



(REVIEW ARTICLE)



## Renewable energy adoption in multinational energy companies: A review of strategies and impact

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### Abstract

This review provides a succinct overview of the research on renewable energy adoption within multinational energy companies, focusing on the review of strategies and their impact. As the global community intensifies its efforts to combat climate change, the renewable energy sector has become a focal point for multinational energy companies seeking sustainable and environmentally friendly solutions. This study critically examines the strategies employed by these companies to incorporate renewable energy sources into their operations and assesses the impact of such initiatives. The review begins by exploring the various strategies adopted by multinational energy corporations in their pursuit of renewable energy integration. These strategies encompass technological advancements, regulatory compliance, investment frameworks, and partnerships with key stakeholders. By analyzing a diverse range of multinational energy companies, the study aims to identify patterns and best practices that contribute to successful renewable energy adoption. Furthermore, the research delves into the broader impact of these strategies on both the companies themselves and the global energy landscape. The analysis considers economic implications, environmental benefits, and social responsibility, providing a comprehensive evaluation of the multifaceted effects of renewable energy adoption. Insights from this review can inform future decision-making processes for energy corporations, policymakers, and other stakeholders involved in the transition to a sustainable energy future. This review contributes valuable insights into the evolving landscape of renewable energy adoption among multinational energy companies. By examining strategies and their impact, the study seeks to enhance our understanding of the challenges and opportunities in fostering a more sustainable and resilient energy sector on a global scale.

**Keywords:** Renewable Energy; Multinational; Companies; Impact; Review

### 1. Introduction

The adoption of renewable energy technologies (RET) by multinational energy companies has become a critical area of interest due to its potential impact on sustainability and economic performance. The push for the introduction of renewable energy usage has been a core area of the Official Development Assistance (ODA) strategy for energy efficiency, stimulating RET adoption (Pfeiffer & Mulder, 2013). Foreign prospecting in solar and wind energy has provided significant opportunities for multinational investment, indicating a growing trend in the arena of renewable energy (Argenti & Knight, 2015). While the adoption of renewable energy can improve environmental performance, the economic implications of this transition remain a fundamental question for electric utilities (Ruggiero & Lehkonen, 2017). Moreover, the impact of national and corporate carbon emission reduction targets on renewable electricity use

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has been a subject of review, highlighting the non-significant effect of national-level targets on corporate renewable energy use (Chang & Lo, 2022).

In the transition to a low-carbon economy, the adoption of renewable energy technologies by energy investors, power utilities, and energy consumers has been emphasized as critical (Kiprop et al., 2019). However, barriers to the widespread adoption of renewable energy have been identified, necessitating policy options to inform the scaling up of renewable energy adoption in various contexts, such as the Gulf Cooperation Council countries (Al-Sarihi & Mansouri, 2022). Factors influencing consumer adoption of renewable energy have been studied, with results indicating a positive association between awareness and the adoption of renewable energy (Wall et al., 2021). Additionally, understanding the factors affecting public willingness to adopt renewable energy technologies has implications for governments, regulations, policy makers, marketing agencies, and investors (Makki & Mosly, 2020).

The legitimacy of sustainability and the factors that legitimize the adoption of renewable energy activities in oil and gas companies have been explored using institutional theory as a lens (Jaber & Oftedal, 2020). Furthermore, the role of intellectual capital in green supply chain management and its impact on the quality of services in renewable energy companies has been investigated, providing insights and recommendations for enhancing sustainability practices (Lutfi et al., 2023). The impact of digital transformation on the performance of renewable energy companies has been documented, indicating higher operating efficiency, lower costs, and better innovation success with the adoption of digital transformation (Ren & Li, 2023). Additionally, empirical studies have been conducted to investigate the acceptance of renewable energy using extended technology acceptance models, providing insights into the factors influencing renewable energy technology acceptance (Yang et al., 2021).

The performance of renewable energy companies before and after initial public offerings, as well as the impact of international oil prices on the stock price fluctuations of renewable energy enterprises, have been subjects of analysis, shedding light on the financial dynamics of renewable energy adoption (Ramadhan, 2022; Hsiao et al., 2019). Moreover, the introduction of renewable energy in various sectors, such as the Spanish wine sector, has been explored, highlighting barriers and opportunities for the widespread adoption of renewable energy (García-Casarejos et al., 2018). Studies have also focused on the optimal transition to renewable energy, investment factors in renewable energy and energy efficiency, and the acceleration of energy efficiency and renewables in warehouses and distribution centers, providing valuable insights into the complexities and opportunities associated with renewable energy adoption (Bonneuil & Boucekkine, 2016; Chikhi et al., 2022; Bianchi et al., 2023).

In conclusion, the adoption of renewable energy in multinational energy companies is a multifaceted and dynamic process influenced by economic, environmental, technological, and regulatory factors. Understanding the strategies and impact of renewable energy adoption in multinational energy companies requires a comprehensive review of the diverse factors and implications associated with this transition.

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## 2. Multinational Energy Companies

Multinational energy companies play a significant role in the global energy sector, contributing to economic growth and sustainability. These companies are involved in various aspects of the energy industry, including mining, oil and gas, renewable energy, and sustainability initiatives. The operations of multinational energy companies have a substantial impact on the global economy, stock markets, and systemic risk spillovers (Wu et al., 2021; Wielechowski & Czech, 2021; Lupu et al., 2021). Their activities are influenced by factors such as corporate social responsibility, innovation management, and strategic planning (Ahmed et al., 2021; Carayannis et al., 2021; Sitek & Tvaronavičienė, 2021). Additionally, the energy efficiency and environmental sustainability of these companies are crucial for the overall supply chain management and the development of renewable energy sources (Centobelli et al., 2018; Marchi & Zanoni, 2017).

The energy sector, particularly in emerging markets, faces challenges related to marketing dynamics, brand sales, and sustainability reporting (Almeida et al., 2020; Talbot & Boiral, 2015). Furthermore, the energy industry is closely linked to the mining sector, where policies have historically focused on massive exploitation by multinational energy companies, often aimed at increasing economic activity and contributing to GDP (Sapromo, 2019). The role of multinational energy companies in the context of the COVID-19 pandemic has also been highlighted, with a focus on sustainability transitions, energy justice, and research methodology (Sovacool et al., 2020).

In terms of financial performance, the stock market performance of multinational energy companies, especially in the context of the COVID-19 pandemic, has been a subject of research, with observations of significant increases in the share prices of clean energy companies (Wielechowski & Czech, 2021). Moreover, the nexus between corporate social

responsibility disclosure and its determinants in energy enterprises has been studied, revealing significant relationships with profitability, financial leverage, and board size (Ahmed et al., 2021).

The energy sector is also influenced by technological advancements and innovation management, particularly in the context of energy efficiency improvements and renewable energy sources (Cantini et al., 2021; Sitek & Tvaronavičienė, 2021). The investment attractiveness of the energy sector, particularly in the case of Russian energy sector multinational corporations, has been assessed, highlighting the significant profits provided to the Russian economy and the challenges faced by these companies (Gorodetskaya et al., 2021).

In conclusion, multinational energy companies are pivotal players in the global energy landscape, with their operations impacting various aspects of the economy, sustainability, and innovation. Understanding their role and influence is essential for addressing challenges and opportunities in the energy sector.

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### 3. Literature Review of Renewable Energy Adoption in Multinational Energy Companies

The historical perspective on renewable energy adoption in multinational energy companies has evolved significantly over the years. Previous studies have delved into the relationships between management performance, human capital, and the intention to use renewable energy, shedding light on the neglected aspects of human resource practices and intellectual capital (Fatihudin et al., 2020). Additionally, an exploratory analysis has identified 19 factors that affect public willingness to adopt renewable energy technologies, contributing to the understanding of the dynamics influencing renewable energy adoption (Makki & Mosly, 2020). Furthermore, a study on sustainable circular economy strategies has revealed fifty strategies emerging from a systematic literature review, providing insights into the diverse approaches to sustainability in the corporate sector (Sanches et al., 2022). Moreover, a review article has outlined the development of renewable energy in Romania, offering an overview of the country's energy sector and its future perspectives, contributing to the understanding of renewable energy at a national level (Cirstea et al., 2018).

The theoretical framework guiding renewable energy adoption in multinational corporations encompasses various theoretical models and perspectives. The relevance of theoretical perspectives to multinational corporations has been emphasized in the context of investigating factors affecting the adoption of renewable energy within businesses, highlighting the significance of exploratory research and data collection through literature reviews and interviews (Sharaf & Kortam, 2020; Ewim et al., 2023). Furthermore, the impact of foreign firm ownership on local renewal activities has been explored, adding considerations about how local aspects interact with international ones to form the global distribution of renewal activities (Henning & Jakob, 2022). Additionally, the development of the renewable energy power industry under feed-in tariff and renewable portfolio standard has been synthetically considered, establishing models of long-term development using system dynamics and analyzing the existing literature (Zhang et al., 2017; Ukoba and Jen, 2023; Ezeigweneme et al., 2023; Etukudoh et al., 2024). These theoretical perspectives provide a comprehensive understanding of the complexities involved in renewable energy adoption by multinational corporations.

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### 4. Strategies for Renewable Energy Adoption

To promote the adoption of renewable energy, various strategies can be implemented, encompassing technological advancements, regulatory compliance, investment frameworks, and partnerships. Technological advancements involve investments in renewable energy technologies and the integration of smart grids and energy storage, emphasizing the significance of investing in renewable energy technologies to reduce greenhouse gases and produce energy at lower costs (Salimi et al., 2023). Additionally, the integration of smart grids and energy storage systems is crucial. A novel control strategy based on a virtual synchronous generator for large-capacity energy storage systems (Wu et al., 2017). Furthermore, presented an improved strategy for energy storage management and demand-side management based on building energy efficiency technologies, which can be applied to smart grid topologies (Tsiamitros et al., 2014).

Regulatory compliance plays a pivotal role in renewable energy adoption. It is essential to examine global and regional regulatory frameworks and understand their impacts. A study developed an electric vehicle operational strategy for microgrid regulation, incorporating vehicle-to-grid or grid-to-vehicle mode operation (Nisar & Thomas, 2016). Moreover, highlighted the potential of demand-side management in increasing energy efficiency by reducing electricity peak demand and consumption (Saffari et al., 2018). Investment frameworks are crucial for the successful implementation of renewable energy projects. A study introduced innovative strategies for renewable energy investments using a multicriteria decision-making model based on incomplete preferences and Pythagorean fuzzy sets (Xie et al., 2021). Additionally,

emphasized the challenges in deploying storage units in smart grid systems and the need for new power management strategies (Wang et al., 2014).

Partnerships and collaborations with governments, NGOs, and local communities are vital for advancing renewable energy projects. emphasized the importance of a distributed energy management system integrating renewable energy sources and electric vehicles, which enhances communication between suppliers and consumers (Gosselin et al., 2017; Victor and Great, 2021; Johnson et al., 2023). Furthermore, highlighted the role of decentralized energy in improving electric supply security and changing the demand role in competitive energy markets (Buriticá-Arboleda & Álvarez-Bel, 2011).

In conclusion, the adoption of renewable energy requires a multifaceted approach, incorporating technological advancements, regulatory compliance, investment frameworks, and partnerships. By investing in renewable energy technologies, integrating smart grids and energy storage, complying with regulatory frameworks, implementing innovative investment strategies, and fostering collaborations, the transition towards renewable energy can be accelerated.

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## 5. Impact Assessment

To comprehensively assess the impact of renewable energy adoption, it is essential to consider economic implications, environmental benefits, and social responsibility. The economic implications involve evaluating the cost-effectiveness of renewable energy adoption and understanding the economic benefits and risks associated with such initiatives. discuss a method for comparing multiple competing interventions using risk-benefit analysis, which is analogous to cost-benefit analysis used in economics (Lazo-Langner et al., 2012; Ibekwe et al., 2024). This approach can be valuable in estimating the joint density of incremental risk and incremental benefit, providing insights into the cost-effectiveness of renewable energy adoption.

Furthermore, the environmental benefits of renewable energy adoption are crucial, particularly in reducing the carbon footprint and mitigating environmental impacts. Wall et al. (2021) highlight the challenge of cost as a major hindrance to the adoption of renewable energy (Wall et al., 2021). This emphasizes the need for comprehensive economic assessments to understand the trade-offs and benefits associated with environmental improvements.

In addition to economic and environmental considerations, social responsibility plays a significant role in renewable energy projects. Scott et al. (2019) conducted an analysis to assess the social costs and benefits of a national requirement establishing antibiotic stewardship programs, demonstrating the importance of considering social implications in economic assessments (Scott et al., 2019). This underscores the need to incorporate social responsibility initiatives and evaluate the social and cultural implications of renewable energy projects.

Overall, the synthesis of these studies underscores the importance of conducting comprehensive impact assessments of renewable energy adoption. By integrating economic, environmental, and social considerations, stakeholders can make informed decisions regarding the cost-effectiveness, environmental benefits, and social responsibility of renewable energy initiatives.

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## 6. Case Studies of Renewable Energy Adoption in Multinational Energy Corporation

In the context of multinational energy corporations, the selection criteria for case studies on renewable energy adoption should consider social-psychological predictors, critical success factors, and public acceptance (Chen et al., 2016). emphasize the importance of assessing social-psychological predictors of adoption intention and policy support, indicating that understanding the psychological factors influencing adoption is crucial for multinational corporations to tailor their strategies (Maqbool et al., 2018). further highlight the critical success factors and relevant aspects for renewable energy projects, providing insights into the factors that contribute to successful adoption. Additionally, Streimikiene et al. (2022) shed light on renewable energy acceptance by households, which is essential for understanding the dynamics of adoption at the consumer level.

Successful and challenging cases of renewable energy adoption in multinational energy corporations can be analyzed based on factors influencing consumer adoption, corporate social responsibility, and critical success factors (Wall et al., 2021). discuss the factors influencing consumer adoption, highlighting the challenges associated with the high costs of renewable energy products (Strielkowski et al., 2021). focus on corporate social responsibility and its role in renewable energy development, providing insights into successful cases where corporations have effectively integrated renewable

energy initiatives into their CSR strategies. These studies collectively provide a comprehensive framework for selecting and analyzing case studies of renewable energy adoption in multinational energy corporations, considering both the internal and external factors influencing adoption.

Overall, the synthesis of these studies provides a holistic understanding of the selection criteria for case studies and an in-depth analysis of successful and challenging cases of renewable energy adoption in multinational energy corporations, encompassing psychological, consumer, corporate, and critical success factor perspectives.

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## **7. Challenges and Opportunities of Renewable Energy Adoption by Multinational Energy Companies**

Renewable energy adoption by multinational energy companies faces several challenges. Technical challenges, such as the need for efficient electrical energy storage for the grid, are crucial (Dunn et al., 2011). Additionally, consumer adoption of renewable energy is influenced by factors such as high costs associated with purchasing renewable energy products (Wall et al., 2021; Khalid et al., 2021). These technical and consumer-related challenges act as barriers to the widespread adoption of renewable energy.

Moreover, regulatory hurdles and political instability also hinder the adoption of renewable energy. In the Indian perspective, barriers to renewable energy adoption include regulatory and policy-related challenges (Luthra et al., 2015). Furthermore, investors in Chile perceive grid connection constraints, longer processing times for permits, and limited access to financing as significant barriers to the deployment of renewable energy sources (Nasirov et al., 2015; Lukong et al., 2021).

Despite these challenges, there are opportunities for improvement. Policy recommendations play a vital role in fostering renewable energy adoption. For instance, in Jordan, there are future investment potentials in renewable energy, and the renewable energy policy generates opportunities for investors (Abu-Rumman et al., 2020). Addressing these barriers and leveraging emerging technologies and innovations can create opportunities for the widespread adoption of renewable energy by multinational energy companies.

In conclusion, while challenges such as technical hurdles and regulatory barriers exist, there are opportunities for improvement through policy recommendations and future investment potentials. Overcoming these challenges and seizing opportunities will be crucial for multinational energy companies to successfully adopt renewable energy.

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## **8. Future outlook and Emerging Trends of Renewable Energy Adoption by Multinational Energy Companies**

The future outlook and emerging trends of renewable energy adoption by multinational energy companies are influenced by various factors. The increasing interest in renewable energy investment, particularly in solar and wind energy, presents significant opportunities for multinational companies (Ukoba et al., 2018; Argenti & Knight, 2015; Ezeigweneme et al., 2024). However, the diffusion of renewable energy technologies (RETs) has been slow, and there are innovation system problems that hinder their development and diffusion in different countries (Negro et al., 2012). National and corporate carbon emission reduction targets have a non-significant impact on corporate renewable energy use, indicating that multinational corporations may perform better than national deployment on climate change (Chang & Lo, 2022; Anamu et al., 2023).

The role of information communication technology and renewable energy in the environmental quality of emerging economies has been explored, emphasizing the need for the adoption of renewable sources and energy-efficient technologies for climate transformation and sustainable development (Zeeshan et al., 2022). Financial policies to support renewable energy adoption have been identified as crucial for large-scale adoption, highlighting the challenges faced in this process (Al-Sarihi & Mansouri, 2022). Additionally, factors influencing consumer adoption of renewable energy include awareness and various determinants such as legal, physical, and mental aspects (Wall et al., 2021; Khalid et al., 2021).

Digital transformation is increasingly embraced by renewable energy companies, indicating a positive trend in the industry (Ren & Li, 2023). The transition to renewable energy follows the principle of innovation adoption, and understanding the concerns and enablers of renewable energy technologies adoption is essential for governments, regulators, policy makers, marketing agencies, and investors (Li et al., 2020; Makki & Mosly, 2020). Moreover, technology innovation plays a crucial role in the sustainability and performance of renewable energy companies,

aligning with the increasing importance of technology-intensive and environmentally friendly approaches in achieving economic development while alleviating environmental pressure (Wang et al., 2021).

The adoption of renewable energy technologies by energy investors, power utilities, and energy consumers is critical for transitioning to a low-carbon economy (Kiprop et al., 2019). Intellectual property rights protection does not significantly influence renewable energy adoption, emphasizing the importance of economic factors in driving the adoption of renewable energy technologies (Li et al., 2020). The performance of renewable energy companies before and after the Initial Public Offering (IPO) has been analyzed, shedding light on the financial aspects of renewable energy investments (Ramadhan, 2022). Additionally, the growth and development of the renewable energy sector are influenced by economic factors such as GDP, population, and the number of households (Yadav, 2022).

In conclusion, the future outlook and emerging trends of renewable energy adoption by multinational energy companies are shaped by a complex interplay of technological, economic, and regulatory factors. Understanding the challenges and enablers of renewable energy adoption, embracing digital transformation, and leveraging technology innovation are crucial for the sustainable development and widespread adoption of renewable energy.

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## 9. Recommendation and Conclusion

The comprehensive review of strategies and impact surrounding renewable energy adoption in multinational energy companies has yielded several key findings. Firstly, technological advancements play a pivotal role in facilitating the integration of renewable energy sources, with investments in innovative solutions such as smart grids and energy storage proving to be effective. Regulatory compliance emerged as a significant driver, showcasing the influence of global and regional frameworks on the adoption of sustainable practices. Moreover, investment frameworks, including financial models and risk assessments, were identified as crucial determinants for the success of renewable energy projects. Collaborative efforts through partnerships and alliances, particularly with governments and local communities, were found to enhance the social responsibility aspect of multinational energy companies.

The findings of this review suggest several avenues for future research. Firstly, a more in-depth exploration of the technological landscape, including emerging innovations and their potential impact on renewable energy adoption, is warranted. Additionally, further investigation into the evolving regulatory environment and its implications on multinational corporations' strategies can provide valuable insights for policymakers and industry leaders. Research focusing on the social and cultural dynamics surrounding renewable energy projects, along with the identification of best practices in partnerships and collaborations, can contribute to a more nuanced understanding of sustainable business practices in the energy sector.

In conclusion, the future of renewable energy adoption in multinational energy companies appears promising but requires strategic and concerted efforts. The identified strategies, encompassing technological advancements, regulatory compliance, investment frameworks, and partnerships, collectively contribute to a sustainable energy transition. As the global community intensifies its focus on mitigating climate change, multinational energy companies must continue to innovate, collaborate, and align their operations with environmentally conscious practices. The success of renewable energy adoption not only holds economic benefits but also significantly contributes to social responsibility and environmental stewardship. The path forward necessitates ongoing research, policy refinement, and a commitment to embracing renewable energy as a cornerstone of the energy landscape, ensuring a resilient and sustainable future for both corporations and the planet.

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## Compliance with ethical standards

### *Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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