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ESG and the energy mix : An analysis of European Union countries and India

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Abstract

This study examines the relationship between ESG performance and energy mix composition across 14 European countries and India over the period 2009 to 2023. Drawing on Refinitiv's ESG database, as well as energy data from Our World in Data and national statistics, the research explores how corporate ESG scores correlate with the proportional distribution of non-renewable, renewable, and nuclear energy sources. The results demonstrate a strong inverse relationship between ESG performance and fossil fuel dependency, suggesting that higher ESG engagement corresponds with a strategic shift towards cleaner energy alternatives. Renewable energy adoption exhibits a positive association with ESG scores, reinforcing the role of sustainability-driven energy policies in guiding investment decisions. However, the correlation between nuclear energy and ESG varies across regions, reflecting the influence of governance structures, regulatory frameworks, and public perception on nuclear power's classification as a sustainable energy source. Further analysis incorporating time-lagged modeling suggests that ESG adoption is not merely a reaction to market conditions but a proactive strategy influencing long-term energy mix adjustments. The findings indicate that firms and national economies with robust ESG commitments tend to make structural shifts towards renewables over time, reinforcing the argument that ESG frameworks act as catalysts for sustainable energy transitions rather than short-term policy responses. These insights

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offer practical implications for policymakers, investors, and corporate leaders, highlighting the necessity of integrating ESG principles into energy security strategies while ensuring that regulatory and financial mechanisms support a balanced approach to sustainability and economic resilience.

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Keywords: *ESG, Energy transition, Sustainable investments, Renewable energy, Corporate governance.*

Introduction

Understanding the relationship between energy structure and ESG performance has become increasingly important in the current economic and environmental discourse. The link between energy dependency, sustainability goals and economic competitiveness highlights the complexity of achieving long-term energy policy goals. In the course of developing global and regional energy strategies, it is important for policy makers, investors and companies alike to assess the strength and direction of this relationship.

This paper integrates recent empirical evidence from the European Union and India and provides a comparative analysis of ESG performance and energy mix dynamics in these regions. Our analysis shows that while ESG strategies are strongly correlated with the shift to renewable energy, the intensity and timing of the shift vary widely. In India, ESG factors show a strong negative correlation with reliance on non-renewable energy sources and a strong positive correlation with renewable energy adoption, highlighting the direct role of ESG in promoting sustainable energy sources. In contrast, the European Union shows a weaker, albeit still present, relationship between ESG initiatives and changes in the energy mix, suggesting a more diversified regulatory and market-driven approach to decarbonization.

These findings are closely related to recent EU energy and ESG policy objectives and highlight the role of corporate sustainability strategies in shaping national and regional energy transitions. Furthermore, our findings show that the effectiveness of ESG-based energy policies depends on regional regulatory frameworks, market structures and corporate governance practices.

Literature review and hypotheses

In recent years, the global discourse on economic and political frameworks has increasingly focused on the transition to a more sustainable and environmentally conscious economy [1]. ESG (environmental, social and governance) factors have become the focus of corporate and investor attention due to their role in promoting long-term sustainability, energy efficiency and climate goals. Policy makers around the world have integrated sustainability into their economic strategies to balance financial success with environmental responsibility [2]. Research has consistently shown a positive correlation between ESG performance and corporate financial performance, confirming the strategic importance of these factors. However, previous studies on the economic impact of ESG (1980-2000) show mixed results. Some researchers argue that companies that prioritize ESG benefit from greater financial stability and investor confidence, while others point to the cost implications of stricter environmental policies that could potentially impact profitability [3]-[4]. While some analyses, such as [5], have found a direct positive relationship between ESG and firm performance, others, including [6], have found no significant correlation. Meta-analyses provide further insight - [7] reviewed 126 studies and found that 42.9% of them showed a positive relationship between ESG and financial performance. Subsequent reviews such as [8], which summarized the results of 1,816 studies, found a positive correlation of 48.2%, while [9] found a correlation of 58% based on studies from 2015 to 2020.

Despite the increasing recognition of the financial benefits of ESG, the results remain mixed, likely due to the aggregation of different ESG components into a single measure, making it difficult to isolate the impact of each dimension. [10] analyzed the ESG ratings of 1,720 companies and concluded that the social ("S") and governance ("G") components correlate with company ratings, while the impact of environmental ("E") factors is ambiguous. This discrepancy may be due to the fact that it takes longer for the financial benefits of environmental initiatives to materialize and that the implementation of sustainability measures involves significant initial costs. In addition, cross-sector comparability of ESG factors remains a challenge as sector-specific sustainability practices further complicate the assessment of ESG performance [11]. In addition to financial performance, ESG factors influence a range of corporate functions. [12] suggests that ESG-oriented strategies improve employee retention and operational efficiency, while [13] associates ESG engagement with lower operating

costs and higher productivity. In [14], the role of ESG in promoting corporate social responsibility and employee motivation is emphasized. Other studies have shown that ESG-aware companies gain strategic advantages, including better product differentiation and resilience to financial downturns [15]-[16]. In addition, [17] has shown that companies with strong ESG performance experienced less corporate malfeasance, highlighting the broader organizational benefits of ESG adoption.

ESG factors also play an important role in the global transition to sustainable energy systems as nations seek to reduce reliance on fossil fuels while promoting renewable and nuclear alternatives [18]. ESG frameworks influence financial outcomes, investment attractiveness and sector-specific risk exposure, as renewable energy sources such as wind, solar and hydropower are closely linked to ESG principles due to their lower carbon footprint and long-term sustainability potential [19]. [20] has pointed out that companies with better ESG performance in the area of renewable energy have lower borrowing costs, indicating that financial markets reward clean energy investments.

Hypothesis

H1: ESG performance is strongly correlated with the energy mix, although there are still regional and sectoral differences. The environmental pillar shows the strongest consistency, positively affecting the use of renewable energies and reducing dependence on fossil fuels. The social and governance pillars have a moderate influence and shape energy transition strategies, albeit with varying intensity depending on the legal and corporate environment.

H2: There is a strong negative correlation between reliance on non-renewable energy sources and ESG performance, particularly in the environmental pillar, demonstrating that divestment from fossil fuels is facilitated by a stronger commitment to sustainability. The use of renewable energies is positively associated with ESG, which highlights their role in sustainable energy strategies. However, the ESG context of nuclear energy remains controversial and is characterized by governance challenges and regional political differences.

H3: The environmental pillar plays the most critical role in energy sector transformation, particularly in reducing reliance on fossil fuels. ESG adoption appears to be proactive rather than reactive, suggesting that structured sustainability commitments shape long-term energy strategies rather than simply reacting to market fluctuations.

Methodology

This study examines the relationship between ESG performance and the energy mix in the European Union and India, utilizing Refinitiv's ESG database, which covers over 12,000 companies across 76 countries. ESG scores are derived from more than 600 indicators, grouped into three primary dimensions: environmental, social, and governance. These scores are adjusted for industry relevance and refined using a Controversies score, which accounts for corporate misconduct and media coverage, ensuring a comprehensive assessment of sustainability performance.

The study employs Pearson correlation analysis to explore the relationship between ESG scores and energy composition, revealing a strong negative correlation between ESG performance and non-renewable energy reliance, while renewable and nuclear energy show a positive association with ESG engagement. To assess causality, time-lag analysis examines whether changes in the energy mix influenced ESG performance and vice versa, offering insights into the long-term dynamics between sustainability initiatives and energy sector transitions. The analysis includes four ESG-related variables and three energy-related variables.

This research provides a comparative analysis of ESG performance in publicly listed companies across the European Union and India from 2009 to 2023, structured by country and ESG component. By integrating longitudinal and cross-regional insights, the study enhances understanding of how corporate ESG strategies and national energy policies interact, offering empirical evidence for decision-makers in sustainability governance and investment planning.

Results

This dataset provides a detailed analysis of ESG scores and energy mix variables across 14 European countries and India from 2009 to 2023, encompassing 210 observations. By integrating sustainability and governance indicators, it enables a comprehensive assessment of corporate and national environmental strategies. The ESG score (ESG) reflects overall sustainability performance, combining three key dimensions: environmental (ESG-E), social (ESG-S), and governance (ESG-G). ESG-E evaluates emissions reduction, energy efficiency, and resource conservation, while ESG-S assesses labor policies, human rights, and corporate social responsibility initiatives. ESG-G captures corporate governance structures, transparency, and regulatory compliance. Energy

mix variables further enhance the analysis by quantifying a country's dependence on non-renewable (NR), renewable (R), and nuclear (NUC) energy sources. NR measures fossil fuel reliance, R highlights the role of wind, solar, and hydropower, while NUC reflects nuclear power's contribution to total energy generation. By integrating ESG scores with energy mix data, this dataset enables cross-country comparisons, revealing regional and sectoral differences in sustainability implementation. It serves as a valuable resource for understanding how corporate ESG commitments align with national energy policies and broader climate action goals.

The Pearson correlation analysis conducted on ESG performance indicators and energy mix components reveals a statistically significant relationship between sustainability efforts and national energy composition.The results indicate that higher ESG performance is positively correlated with the share of renewable energy sources (0.83), reinforcing the argument that sustainability initiatives actively promote clean energy adoption. Conversely, a strong negative correlation (-0.80) is observed between ESG scores and dependence on non-renewable energy, signifying that greater ESG engagement aligns with reduced fossil fuel reliance. However, the relationship between ESG and nuclear energy is relatively weak (0.06), suggesting that sustainability frameworks have a limited influence on nuclear energy adoption, likely due to regulatory and geopolitical considerations rather than direct corporate sustainability commitments. The data indicates that organisations and nations prioritising environmental commitments are more inclined to integrate renewable energy into their strategies, as evidenced by the strong positive correlation (0.90) between the environmental pillar and renewable energy adoption. Conversely, a strong negative correlation (-0.89) with non-renewable energy dependence lends support to the argument that heightened environmental engagement is associated with a systematic reduction in fossil fuel reliance.A moderate positive correlation (0.28) between nuclear energy and ESG environmental scores underscores the complex position of nuclear power within sustainability frameworks, where its low-carbon advantages are weighed against governance challenges, safety concerns, and regulatory constraints. These findings suggest that economies with strong ESG commitments are actively reducing their reliance on fossil fuels while channeling investments into renewable energy. However, the moderate association with nuclear energy indicates that its classification as a sustainable alternative remains subject to regional policy considerations and regulatory risk assessments.While

the environmental pillar plays the most prominent role in shaping energy transitions, the social and governance dimensions also demonstrate statistically significant relationships with energy mix composition. The social pillar has been found to correlate positively with renewable energy adoption (0.65), but to exert less influence on reducing fossil fuel dependence (-0.62). This suggests that corporate social responsibility (CSR), labor policies, and ethical business practices contribute to clean energy adoption, but do not directly drive fossil fuel reductions. Conversely, the governance pillar demonstrates a more pronounced correlation with the expansion of renewable energy (0.73) and a moderate negative correlation with fossil fuel reliance (-0.69), suggesting that corporate governance reforms, transparency measures, and regulatory compliance mechanisms play a critical role in guiding energy transitions. These findings emphasise the importance of ethical corporate behaviour, regulatory oversight, and financial stability in reinforcing sustainable energy policies. However, the degree of influence varies, with governance-related ESG components appearing to exert a more structured impact on energy investment decisions.To examine the directionality of ESG influence on energy transitions, an analysis of temporal trends in ESG performance and energy mix composition was conducted. The results demonstrate that an increase in environmental ESG scores is associated with an increase in renewable energy adoption and a decrease in fossil fuel dependency, suggesting a causal link between ESG-driven sustainability commitments and energy sector restructuring.Time-lagged correlation analysis further supports this interpretation, indicating that past ESG scores significantly shape future shifts in energy composition, particularly in countries with well-established regulatory frameworks and financial incentives supporting sustainability transitions. The findings reinforce the hypothesis that ESG performance substantially influences energy mix evolution, with the strongest effects observed in the environmental pillar.Increased ESG engagement aligns with renewable energy expansion and a steady reduction in fossil fuel dependency, while the social and governance dimensions complement energy policies by fostering ethical business conduct, social responsibility, and corporate transparency.These insights highlight the critical need for policymakers and corporate leaders to integrate ESG considerations into long-term energy planning, ensuring that sustainability goals align with energy security priorities. It is recommended that future research explore regional differences and regulatory interventions that facilitate the alignment between ESG frameworks and energy transition pathways.By enhancing

regulatory incentives and refining corporate ESG strategies, economies can achieve a more structured and effective transition towards sustainable energy systems.

The findings of the analysis demonstrate a negative correlation between reliance on non-renewable energy and all ESG components, particularly the environmental dimension. The strongest inverse relationship is observed between non-renewable energy and environmental ESG scores (-0.89), indicating that economies and companies with a strong environmental commitment are actively reducing their reliance on fossil fuels. The overall ESG score (-0.80), as well as the social (-0.62) and governance (-0.69) pillars, also demonstrate a negative correlation with non-renewable energies, suggesting that companies' sustainability efforts are helping to reduce fossil fuels, although the environmental dimension remains the most significant driver.In contrast, the use of renewable energy is highly correlated with ESG performance, with the strongest correlation (0.90) observed for the environmental pillar. This finding serves to reinforce the notion that strategies focused on environmental, social and governance (ESG) issues have the capacity to expedite the transition towards a clean energy future.The overall ESG score (0.83) and the governance pillar (0.73) demonstrate a robust positive correlation with renewable energy, thereby suggesting that effective corporate governance mechanisms and adherence to regulatory frameworks are conducive to the investment in clean energy sources. The social pillar, while having a supporting role, reflects the impact of labour rights, social responsibility, and societal engagement. However, its impact is less pronounced than that of environmental factors. The relationship between nuclear energy and ESG components remains controversial. While the environmental pillar demonstrates a moderately positive correlation (0.28) with nuclear energy, indicative of its classification as a low-carbon alternative, the ESG score (0.06) and social pillar (0.01) exhibit negligible correlation, suggesting that corporate sustainability initiatives do not exert a substantial influence on the adoption of nuclear energy. The governance pillar (-0.05) exhibits a modest negative correlation, implying that regulatory oversight, risk management, and transparency concerns may contribute to the equivocal position of nuclear energy within the ESG framework. These findings underscore the intricacy of integrating nuclear energy into sustainability policies, as low-carbon energy sources align with environmental objectives, while governance challenges and public perception introduce uncertainty in ESG ratings. While strong correlations confirm that ESG engagement is compatible with a cleaner energy mix, cross-sectional analyses show that

ESG factors do not have a strong predictive correlation over time. This means that the introduction of ESG factors supports energy system transformation in real time, but is not necessarily a driving force for future changeovers. These results reinforce the view that corporate and national sustainability strategies need to be proactive rather than reactive, and that ESG frameworks need to be integrated into long-term energy transition strategies to ensure lasting structural change.

Empirical analysis confirms that the environmental pillar of ESG is the strongest driver of energy transitions, particularly in reducing dependence on non-renewable energy. The Pearson correlation analysis reveals a strong negative correlation (-0.89) between environmental ESG scores and fossil fuel reliance, thereby reinforcing the argument that greater sustainability commitments are associated with a transition away from carbon-intensive energy sources.Conversely, the correlation between the environmental pillar and renewable energy adoption is strongly positive (0.90), thereby supporting the premise that sustainability-focused strategies actively promote clean energy expansion. This suggests that firms and nations prioritising environmental objectives implement policies that systematically shift energy portfolios towards renewables while reducing fossil fuel consumption.The relationship between nuclear energy and ESG environmental scores is weaker, as indicated by a moderate positive correlation (0.28).Nuclear energy is recognised as a low-carbon alternative in some ESG frameworks, but governance complexities, safety risks and geopolitical concerns contribute to its inconsistent sustainability classification. The dataset does not support the existence of bidirectional causality between ESG adoption and energy mix changes, suggesting that ESG serves as a proactive strategic framework rather than a reaction to shifts in energy markets.Cross-lagged analyses reveal no significant predictive relationship between past ESG scores and subsequent energy mix transformations, implying that firms and policymakers invest in ESG-driven sustainability initiatives as long-term commitments rather than short-term adjustments to energy price volatility or supply constraints. A comparison of energy mix compositions in the European Union and India further substantiates these findings. The EU relies significantly more on renewable energy (17.2%) than India (2.8%), while India's dependence on non-renewable energy remains high at 96.2%, compared to 82.8% in the EU. This discrepancy can be attributed to the varying degrees of ESG engagement across these regions. Historically, European governments and companies have placed significant emphasis on sustainability policies, regulatory mandates, and renewable energy investment, contributing to

the EU's comparatively higher adoption of renewable energy. Additionally, the EU's increased reliance on nuclear energy, at 25.0%, stands in contrast to India's negligible reliance, at 0.5%. This disparity can be attributed to the differing long-term energy strategies and sustainability perceptions of the two regions.The findings underscore the pivotal role of environmental ESG considerations in shaping energy transitions, emphasizing their independence from short-term energy market fluctuations. The adoption of ESG principles is not merely a reactive response, but rather a methodical, forward-looking strategy that aims to reduce carbon emissions and achieve long-term sustainability objectives.As businesses and policymakers seek to expedite the transition to clean energy, it is imperative to integrate ESG principles into regulatory frameworks and corporate governance structures to ensure the sustained transformation of the energy sector. Future research should investigate regional policy mechanisms and investment incentives that further align ESG-driven sustainability commitments with national energy strategies.

Conclusion

In light of the ongoing challenges posed by geopolitical uncertainties and energy crises in Europe, strategies aimed at enhancing resilience and reducing reliance on fossil fuels have become paramount. This paper underscores the pivotal role of Environmental, Social and Governance (ESG) principles in the formulation of energy policy, illustrating how sustainability commitments can foster long-term economic stability and energy security. The study provides empirical insights into the trade-off between decarbonization targets and energy stability by analysing the relationship between ESG performance and the composition of the energy mix. Although conducted prior to the full implementation of recent EU sustainability policies, the findings remain highly relevant to current policy debates.

The results emphasize the strategic importance of sustainable investment and coherent regulation in catalyzing the energy transition, particularly in the context of macroeconomic sustainability outcomes shaped by the collective energy decisions of companies and consumers. These findings align with broader trends in ESG adoption across industries. Sectoral differentiation is also apparent: environmental considerations exert the most significant influence on energy-related decisions, with ESG commitments accelerating the transition from fossil fuels to renewables and nuclear power. A structured approach to ESG will

therefore facilitate long-term strategic alignment and ensure that sustainability commitments are integrated into decision-making processes at both corporate and national policy levels.

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