it needs to develop a balance between production targets, maintain its market position and global sustainability agenda. Global energy transition policies has the potential to negatively impact the UAE's oil exports by decreasing demand and incurring costs on hydrocarbon fuels. The UAE needs to foster economic partnerships with the global partners while bringing timely interventions for transforming its oil and gas sector and aligning it with global sustainability agenda.

Workforce Transition and Social Implications

The shift towards sustainable oil and gas sector will significantly impact employment of its workforce. For this purpose, a structured workforce transition plan is essential such as reskilling programs in advanced technologies such as AI.

Analysis and Global Benchmarking

Applying the MLP and transition management frameworks reveals that the UAE's decarbonisation efforts are at a critical juncture. While technological and policy innovations are evident, institutional inertia and economic dependencies pose significant challenges. Lessons from Norway and Canada suggest that multi-actor governance, robust regulatory frameworks, and sustained investment in human capital (e.g., workforce reskilling) are essential for successful energy transitions (Markard et al., 2012; Bang et al., 2017). The UAE's ability to adapt its governance structures and foster cross-sectoral collaboration will determine the effectiveness of its transition.

Norway has successfully electrified offshore oil platforms, significantly reducing upstream emissions through collaborative governance involving industry and civil society (Gravdal, 2022; Bang et al., 2017). Canada has incentivised CCUS through subsidies and regulatory frameworks, fostering public-private partnerships (Cortinovis, 2023). Saudi Arabia's NEOM hydrogen initiative demonstrates the integration of renewable energy and circular carbon economy principles (Islam & Ali, 2024).

In contrast, the UAE's approach is predominantly state-led, with limited mechanisms for participatory governance or independent evaluation. This centralisation may facilitate rapid deployment but risks overlooking local context and stakeholder buy-in, which are critical for long-term sustainability (Cherp et al., 2018).

Recommendations and Roadmap for a Sustainable Future

To accelerate the UAE's sustainable energy transition, UAE needs to strengthen its framework of adopting advanced technologies in its Oil and Gas sector to reduce the harmful impacts of conventional practices in the sector, carbon credits/pricing, green financing, and enhance regulatory measures for emissions control. UAE may enhance regional cooperation among Gulf countries and take the lead to enable a just transformation of the region's Oil and Gas sector while ensuring economic growth and social uplift.

Conclusion

The UAE's sustainable transformation of its oil and gas sector requires an integrated approach that combines technological innovation, robust policy frameworks, and institutional reform. By learning from global leaders and embracing participatory governance, the UAE can position itself as a pioneer in sustainable energy while safeguarding economic and environmental resilience.

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