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## Bridging Borders: International business strategies for harmonizing sustainability in the oil and gas industry

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### Abstract

The ecological traits of the oil and gas industry are not homogeneous with the different regulatory frameworks, different expectations from stakeholders and technological differences in various areas. This review examines international business strategies addressed to these challenges and proposes mechanisms to facilitate international collaboration and sustainable development. Technology transfer, stakeholder engagement, and standardised sustainability metrics are key strategies identified for better accountability of best practices. The study highlights the critical importance of public-private partnerships and financial instruments like green bonds in overcoming the challenges of de-carbonizing our economy. Furthermore, it examines the extent to which renewable energy integration into operational strategies brings about synergy with global sustainability goals, especially the United Nations Sustainable Development Goals (SDGs). This research analyzes 16 case studies from different regional contexts to provide actionable insights about policy alignment, innovation promotion, and the creation of frameworks for multi-stakeholder collaboration. To make global sustainability efforts uniform and reflect the regulatory space discrepancies, the proposed strategic framework advocates for resource allocation equity, advocates the use of new technology, and harnesses the existing technology. With a focus on providing a helpful resource for policymakers, industry practitioners, and other stakeholders in their work to balance a progressive environmental stewardship approach with healthy economic growth and ecological preservation, this work is an invaluable commodity.

**Keywords:** Sustainability; Decarbonization; Innovation; Stakeholders

### 1. Introduction

More and more, the oil and gas industry is turning to 'greening' its operations to reduce its considerable environmental footprints, including greenhouse gas emissions and land degradation. Strategies include using weighting matrices to assess and mitigate environmental effects in Environmental Management Systems (EMS) that would increase operational efficiency and sustainability (Guerrero-Martin et al., 2023). Technological innovations regarding oil and gas transport and storage in supply chains are also important in aiming at energy efficiency and emission reductions across supply chains (Chen et al., 2023). Additionally, artificial intelligence has its place in environmental management as an integrated approach that not only enhances ecological outcomes but also financial gains in accordance with Sustainable Development Goals (SDG) (Chutcheva et al., 2022). This is done alongside strategic frameworks that pair business

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analysis with sustainability and environmental compliance for reducing carbon footprints (Bello, 2024; Bello et al., 2024).

Furthermore, this can build the firm performance by installing a green governance framework that addresses economic, social and environmental risk, to foster cleaner operation (Shah et al., 2022). The form of these efforts reflects a complicated interrelationship of regulatory frameworks, stakeholder desires and technological progress in bringing about an equilibrium between economic development and ecological protection (Ibrahim et al., 2023). As a highly globalized industry, the oil and gas industry experience many complications due to its diverse regulatory frameworks across nations that reflect differing local priorities concerning environmental standards and development. The different stringency and focus of compliance requirements to which multinational enterprises must adapt create challenges for them, and result in strategic inconsistencies in terms of the development and implementation of sustainability efforts (Lo et al., 2020; Wijen & Tulder, 2011). To provide a practical understanding of the effects of these conflicting factors, countries with strict environmental regulations impose higher compliance costs and vice versa and other countries may prioritise economic growth while others will utilize a fragmented approach to sustainability, which hinders unified global strategies (Ahmad et al., 2023; Schilling-Vacaflor & Gustafsson, 2023). Additionally, initiatives to promote corporate social responsibility related to environmental impacts are implemented in largely Global North states, but political dynamics and managerial discretion continue to impede compliance across different jurisdictions (Restrepo, 2023).

Being pressured from many aspects by stakeholders, oil and gas companies must innovate to align with local needs of operation profiles and global sustainability goals. Environmental laws impose compliance on governments and regulatory bodies, and as such, companies are required to innovate and integrate clean technology to comply with United Nations Sustainable Development Goals (SDGs) (Menéndez-Sánchez et al., 2023). Environmental, social, and governance (ESG) principles, coupled with input from local communities, are continually advocated to rectify pollution and land use, and investors favoring the principles are increasingly prioritizing their impact on corporate performance and sustainability (Ahmad et al., 2023). The interrelations of these pressures engender a complex ecosystem where enhanced scrutiny by stakeholders increases the credibility of corporate social responsibility (CSR) efforts and influences firm performance (Forcadell et al., 2022). In this case, oil and gas companies must carefully straddle these mixed expectations to achieve both economic and environmental performance (Hernández-Arzaba et al., 2022).

Technological innovation has a vital role to play in oil and gas sustainability by the means of carbon capture and storage, green hydrogen production and digital monitoring tools changes. We observe that nonrenewable energy use and carbon emission are inversely related to renewables performance in European economies (Umar et al. 2023). Yet the unequal exploitation of these technologies, particularly in developing countries, demonstrates disparity in infrastructure and investment capabilities, which limit development along the path to sustainability (Chen et al., 2023). However, digital technologies, such as IoT and AI, are also critical for optimising energy systems and increasing the operational efficiency, but this is limited by the implementation challenges that need to be addressed so that these technologies can be equally advanced across regions (Singh et al., 2022).

Addressing sustainability challenges increasingly require collaboration between stakeholders, and this is especially the case if we aim at the Sustainable Development Goals (SDGs). Such as the emphasis at SDG 17 on multi stakeholder partnerships which serve to integrate diverse interests and resources necessary to country tackle transboundary issues such as air and water pollution (Bulmer & Yáñez-Araque, 2023). An example is produced from the construction sector, where the circular economy principles have to be applied and the effective stakeholder engagement has to take place to optimise the use of the resource (Senaratne et al., 2023). Additionally, frameworks for stakeholder engagement, including Innovation Platforms, have proved successful in bridging cooperation on complex social problems (Edlmann & Grobbelaar, 2021). Nevertheless, a lack of governance complexities and regional disparities makes achieving the SDGs difficult, requiring standardized sustainability metrics and accountability mechanisms (Allen et al., 2023; Nonet et al., 2022).

The financial dimension of sustainability will shape the harmonization of the oil and gas industry particularly in cross border capital flows and green investments. More recently, global financial institutions are providing increasing incentives for oil and gas companies to shift toward low carbon strategies, yet, as Chen et al. (2023) specify, challenges abide, particularly in developing regions where access to clean energy financing remains restricted (Udeagha and Muchapondwa, 2023). The need for enhanced green finance mechanisms becomes clear in the case of development of the BRICS nations despite substantial renewable energy potential, as the lack of overcoming this inertia represents a challenge in reducing fossil fuel reliance (Udeagha & Muchapondwa, 2023). Geopolitical actions complicate efforts towards sustainability through political tensions and trade policies, which hinder the transfer of technology and

collaboration, and cooperation agreement may assist aligning sustainability goals (Baur and Todorova, 2023; Grosu et al., 2023).

In the oil and gas industry's transition toward sustainability, corporate responsibility is an important part of the transition as companies increasingly incorporate corporate social responsibility (CSR) within their core strategy. Additionally, these initiatives contribute to improving transparency, restoring stakeholders' trust, and they better meet local and global sustainability expectations for implementation (Batool et al, 2023) (Karagiannopoulou et al, 2023). Despite the challenges, the increase of renewables brings, oil and gas companies are racing to adapt, with investments in renewables as oil and gas firms diversify their portfolios in response to the global energy transition (Stawicka 2021; Wu & Jin, 2022). Nevertheless, any effectiveness of these CSR efforts hinges on strong corporate governance as well as innovation in meeting market demands, as indicated by the positive relationship between CSR practices and the sustainable development outcomes (Wu & Jin, 2022; Alregab, 2022).

For these reasons, this study addresses the gap in the literature for frameworks that help to harmonize sustainability strategies in the oil and gas industry across various regulatory, technological, and regional contexts. It proposes mechanisms to implement global synchronization across borders, highlights the potential for efficient transfer of technology to resource low regions, and presents actionable models for multi stakeholder collaboration. Moreover, the research investigates the neglected role of standardized sustainability metrics and alternative green financial deals such as green bonds as drivers of equitable access to decarbonization resources. Our insights attempt to provide a coherent vision of how the industry should address global sustainability. The goals of this study are to harmonize sustainability efforts in the oil and gas industry through the elimination of regional regulatory disparities and the bridging of cross border policy alignment in the industry. It also aims to examine creative methods for overcoming obstacles and moving toward decarbonisation such as technology transfer, cooperative partnerships, and green bonds financing techniques. Finally, proposes a strategic framework for the integration of sustainable technologies and public private collaboration to provide actionable insights for policymakers and industry leaders as they strive to reach global sustainability goals while helping achieve long term environmental and economic balance.

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## 2. Methodology

### 2.1. Literature Search Strategy

The review adopted a systematic approach to identify relevant studies on international business strategies for harmonizing sustainability in the oil and gas industry. Databases such as Scopus, Web of Science, and Google Scholar were utilized to retrieve peer-reviewed articles, industry reports, and policy papers. Keywords like "oil and gas sustainability," "cross-border policy alignment," "technology transfer," "green bonds," and "SDGs in energy" were employed. The search spanned a broad timeframe to capture both historical trends and recent innovations, with filters applied to prioritize high-impact journals and case studies addressing regional and global contexts.

### 2.2. Selection Criteria

The inclusion criteria focused on case studies and research articles that directly addressed sustainability in the oil and gas industry. Selected studies needed to provide:

- Evidence of cross-border collaboration or policy alignment.
- Insights into technological or financial mechanisms for achieving sustainability.
- Evaluations of multi-stakeholder engagement models, particularly in regions with significant environmental or regulatory challenges.
- Exclusion criteria omitted studies focused purely on theoretical frameworks, lacking empirical analysis, or unrelated to the oil and gas sector. 16 case studies were shortlisted from out of this set of 100+ initial records, covering a range of regional and thematic perspectives.

### 2.3. Research Questions

To guide the review, the following research questions were formulated:

- How can international business strategies address cross-border regulatory and sustainability challenges in the oil and gas industry?
- What role do technological innovations and financial instruments play in harmonizing global sustainability efforts?

- How do multi-stakeholder partnerships contribute to aligning regional initiatives with global sustainability goals, such as the SDGs?
  - What frameworks can be proposed to standardize sustainability metrics and improve accountability across diverse regulatory landscapes?
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### **3. Result**

Results are presented from 16 case studies (table I), organized into thematic clusters to address specific challenges and strategies related to harmonizing the sustainability of the oil and gas industry. Every cluster provides a list of key observations, context from the region, and an overview of future directions.

#### **3.1. Regional Regulatory Disparities and Policy Alignment**

The challenge and opportunity of aligning sustainability policies across regions are featured in this cluster. She examines the regulatory and political dimensions of sustainable infrastructure development between Canada and the U.S., in the context of cross-border energy governance (Hale 2019). The emphasis is on the strong engagement between policymakers and suggests that multinational infrastructure projects are fostered both for greater collaboration and to ensure minimum coordination over common investments. The sustainability reporting practice of Petrobras (Brazil), and Repsol (Spain) is demonstrated by Junior et al. (2017). Strong alignment with regional reporting framework is found, but there is a need on globalizing reporting frameworks to increase transparency and accountability.

#### **3.2. Collaborative Partnerships and Stakeholder Engagement**

In this cluster, studies are devoted to promoting partnership for better sustainability. Azu and Eze (2018) explore the Chevron and Shell's Nigeria model of the Global Memorandum of Understanding (GMOU), to assess how this model encourages active community involvement and conflict resolution. For the study, the model was nevertheless able to demonstrate scalability to other regions despite limited policy integration. According to Abro et al. (2016), Saudi Aramco's Corporate Social Responsibility (CSR) carried out through strong community engagement and alignment with local policies. The study recommends extending corporate social responsibility practices to meet global sustainability challenges. Vilardo and La Rovere (2018) study environmental impact assessments of offshore oil and gas projects in Brazil, recommending local authorities' participation in harmonising compliance strategies.

#### **3.3. Technological Innovation and Learning**

The theme of this cluster is the role of innovation in improving the sustainability. Hassan et al. (2024) examines Saudi Arabia's transition to green hydrogen as central to the country's energy vision, and determine that strong public-private partnerships and leading a transition to mitigate climate change. The focus of Mirimoghadam and Ghazinoory (2017) is institutional learning in Iran's South Pars Gas Field in combination with sustainable technology integration. Technology transfer is possible as a crucial factor for cross-border sustainability according to the study. In their paper, Cheng et al. (2023) explore green innovations in oil and gas exploration globally, focusing on the need to design the technological advancement and sustainability goal alignment using multinational collaborative model.

#### **3.4. Financial Strategies for Sustainability**

This cluster looks at the financial tools for decarbonization. Emodi et al. (2023) study the role of cross border capital flows in funding the optimization of investments towards decarbonization using frameworks for sustainable funding mechanisms. To finance renewable energy projects, Azhgaliyeva et al. (2020) review green bonds in Southeast Asia. This study stresses the take of governments and investors and encourages the expansion of the use of green bonds around the globe. Tyaglov et al. (2021) analyses localized financial strategies in Russia for mitigation of climate change, suggesting relatively strong alignment with global SDGs and the need to embed these targets in regional financial policy.

#### **3.5. Low-Carbon and Renewable Energy Transition**

In this cluster of studies, we consider strategies for transitioning to cleaner energy sources. A strong collaboration between government and industry supports Lu et al. (2019) study of how Chinese oil companies integrate the low carbon strategies. It further recommends further integration of renewable energy into operational strategies. In a 2018 study of international oil companies' renewable energy investments, Zhong and Bazilian (2018) show how such investments are based on energy policies and innovation toward reducing carbon footprints.

### **3.6. Contribution to SDGs and Ecosystem Engagement**

The oil and gas sector is evaluated within this cluster against global sustainability goals. The contribution of local innovation ecosystems to SDGs is explored by Menéndez-Sánchez et al. The importance of ecosystem level engagement and building multi stakeholder innovation frameworks is emphasized by the study. As in Ponomarenko et al. (2021), the methodologies that Ponomarenko et al. (2021) proposes for corporate sustainability assessments are based on harmonizing regulatory frameworks.

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## **4. Discussion**

Comparative analysis of the results occur in this section, in which the findings of the case studies are contextualized with broader literature in order to identify global trends in, and gaps of, how the oil and gas sector are being rolled out with respect to sustainability practices.

### **4.1. Regional Policy Alignment**

Hale (2019) and Junior et al. (2017) deal with policy alignment and regional regulatory disparities. Through an analysis of cross border energy governance between Canada and the U.S, this thesis analyzes the ways in which policymakers can overcome regulatory barriers. Petrobras and Repsol reports of sustainability, as examined by Junior et al, reveal regional discrepancies and global harmonisation. These results are in line with Peña-Ramos et al. (2021) and Pietzcker et al. (2021). Peña-Ramos et al. (2021) compares Spain's alignment with the EU, Green Deal, weighing national and EU priorities. For example, Pietzcker et al. (2021) reviews tightening caps of the EU Emissions Trading Scheme and reports how it influences decarbonization in different member states. Moreover, Lu et al. (2019) examining low carbon strategies in China argues that the governmental coordination align national policies with industry practices.

### **4.2. Stakeholder Engagement and Collaborative Partnerships**

This is also highlighted by Azu and Eze (2018) and Abro et al. (2016) as the importance of regional stakeholder engagement. In Nigeria, Azu and Eze focus on the GMoU model, whilst Abro et al. discuss Saudi Aramco's CSR practices; both of which stress the community-centred aspect of sustainability. Guest contributions include Vilaro and La Rovere (2018) analyzing the working of local authorities with environmental impact assessment processes for offshore projects in Brazil. These findings are in agreement with Rustad et al. (2017) and Sovacool et al. (2016), involving the Extractive Industries Transparency Initiative (EITI). Rustad et al. show how EITI can facilitate multi stakeholder collaboration globally and Sovacool et al give insight into the structural inequities which can hinder wider adoption. This is further supported by Kirchhoff et al. (2016) who demonstrate how community driven microgrid projects in the Global South and Germany give voice to stakeholders.

### **4.3. Technology and Innovation**

Cheng et al. (2023), Hassan et al. (2024) and Mirimoghadam and Ghazinoory (2017) emphasize on the transformable potential of achieving technological innovation. An investigation of Saudi Arabia's green hydrogen initiatives, Hassan; Cheng looks at global green innovations in oil exploration, focusing on multi national collaboration. In the context of Iran's South Pars Gas Field, Mirimoghadam and Ghazinoory examine institutional learning, describing barriers to the adoption of new technologies. These studies confirm with Moner Girona et al. (2018) and Zhong and Bazilian (2018). In a discussion of technology transfer to resource-limited regions, Moner-Girona et al. (2018) discusses the deployment of hybrid mini grids in Sub-Saharan Africa. Since international oil companies continue to invest in renewable energy, Zhong and Bazilian (2018) take a closer look at whether these ventures are backing into sustainability goals.

**Table 1** Case Studies for Review Manuscript

Reference	Study Methodology	Case Study	Focus Area	Key Insights	Regional Context	Stakeholder Involvement	Policy Alignment	Innovation Leadership	Future Directions
Abro et al. (2016)	Qualitative Analysis	Saudi Aramco CSR Practices	Corporate Social Responsibility (CSR)	Explores how Saudi Aramco integrates CSR practices within the local and global regulatory framework to align sustainability initiatives.	Saudi Arabia	Strong corporate and community engagement	High alignment with regional policies	Limited focus on technology	Expand CSR to address global sustainability
Azhgaliyeva et al. (2020)	Policy Review	Green Bonds for Renewable Energy in Southeast Asia	Climate Finance Mechanisms	Evaluates the role of green bonds in financing renewable energy and energy efficiency projects.	Southeast Asia	Involvement of governments and investors	High alignment with global finance policies	Limited role in technical innovation	Expand adoption of green bonds across regions
Azu & Eze (2018)	Comparative Case Study	Chevron and Shell GMoU in Nigeria	Collaborative Partnerships	Highlights the Global Memorandum of Understanding (GMoU) model for fostering community relations, conflict resolution, and sustainability in Nigeria's oil and gas sector.	Nigeria	Active involvement of local communities	Limited policy integration	Limited focus on technology	Scaling the GMoU model across regions

Cheng et al. (2023)	Policy Review	Green Innovation in Oil and Gas Exploration and Production	Innovation and Sustainability Goals	Discusses innovative technologies and methods in oil and gas exploration to align with global sustainability goals, offering insights for harmonizing strategies across borders.	Global	Collaboration across multinational companies	Alignment with global SDGs	Strong technological innovation	Focus on scaling green innovation globally
Emodi et al. (2023)	Financial Analysis	Cross-Border Capital Flows for Decarbonization	Financial Strategies for Sustainability	Examines the role of international financial flows in driving decarbonization in the global energy sector, emphasizing the harmonization of investments across borders.	Global	Involves investors and energy policymakers	High alignment with global financial policies	Moderate role in enabling decarbonization	Develop frameworks for decarbonization funding
Hale (2019)	Policy Analysis	Cross-Border Energy Infrastructure Governance	Policy and Infrastructure	Analyzes political and regulatory aspects of cross-border energy infrastructure development between Canada and the U.S., focusing on sustainable governance models.	Canada & U.S.	Engagement of policymakers and regulators	Strong policy alignment	Minimal focus on technology	Encourage multi-national infrastructure projects

Hassan et al. (2024)	Strategic Roadmap	Saudi Arabia Energy Transition to Green Hydrogen	Climate Change Mitigation and Sustainable Technologies	Evaluates the potential of green hydrogen as part of Saudi Arabia's energy transition strategy, offering insights into integrating sustainable technologies and partnerships in the energy sector.	Saudi Arabia	Public-private partnerships	Strong alignment with national goals	Strong focus on green hydrogen innovation	Promote regional leadership in green hydrogen
Junior et al. (2017)	Comparative Analysis	Petrobras and Repsol Sustainability Reporting	Sustainability Reporting	Comparative analysis of sustainability strategies in reporting by Petrobras (Brazil) and Repsol (Spain), emphasizing transparency and regional regulatory harmonization.	Brazil & Spain	Stakeholder transparency	Medium alignment with reporting standards	Minimal focus on technology	Harmonize global reporting frameworks
Lu et al. (2019)	Industry Analysis	Low-Carbon Strategies of Oil Companies (China)	Low-Carbon Transition	Explores strategies adopted by oil companies in transitioning to integrated energy companies with a focus on low-carbon emissions and	China	Industry and government collaboration	Alignment with national low-carbon policies	Moderate focus on sustainable technologies	Integrate renewable energy sources further



				innovation in China.					
Menéndez-Sánchez et al. (2023)	Strategic Review	Sustainability Strategies by Global Oil and Gas Companies	Contribution to SDGs and Innovation Ecosystems	Examines how international oil and gas companies contribute to Sustainable Development Goals (SDGs) through local innovation ecosystems and harmonized sustainability approaches.	Global	Ecosystem-level engagement	Strong alignment with SDGs	Moderate focus on fostering innovations	Build multi-stakeholder innovation ecosystems
Mirimoghadam & Ghazinoory (2017)	Case Study	South Pars Gas Field Development (Iran)	Technological Learning and Sustainability	Case study on institutional and technological learning in Iran's oil and gas industry, emphasizing the transfer and integration of sustainable technologies.	Iran	Institutional involvement in learning	Medium alignment with regional policies	Strong emphasis on technology integration	Promote cross-border technological transfer
Peña-Ramos et al. (2021)	Case Study	Spanish Energy Transition in the EU Green Deal	Policy Alignment	Examines Spain's alignment with the EU Green Deal, highlighting regulatory challenges and synergies.	Spain	Collaboration between EU and national stakeholders	High alignment with EU frameworks	Limited technological innovation	Address paradoxes in policy harmonization

Ponomarenko et al. (2021)	Framework Proposal	Corporate Sustainability Assessment Methods in Oil and Gas	Strategic Framework Development	Details methodologies for assessing corporate sustainability performance, focusing on harmonization across diverse regulatory frameworks in the oil and gas sector.	Global	Corporate-centric assessment	High alignment with industry standards	Limited focus on technology	Develop advanced sustainability metrics
Vilardo & La Rovere (2018)	Case Study	Offshore Oil and Gas in Brazil	Environmental Impact Assessment	Insights into multi-project environmental impact assessment for offshore oil and gas projects in Brazil, focusing on regional challenges and harmonized compliance strategies.	Brazil	Engagement of local authorities	Strong alignment with environmental policies	Moderate focus on technology for impact mitigation	Scale environmental assessments for global use
Tyaglov et al. (2021)	Conference Study	Russian Oil and Gas Companies and Climate Change Goals	SDG Implementation	Highlights how Russian oil and gas companies contribute to climate change mitigation through localized sustainability strategies and cross-border collaboration.	Russia	Limited community engagement	Medium alignment with SDGs	Minimal focus on technology	Integrate SDG goals into regional strategies

Zhong & Bazilian (2018)	Industry Review	International Oil Companies' Renewable Energy Investments	Energy Transition and Innovation	Investigates the role of renewable energy investments by international oil companies in shaping the global energy transition and reducing carbon footprints.	Global	Multinational corporate involvement	Strong alignment with renewable energy policies	Strong focus on renewable energy innovation	Increase investments in emerging markets
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#### 4.4. Financial Strategies and Decarbonization

Financial strategies for sustainability are explored by Emodi et al. (2023) and Tyaglov et al. (2021). In emodi et al. the role of cross border capital flows in driving decarbonisation is emphasised, whereas in tyaglov the localized financial strategies in Russia are evaluated and the moderate alignment with global SDGs concluded. This mirrors Azhgaliyeva et al. (2020), concerning green bonds in Southeast Asia as a means to finance renewable energy projects. Barua and Aziz (2022) and Dhakal and Shrestha (2021) offer further insights into green finance in the emerging economies and barriers to resource allocation. Ng and Tao (2016) compare bond financing to Asia with its scalability for decarbonization.

#### 4.5. Reporting and SDG Contributions

According to Junior et al. (2017) and Menéndez-Sánchez et al. (2023) sustainability reporting is vital and should be transparent and align with global SDGs. Petrobras and Repsol are also shown to differ in their reporting practices by Junior et al. (2017), which advocates for uniform frameworks, and Menéndez-Sánchez et al. (2023) looks at how global oil companies put SDGs into practice based locally in the form of innovation ecosystems. In the oil and gas sector, Alazzani and Wan Hussin (2013) discuss the use of GRI standards for transparency and comparability improvement. Variability in greenhouse gas reporting practices is identified by Comyns (2016) and the need for harmonised metrics is highlighted. As Okeke (2021) goes further to enhance, she criticizes the relatively meager emphasis on the correlation between business strategies and global sustainability standards.

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### 5. Conclusion and Recommendations

#### 5.1. Limitations of study

However, this study has several limitations, although its scope is comprehensive. Case studies, although illustrative, may not fully represent the complexity of sustainability practice in the industry. While the selected cases are geographically diverse, they may not be samples of all regional contexts, or of all regulatory environments. Second, the study draws principally on secondary data and published reports, which may limit the depth of insights especially in areas of rapid technology development such as green hydrogen technology and renewable energy integration. Moreover, variations in the richness and depth of data among the case studies may have changed the findings. The study finally tests the boundaries of currently available frameworks, mooted future prospects of the interplay of business and technological changes resulting from developing scenarios for the most likely events that can disrupt the chosen sustainability trajectories in the oil and gas sector.

#### 5.2. Conclusion

The oil and gas industry faces this challenge, what has struggled to merge the sustainability strategies into the global oil and gas industry in a multifaceted fashion is highlighted in this review. It accomplishes this by analyzing 16 case studies and revealing in what ways addressing regional regulatory disparities, engaging with stakeholders, and deploying innovative technologies are essential to attaining global sustainability goals. Green financial mechanisms like bonds and capital flows are highlighted as the way to facilitate a fair decarbonisation between regions. Additionally, the development of standardized sustainability metrics and the forging of collaborative partnerships establish the possibility of a convergence of diverse efforts toward alignment with the United Nations Sustainable Development Goals (SDGs).

Still, the analysis identifies persistent failures in cross border policy alignment, technology transfer to resource constrained regions and equitable access to financial resources. Due to these gaps, research for a sustainable and equitable energy future has to bridge these gaps through new approaches that strike the right balance between local priorities and global aspirations. Taking a practical approach for policymakers, industry leaders, and stakeholders to harmonized global sustainability while maintaining economic viability, the study offers actionable recommendations of brand sustainability.

#### *Recommendation for Future Studies*

The case studies describe some impressive achievements, although there are still gaps that pose future research opportunities. Hassan et al. (2024) stresses the scalability of green hydrogen technologies as one area. Research will be centred on the areas as barriers to adoption such as infrastructure constraints and technology transfer across borders. Similarly, renewable energy investments, described by Zhong and Bazilian (2018), are yet to be fully explored, in particular in emerging markets that face missing finance and policy support. Additional directions include standardising sustainability reporting frameworks in order to improve global accountability and studying mechanisms to evenly

distribute green financing tools, such as bonds and climate funds. Also worthy of further investigation are strengthening multi stakeholder collaboration models of addressing structural inequities and promoting inclusive decision making. The oil and gas sector holds these areas as a basis for advancing sustainability harmonization.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

### *Statement of informed consent*

Informed consent was obtained from all individual participants included in the study.

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