

Article

Environmental, Social, and Governance (ESG) Dynamics in the Energy Sector: Strategic Approaches for Sustainable Development

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Abstract: ESG metrics have become increasingly important in evaluating corporate sustainability and meeting regulatory expectations. Thus, it is essential to explore these elements for a clearer understanding. This study examined the environmental (E), social (S), and governance (G) scores across various sub-sectors of the energy industry. Using systems thinking and creating shared value (CSV) approaches, the research investigated whether ESG performance varies significantly among the sub-sectors and how changes in one pillar might influence the others. Data from 576 companies in the Thomson Reuters EIKON database were analyzed using ANOVA, correlation, and multiple regression. The results revealed distinct differences in the ESG scores among sub-sectors, with environmental and social practices often reinforcing each other. However, governance showed a weaker influence, highlighting the need for further research on governance frameworks to clarify the underlying reasons and to integrate better with other ESG pillars. The research has specific implications for strategic management and provided recommendations for further studies.

Keywords: sustainability strategies; ESG performance; systems thinking; creating shared value (CSV); energy industry



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1. Introduction

The global transition towards a sustainable economy has emphasized the importance of ESG metrics in corporate performance, consisting of environmental (E), social (S), and governance (G) pillars. The metrics provide a comprehensive framework for assessing a company's commitment to a sustainable environment, social responsibility, and applicable governance practices, which are crucial for promoting resilience and for meeting regulatory and stakeholder demands [1,2]. On the other hand, the energy industry has become strategically important since the 1970s, mostly due to the growing concerns about energy security, ensuring an uninterrupted and affordable energy supply and sustainability [3], and focusing on meeting present needs without compromising the ability of future generations to meet their own needs [4]. ESG frameworks became particularly relevant in the energy sector as sustainability gained prominence in energy strategies. For instance, the implementation of ESG standards in European energy projects provides guidance for countries such as Ukraine to align their energy legislation with international sustainability goals [5].

Differences in company profiles, particularly the industry type, significantly impact ESG performance. Sub-sectors such as oil, coal, renewables, and nuclear power face unique challenges and opportunities in terms of ESG performance, although these sectors are classified as being in the energy industry [6]. For instance, firms in renewable energy are usually expected to perform better in environmental metrics due to their low carbon emissions, whereas companies in the oil and coal sectors are subject to stricter regulatory

frameworks and stakeholder pressures [7,8]. In this context, this study investigated whether ESG performances differ significantly across the sub-sectors of the energy industry.

Additionally, while ESG criteria have been widely adopted in the energy industry, the relationships between the E, S, and G pillars, particularly on a sub-sectoral basis, remain underexplored. Understanding these interconnections is crucial for developing strategies that improve overall ESG performance, while achieving competitive advantage. Therefore, this study also aimed to explore the interdependencies between the E, S, and G scores across various sub-sectors of the energy industry. This study applied systems thinking and creating shared value (CSV) approaches as a guide to further understanding how energy firms can leverage interconnected ESG strategies to achieve sustainable outcomes.

Systems thinking highlights the interconnectivity of components within a system, where actions in one area can influence the entire system. Originating from disciplines such as systems science and engineering, it aims to address complex, real-world problems [9,10]. Relationships, especially feedback loops, are crucial in the approach, emphasizing the interconnectedness of actions and reactions [10]. The strength of systems thinking lies in its ability to capture the dynamic interactions between components [11]. In the ESG context, the approach suggests that improvements in one pillar may impact other pillars. In other words, a change in the E score may indirectly affect the S or G scores [12]. In a corporate setting, for example, implementing better environmental practices, such as reducing carbon emissions, may lead to greater stakeholder relations, improved community engagement, and enhanced regulatory compliance [13,14]. Therefore, the systems thinking approach helps to examine ESG interdependencies in the energy industry by capturing the interplay of feedback loops between components.

Furthermore, creating shared value (CSV) proposes that firms can enhance their competitive advantage by simultaneously creating value for the company and society. Thus, it involves integrating societal and environmental implementations with the economic goals of a business [15]. This approach emphasizes that firms are rational actors and that no universal method exists for creating shared value. The implementation depends on various internal and external factors, such as opportunity and transaction costs, competitors, and government influences, which affect a firm's ability to implement CSV effectively [16]. Nevertheless, successful CSV implementations can foster innovation and productivity. Thus, it can lead to a cycle of mutual prosperity for the company and the community [15,17]. Given that the energy industry has a significant impact on communities and the environment [5], CSV provides a practical approach to align business objectives with societal needs [15]. Therefore, the approach offers a pathway for energy firms to achieve mutual benefits for both business and society.

Finally, based on the literature regarding the energy sector, systems thinking, and CSV, this study asked: To what extent do environmental, social, and governance scores differ and influence one another in different energy sub-sectors? And, how can these insights be used to develop integrated strategies for sustainability? In response, this paper first provides a review of ESG in the energy sector, industrial differences in ESG performance, interconnections between ESG dimensions, and the incorporation of strategic approaches. Moreover, this study performed ANOVA, correlation, and regression analyses for each component across the different sub-sectors in the energy industry. By filtering more than 2000 companies based on the data available, 576 companies in the energy sector of the Thomson Reuters EIKON database were analyzed. The findings indicated a significant difference in ESG (also E, S, and G) performance across the sub-sectors, suggesting a need for sector-specific strategies. Also, environmental and social practices were found to develop each other reciprocally, causing a feedback loop that firms can take advantage of. Nevertheless, in most cases, the study found no significant relationship with governance aspects, suggesting the necessity of enhancing corporate governance practices to integrate other dimensions. By exploring the sub-sectoral differences in ESG performance and the interconnections between the E, S, and G components, as well as utilizing systems thinking

and CSV approaches, this study developed and discussed management strategies for more sustainable implementations.

2. Literature

Corporate success was predominantly measured through financial metrics, with environmental and social factors receiving less attention [18,19]. However, the need for a more holistic approach to assess corporate performance has become more vital, particularly because of the global course in recent years, which is affecting resource-intensive industries, such as energy [3,19]. The necessity of energy transition has placed energy companies at the center of governmental policies and stakeholder expectations, leading to intense public scrutiny of these companies to ensure they address a broader set of social responsibilities and environmental performance [20,21]. While environmental performance, such as reducing carbon emissions and improving resource efficiency, is a valuable focus in the energy sector [22], social and governance dimensions are also crucial. As previous studies have shown, these two dimensions also have a significant impact on the energy industry [23,24]. In particular, ESG implementation mediates the relationship between a firm's ESG strategy and its impact on sustainable development goals (SDGs), with governance structures acting as a moderating influence. Aligning ESG initiatives with the SDGs not only enhances stakeholder well-being but also amplifies social impact, demonstrating an inherent synergy between ESG and SDG objectives [25]. Subsequently, the adoption of ESG criteria has become increasingly important in corporate sustainability strategies [5,26].

The overall ESG score is a calculation of three pillars, which are weighted 34% for E, 35.5% for S, and 30.5% for G. The environmental pillar covers resource use, emissions, and innovation, assessing environmental impact management. The social pillar includes workforce, human rights, community, and product responsibility, which evaluate the issues regarding social practices. On the other hand, the governance pillar focuses on management, shareholder rights, and CSR strategies, examining corporate management initiatives [2].

Studies have shown that the implementation of ESG practices and their impact vary based on a company's profile. For example, ESG factors positively influence profitability in larger firms [27], since large companies are more visible and subject to greater societal scrutiny [28]. Furthermore, family ownership has an adverse moderating effect on the relationship between ESG disclosure and the cost of capital for SMEs, while ESG practices have significantly less impact on a firm's financial and stock market performance in state-owned enterprises [29]. Innovation, which is measured by R&D investments and patent development, was also found to positively influence ESG performance in industrial firms across several countries [30]. A company's region is another determinant, for example, multinational companies headquartered in Asia or North America tend to be more successful in ESG implementation, whereas Latin American firms face challenges [31]. In emerging markets, increased competition can negatively affect ESG practices, contrasting with developed economies [32]. Moreover, cultural differences in various regions, such as individualism, masculinity, power distance, and uncertainty avoidance, play a significant role in the relationship between ESG performance and financial outcomes [33,34]. For example, power distance and long-term orientation significantly moderate the relationship between ESG disclosure and a firm's performance in the energy sector [35]. The industry type also affects the implementation of ESG and its consequences [36]. For instance, in the industrial sector, ESG practices are increasingly focused on reducing carbon emissions, with European regulations driving adoption [37]. In sensitive industries, such as the energy industry, the role of ESG practices have become even more crucial since such industries are more likely to cause social and environmental harm, therefore, they encounter stricter regulations and higher stakeholder expectations [6,38].

Previous studies have exhibited complicated findings for the energy industry, for example, the environmental and governance dimensions of ESG were seen to have a more significant and varied impact in the oil and gas sector due to the industry's high exposure

to environmental and regulatory challenges [39]. Moreover, ESG adoption in the oil sector has short-term-cause difficulties in operational costs and various financial metrics, but it is strategically convenient in the long term, with enhanced sustainability, corporate value, and alignment with global trends toward cleaner energy [40]. Similar complications apply to renewable energy companies. For instance, ESG ratings have been found to promote low-carbon investment, leading to further investment growth [41], and incorporating ESG factors enhances economic viability [42]. On the other hand, some findings have revealed that the profitability of renewable energy companies is marginally and negatively affected by their ESG performance, particularly the environmental pillar, which has shown a significant negative effect. In contrast, corporate social and governance responsibilities are positively—but not significantly—associated with a company's financial profitability [1]. Overall, the energy industry has complexities in comprehending the results of ESG practices. Each pillar of ESG has varying impacts on corporate financial performance, depending on the balance among them [43].

In addition, the sub-sectors across the energy industry have unique challenges related to each dimension. For example, the oil and gas sectors face environmental challenges because of their high amount of greenhouse gas emissions, water contamination, and methane emissions [39]. Moreover, their negative environmental effects cause significant pressure from investors, environmentalists, and the general population in the social dimension. Furthermore, geopolitical conflicts, local disruptions, and stricter regulatory frameworks are the main challenges in the governance dimension. [39,40]. On the other hand, the renewable energy sub-sector also has distinct environmental concerns, including habitat disruption, extensive land usage, and the life cycle of materials [44]. Furthermore, the sub-sector often encounters opposition from communities due to concerns over environmental issues, visual impact, cultural or ideological reasons, and the potential depreciation of property values [45]. Finally, renewable energy companies face governance challenges, including fluctuating material prices, regulatory shifts, technological advancement, and the availability of skilled labor [44].

Systems thinking is an approach to reasoning and the treatment of real-world problems that is based on the fundamental notion of a system, which refers to a purposeful assembly of components [10]. It is a powerful and logical approach that represents the interconnectedness of components, focusing on the dynamic feedback loops that interactively bind elements [46] within the whole system [47]. The approach is becoming more vital in addressing sustainability issues, as it enhances sustainability assessment by focusing on the whole system and the interacting parts that affect the system's behavior [48]. In fact, sustainability assessment requires balancing multiple aspects, including economic, social, and environmental factors, while addressing the interactions among them [49]. Along the same lines, achieving sustainability in water management requires a systems-thinking approach to integrate environmental, social, and economic outcomes [50]. Furthermore, embedding systems thinking principles into early-stage sustainability assessments reduces negative trade-offs and helps to comprehend the sustainability of business model innovations [51]. Subsequently, the approach enables a holistic perspective, which identifies interdependencies within governance structures and highlights the importance of feedback loops in preventing environmental degradation [52].

Creating shared value (CSV) is a strategic approach that allows companies to address social issues while generating business value simultaneously [16]. It integrates societal and environmental considerations into core business models [53] and offers a meaningful addition to the existing literature [16]. For instance, CSV can positively influence consumer brand attitudes through both economic and social contributions [54]. Conversely, CSV has been criticized for failing to adequately incorporate stakeholder interests and accountability [55], as it tends to overlook the inherent trade-offs between economic interests and societal needs [56]. Thus, compiling a multidimensional value framework, which considers the interests, perspectives, and trade-offs of various stakeholders across multiple dimensions of value creation, can offer significant benefits [57].

Considering the two approaches, the pillars of ESG, environmental (E), social (S), and governance (G) represent distinct yet interconnected aspects of a company, purposefully assembled with the weighted average of these three pillars [58], aligning with a systems thinking approach [10]. Also, while ESG focuses on the non-financial aspects of companies, high ESG performance leads to better overall performance, including financial performance, such as net profitability and stock return performance [59]. As CSV aims to enhance economic performance while considering environmental and social factors [16], taking these two approaches into account will enhance the comprehension of the system. Furthermore, the literature has indicated that improvements in one ESG dimension may positively impact others. For example, in [60], it was concluded that environment investments increased social satisfaction in China by reducing air pollution, and [13] concluded that corporate wildlife habitat programs boosted employee morale, enhanced relationships with environmental groups and communities, and improved regulatory compliance. It was also obvious that the impact works in multiple directions, as stakeholders—including governments, regulators, clients, and NGOs—exert pressures on firms to adopt environmental management practices beyond regulatory requirements [14,61]. Moreover, governance applications, such as enhanced access to environmental risk and gaining maturity in corporate environmental governance, enhance stakeholder relations [62,63].

Thus, the literature suggested that improvements in one ESG dimension may positively impact the others. Moreover, the employment of regression models to understand cause and effect relations was popular in the literature, particularly regarding the impact of ESG scores [58,64,65]. However, the extent of this relationship, especially across the sub-sectors of the energy industry remains underexplored. This study utilized multiple regression analyses to expose the impact of ESG components on each other in each sub-sector of the energy industry.

3. Materials and Methods

3.1. Hypotheses, Data Acquisition, and Sampling

The purpose of this study was to explore the differences in ESG (E, S, G) performance, the extent to which the components of ESG have a significant impact on each other in the energy sector, across its sub-sectors, and to evaluate the results in the strategic perspective, particularly with systems thinking and CSV approaches. Figure 1 illustrates the framework of the study.

Accordingly, the following hypotheses were developed for the analysis:

- H1.** *ESG, E, S, and G scores significantly differ across sub-sectors of the energy industry.*
- H2.** *E scores are positively influenced by both S and G scores.*
- H3.** *S scores are positively influenced by E and G scores.*
- H4.** *G scores are positively influenced by E and S scores.*

To test the hypotheses, the study analyzed data from the energy industry category of the Thomson Reuters EIKON database, which provided comprehensive, reliable ESG data and a detailed scoring system, encompassing over 400 data points and more than 70 key performance indicators per company [66]. This study focused exclusively on 2023 to avoid potential distortions from the COVID-19 period [58]. Companies with missing data for 2023 were removed, resulting in a sample of 576 firms, categorized into 9 sub-sectors, based on their core operations and sample sizes. The renewable fuels sub-sector was merged with renewable equipment services due to a small sample size of 8, while the uranium sub-sector was retained independently due to its distinctive operational and regulatory characteristics. The final sample represented global energy firms with complete ESG data for 2023, as shown in Table 1.

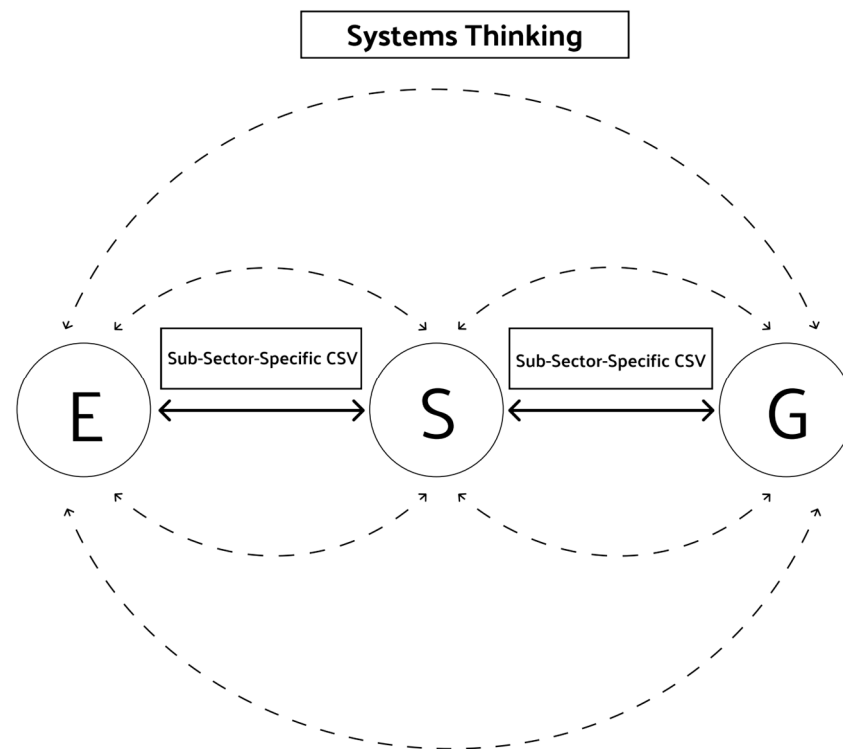


Figure 1. Systems thinking and CSV across ESG pillars in energy sub-sectors.

Table 1. Frequency and percentage of sub-sectors.

Sub-Sector	Frequency	Percent
Coal	53	9.2
Integrated Oil and Services	30	5.2
Oil and Gas Drilling	20	3.5
Oil and Gas Exploration and Production	141	24.5
Oil and Gas Refining and Marketing	89	15.5
Oil and Gas Transportation Services	61	10.6
Oil-related Services and Equipment	83	14.4
Renewable Energy Equipment and Services	84	14.6
Uranium	15	2.6
Total	576	100.0

Table 1 shows that Oil and Gas Exploration and Production was the largest sub-sector, accounting for 24.5%, with 141 companies, so was the dominant segment in the analysis. Also, Oil and Gas Refining and Marketing followed, contributing 15.5% of the total, with 89 companies. Furthermore, Renewable Energy Equipment and Services and Oil-related Services and Equipment were similarly significant, representing 14.6% and 14.4%, respectively. Oil and Gas Transportation Services, with 10.6%, and Coal, with 9.2%, also showed substantial representation. Finally, the smallest sub-sectors were Oil and Gas Drilling and Uranium, comprising 2.6% and 3.5%, respectively. It was clear that traditional energy sectors related to oil and gas were in the majority, although the renewable energy sector held a significant place.

3.2. Analysis Methods

This study examined the differences in ESG performance across the sub-sectors of the energy industry. Therefore, ANOVA with Tukey's HSD post-hoc test was performed to evaluate whether the ESG scores significantly varied among the sub-sectors of the energy industry. Furthermore, correlation and multiple regression analyses were conducted to explore the interrelationships and influences among the E, S, and G pillars within each sub-

sector, contributing to a deeper understanding of the ESG dynamics through the systems thinking and CSV approaches.

At first, ANOVA assessed whether the means of multiple groups differed significantly [67]. The analysis provided a single p -value that indicated whether there were significant differences among the groups. When significant, the post-hoc tests identified which specific groups differed from each other. Selecting an appropriate post-hoc test depended on the homogeneity of the variances. Tukey's HSD is a common test when variances are homogeneous [68] since it produces the fewest type I (family-wise) errors, ensuring the exclusion of false positives [69]. Therefore, Tukey's HSD test was more appropriate for this study.

Moreover, the study performed a correlation analysis to assess the strength and direction of the linear relationship between two continuous variables. In the correlation analysis, Pearson's correlation coefficient is a common metric, which ranges from -1 to 1 . While a value of 1 indicates a perfect positive correlation, -1 signifies a perfect negative correlation, and a value of 0 indicates no correlation [67]. The correlation analysis is particularly useful for examining non-causal relationships, providing insights into complex real-world dynamics. It is frequently employed to test hypotheses, predict trends, and identify the key factors that influence various outcomes [70]. This study evaluated the correlation results based on the values proposed by [71], as follows:

- 0.00–0.19: very weak
- 0.20–0.39: weak
- 0.40–0.59: moderate
- 0.60–0.79: strong
- 0.80–1.00: very strong

The correlation analysis identified significant relationships, which could guide policy development and management decisions [72].

Furthermore, this study included a regression analysis to examine the relationship between a dependent variable and one or more independent variables. The method is useful for a detailed assessment of how changes in independent variables influence dependent variables, thus, it provides significant insights for predictive modeling and pattern identification [73]. The equation used was as follows:

$$Y = \beta_0 + \beta_1 X_1 + \dots + \beta_n X_n + \epsilon \quad (1)$$

where Y represents the dependent variable; β_0 is the intercept; $\beta_1 \dots \beta_n$ are the coefficients representing the effect of each independent variable; $X_1 \dots X_n$ refers to independent variables; and ϵ presents the error term. By including multiple independent variables and assessing their combined effects on the dependent variable, the analysis provides more accurate results [74,75].

In conclusion, this study included ANOVA with Tukey's HSD post-hoc to expose reliable distinctions between the sub-sectors regarding ESG, E, S, and G scores. Also, it employed a correlation analysis to identify relationships among the ESG pillars in each sub-sector and performed multiple regression models to gain deeper insights into the relationships among these components. Through the lens of systems thinking, correlation and regression analyses helped to explore how changes in one ESG pillar may cause interconnected responses in other pillars. In particular, the multiple regression analysis captured feedback loops by revealing the bi-directional impact among the ESG pillars. It also aligned with the CSV principles, supporting a strategic evaluation of how economic, environmental, and social factors should be managed simultaneously.

4. Findings

This section presents the quantitative analysis results, along with their raw explanations, aiming to provide the groundwork for the subsequent sections. First, the effective

utilization of the analyses required that the data exhibited a normal distribution and homogeneity of variances [76]. Table 2 shows the results for normality and homogeneity.

Table 2. Normality and homogeneity.

Variables	Normality		Homogeneity
	Skewness	Kurtosis	Sig.
ESG score	−0.095	−0.878	0.170
E score	0.041	−1.012	0.053
S score	0.002	−1.046	0.139
G score	−0.143	−1.071	0.352

The table demonstrates that the skewness and kurtosis values fell within the typical range of −1.5 to +1.5, which is often used as a criterion for normality in the social sciences [77]. For homogeneity, the results of Levene’s test showed that the significance values for all variables, including the E score (Sig. = 0.053), in spite of being borderline, were above the 0.05 threshold. Overall, both the normality and homogeneity assumptions showed the appropriate use of parametric tests. Table 3 presents the ANOVA results.

Table 3. Analysis of variance (ANOVA).

Variables	F	df (Between)	df (Within)	Sig.
ESG score	4.543	8	567	0.000
E score	8.365	8	567	0.000
S score	4.043	8	567	0.000
G score	3.069	8	567	0.002

The results indicated significant differences in the means across the various sub-sectors for all four scores (ESG, E, S, and G). Specifically, the E score showed the strongest effect, with an F-value of 8.365 and a significance level of $p < 0.001$, highlighting particularly pronounced differences between the sub-sector means. Significant differences were also found for the ESG score ($F = 4.543$, $p < 0.001$) and the S score ($F = 4.043$, $p < 0.001$). The G score ($F = 3.069$, $p = 0.002$) showed the weakest (but still statistically significant) differences [76]. Given the significant findings, Table 4 shows the post-hoc (Tukey’s HSD) analysis, identifying specific pairwise differences between the sub-sectors.

Table 4 presents only the significant comparisons for clarity. Tukey’s HSD was chosen for the study since it only considers strong differences between the variables, ensuring the exclusion of false positives. On the other hand, it may omit some differences, which are weak, but still significant. For instance, the G score was omitted as no significant differences were found in the governance scores among the sub-sectors, according to Tukey’s HSD.

It was clear that the Integrated Oil and Services sector showed significantly higher ESG scores than the Oil and Gas Exploration and Production sector (mean difference = 20.53, $p < 0.001$) and the Renewable Energy Equipment and Services sector (mean difference = 13.72, $p = 0.050$). Furthermore, the Oil and Gas Exploration and Production sector had significantly lower ESG scores compared to Oil and Gas Refining and Marketing (mean difference = −11.99, $p < 0.001$) and Oil-related Services and Equipment (mean difference = −9.51, $p = 0.027$). The differences highlighted that certain sub-sectors (such as Integrated Oil and Services) have better overall ESG performance, whereas Oil and Gas Exploration and Production performs worse.

In the E score, the Integrated Oil and Services sector stood out, with much higher scores compared to Oil and Gas Exploration and Production (mean difference = 29.53, $p < 0.001$) and Uranium (mean difference = 25.22, $p = 0.031$). Also, Oil and Gas Exploration and Production had lower environmental scores than several other sub-sectors, including Coal (mean difference = −17.45, $p < 0.001$), and Oil and Gas Refining and Marketing (mean difference = −19.59, $p < 0.001$). Therefore, it was obvious that there are significant

differences in environmental performance across the sub-sectors, with Integrated Oil and Services having the strongest environmental performance, while Oil and Gas Exploration and Production performed poorly in comparison to many others.

Table 4. Post-hoc (Tukey’s HSD) analysis.

Dependent Variable	(I) Industry Separated	(J) Industry Separated	Mean Difference (I-J)	Std. Error	Sig.
ESG score	Integrated Oil and Services	Oil and Gas Exploration and Production	20.53	4.17	0.000
		Renewable Energy Equipment and Services	13.72	4.41	0.050
	Oil and Gas Exploration and Production	Integrated Oil and Services	−20.53	4.17	0.000
		Oil and Gas Refining and Marketing	−11.99	2.80	0.001
		Oil-related Services and Equipment	−9.51	2.87	0.027
	Oil and Gas Refining and Marketing	Oil and Gas Exploration and Production	11.99	2.80	0.001
	Oil-related Services and Equipment	Oil and Gas Exploration and Production	9.51	2.87	0.027
	Renewable Energy Equipment and Services	Integrated Oil and Services	−13.72	4.41	0.050
E score	Coal	Oil and Gas Exploration and Production	17.45	3.92	0.000
	Integrated Oil and Services	Oil and Gas Exploration and Production	29.53	4.90	0.000
		Uranium	25.22	7.70	0.031
	Oil and Gas Exploration and Production	Coal	−17.45	3.92	0.000
		Integrated Oil and Services	−29.53	4.90	0.000
		Oil and Gas Refining and Marketing	−19.59	3.30	0.000
		Oil-related Services and Equipment	−14.82	3.37	0.000
		Renewable Energy Equipment and Services	−14.82	3.36	0.000
	Oil and Gas Refining and Marketing	Oil and Gas Exploration and Production	19.59	3.30	0.000
	Oil and Gas Transportation Services	Oil and Gas Exploration and Production	17.15	3.73	0.000
	Oil-related Services and Equipment	Oil and Gas Exploration and Production	14.82	3.37	0.000
	Renewable Energy Equipment and Services	Oil and Gas Exploration and Production	14.82	3.36	0.000
	Uranium	Integrated Oil and Services	−25.22	7.70	0.031
S score	Integrated Oil and Services	Oil and Gas Drilling	22.06	6.94	0.041
		Oil and Gas Exploration and Production	22.30	4.83	0.000
	Oil and Gas Drilling	Integrated Oil and Services	−22.06	6.94	0.041
	Oil and Gas Exploration and Production	Integrated Oil and Services	−22.30	4.83	0.000
		Oil and Gas Refining and Marketing	−12.17	3.25	0.006
		Renewable Energy Equipment and Services	−10.47	3.31	0.044
	Oil and Gas Refining and Marketing	Oil and Gas Exploration and Production	12.17	3.25	0.006
	Renewable Energy Equipment and Services	Oil and Gas Exploration and Production	10.47	3.31	0.044

As for the S score, the Integrated Oil and Services sector again outperformed the Oil and Gas Drilling (mean difference = 22.06, $p = 0.041$) and Oil and Gas Exploration and Production sectors (mean difference = 22.30, $p < 0.001$). The Oil and Gas Exploration and Production sector performed worse than Oil and Gas Refining and Marketing (mean difference = -12.17 , $p = 0.006$) and Renewable Energy Equipment and Services (mean difference = -10.47 , $p = 0.044$). Thus, it was clear that Integrated Oil and Service exhibited a greater performance, and Oil and Gas Exploration and Production lags behind other sub-sectors in terms of social responsibility.

Despite being significant in ANOVA, the G scores did not show significant differences in Tukey's HSD, aligning with the lowest F-value ($F = 3$). The results do not necessarily mean there were no significant results, but the differences were rather small, suggesting that governance practices are relatively uniform across the sub-sectors.

The results showed that there are significant differences in ESG, E, S, and G performance among the sub-sectors in the energy industry. Furthermore, the study sought to understand whether there was any relationship between the scores, and the relationships differed depending on the sub-sector. Utilizing the Pearson correlation analysis helped to understand the connections between the variables and their directions, providing a baseline for the regression analysis. Table 5 demonstrates the correlation results for each sub-sector.

While the table demonstrates strong positive correlations among the ESG, E, and S scores, it is clear that significant variations exist among the G scores, showing lower correlations with the others. For instance, the G score had no correlation with E and S and showed a weak correlation with the ESG in the Oil and Gas Drilling sector, whereas it exhibited a strong correlation among the E, S, and ESG. Moreover, the absence of a strong correlation of G with the E and S scores was obvious across all sectors. Despite the higher values in the correlation between G and overall ESG in some sectors, it was observable that the G scores had lower values, indicating typically weak and intermediate correlation levels.

In addition to their connections, the analysis encompassed the impacts of the components on each other, requiring multiple regression analyses for each sub-sector in the energy industry. Table 6 represents the regression analysis results for each sub-sector.

The table demonstrates the key metrics for analyzing the relationships between the independent and dependent variables (E, S, or G) across the sub-sectors. The R-squared values show how much of the variability in the dependent variables are explained by the independent variables (S and G for E; E and G for S; or E and S for G), with higher values indicating better explanatory power. The Beta coefficients represent the strength and direction of these relationships, where positive values indicate a direct relationship, and negative values indicate an inverse relationship. The p -values indicate statistical significance, with values below 0.05 showing that the relationships are statistically significant.

It was clear that across most sub-sectors, the S score has a strong, positive, and statistically significant impact on the E score. Thus, companies that performed well in social aspects (such as employee welfare and community engagement) also tended to show better environmental performance. In contrast, the G score often showed a weaker or non-significant effect on the E score, suggesting that governance practices alone may not directly drive better environmental performance in these sectors. Moreover, the results for the G score varied more widely across the sub-sectors, with lower R-squared values in many cases, indicating that the model explains less of the variability in these instances.

Table 5. Pearson correlation results by sub-sector, significant at the 0.01 level.

Coal (N = 53)	ESG Score	E Score	S Score	G Score
ESG score	1	0.939	0.858	0.758
E score	0.939	1	0.764	0.569
S score	0.858	0.764	1	0.448
G score	0.758	0.569	0.448	1
Integrated Oil and Services (N = 30)				
ESG score	1	0.915	0.916	0.610
E score	0.915	1	0.774	0.446
S score	0.916	0.774	1	0.328
G score	0.610	0.446	0.328	1
Oil and Gas Drilling (N = 20)				
ESG score	1	0.886	0.893	0.398
E score	0.886	1	0.783	0.048
S score	0.893	0.783	1	0.078
G score	0.398	0.048	0.078	1
Oil and Gas Exploration and Production (N = 141)				
ESG score	1	0.921	0.949	0.723
E score	0.921	1	0.860	0.504
S score	0.949	0.860	1	0.528
G score	0.723	0.504	0.528	1
Oil and Gas Refining and Marketing (N = 89)				
ESG score	1	0.902	0.939	0.715
E score	0.902	1	0.788	0.469
S score	0.939	0.788	1	0.547
G score	0.715	0.469	0.547	1
Oil and Gas Transportation Services (N = 61)				
ESG score	1	0.910	0.880	0.677
E score	0.910	1	0.792	0.435
S score	0.880	0.792	1	0.325
G score	0.677	0.435	0.325	1
Oil-related Services and Equipment (N = 83)				
ESG score	1	0.918	0.945	0.717
E score	0.918	1	0.857	0.462
S score	0.945	0.857	1	0.530
G score	0.717	0.462	0.530	1
Renewable Energy Equipment and Services (N = 84)				
ESG score	1	0.886	0.895	0.733
E score	0.886	1	0.795	0.383
S score	0.895	0.795	1	0.491
G score	0.733	0.383	0.491	1
Uranium (N = 15)				
ESG score	1	0.920	0.902	0.645
E score	0.920	1	0.846	0.326
S score	0.902	0.846	1	0.405
G score	0.645	0.326	0.405	1

Table 6. Multiple regression analysis results by sub-sector.

E Score	R-Squared	Beta (S)	Sig. (S)	Beta (G)	Sig. (G)
Coal	0.648	0.637	0.000	0.284	0.004
Integrated Oil and Services	0.640	0.703	0.000	0.216	0.088
Oil and Gas Drilling	0.613	0.784	0.000	−0.013	0.930
Oil and Gas Exploration and Production	0.743	0.823	0.000	0.070	0.170
Oil and Gas Refining and Marketing	0.624	0.759	0.000	0.054	0.495
Oil and Gas Transportation Services	0.662	0.727	0.000	0.199	0.017
Oil-related Services and Equipment	0.734	0.851	0.000	0.011	0.874
Renewable Energy Equipment and Services	0.632	0.800	0.000	−0.010	0.901
Uranium	0.716	0.854	0.000	−0.020	0.909
S Score	R-Squared	Beta (E)	Sig. (E)	Beta (G)	Sig. (G)
Coal	0.584	0.753	0.000	0.019	0.861
Integrated Oil and Services	0.599	0.783	0.000	−0.022	0.873
Oil and Gas Drilling	0.615	0.781	0.000	0.041	0.789
Oil and Gas Exploration and Production	0.751	0.796	0.000	0.126	0.011
Oil and Gas Refining and Marketing	0.662	0.682	0.000	0.227	0.002
Oil and Gas Transportation Services	0.628	0.802	0.000	−0.024	0.787
Oil-related Services and Equipment	0.757	0.778	0.000	0.171	0.007
Renewable Energy Equipment and Services	0.673	0.711	0.000	0.219	0.002
Uranium	0.734	0.799	0.000	0.145	0.376
G Score	R-Squared	Beta (E)	Sig. (E)	Beta (S)	Sig. (S)
Coal	0.325	0.545	0.004	0.032	0.861
Integrated Oil and Services	0.200	0.480	0.088	−0.044	0.873
Oil and Gas Drilling	0.007	−0.035	0.930	0.105	0.789
Oil and Gas Exploration and Production	0.288	0.194	0.170	0.361	0.011
Oil and Gas Refining and Marketing	0.303	0.100	0.495	0.468	0.002
Oil and Gas Transportation Services	0.190	0.477	0.017	−0.053	0.787
Oil-related Services and Equipment	0.281	0.029	0.874	0.505	0.007
Renewable Energy Equipment and Services	0.241	−0.020	0.901	0.507	0.002
Uranium	0.165	−0.058	0.909	0.454	0.376

5. Discussion

One of the most significant findings from this study was the strong mutual influence between the E and S scores across the sub-sectors. The regression analysis showed that S performance significantly drives E outcomes, especially in sub-sectors such as Uranium ($R^2 = 0.716$, $\beta = 0.854$) and Oil and Gas Exploration and Production ($R^2 = 0.743$, $\beta = 0.823$). Moreover, E performance also strongly influences S scores, as data for Uranium ($R^2 = 0.734$, $\beta = 0.799$) and Oil and Gas Exploration and Production ($R^2 = 0.751$, $\beta = 0.796$) confirmed. Despite minor differences, the reciprocal relationship was distinctive across all the sub-sectors. The results partially validated H2 and H3, that E and S performance significantly influence each other across the sub-sectors. Furthermore, the emerging feedback loop was notable, in line with the systems thinking approach [78,79]. For instance, social initiatives, such as community engagement and social responsibility, influence stronger environmental outcomes [50], and companies investing in environmental practices, such as reducing emissions and conserving habitat, gain more stakeholder support [13,60]. Thus, a company's environmental efforts directly enhance its social legitimacy, creating shared value both for the company and for society, as the CSV approach suggests [15]. Obviously, environmental concerns are related to both public and private spheres. Therefore, the burden cannot be left solely to the private sector [80–82]. Accordingly, companies can seek stakeholder aid for environmental implementations to create shared value, and can take advantage of environmental practices backed by stakeholders to develop further social appreciation, which can result in greater stakeholder engagement, reinforcing the feedback loop of the systems thinking approach [10].

This study also revealed that G performance has a mixed influence on E and S scores, which was mostly insignificant. For instance, in the Oil and Gas Drilling sub-sector, governance did not significantly impact environmental or social performance ($p = 0.930$ and $p = 0.789$ for E and S scores, respectively). Yet, in a few sub-sectors, such as Oil and Gas Refining and Marketing, governance showed a more positive relationship with S performance ($\beta = 0.227$, $p = 0.002$), despite being relatively weak when compared with the relationships among the other pillars. The finding suggests that governance frameworks in the energy industry need stronger integration with environmental and social strategies, as suggested in previous studies [83,84]. The results partially contradicted H2 and H3, as they suggested that E and S performances were influenced by G scores. Also, H4—stating governance performance is influenced by E and S scores—was contradicted for the majority of the sub-sectors. The reason for the largely insignificant or weak relationship between G performance and the other pillars across the sub-sectors, particularly in Oil and Gas Drilling, may stem from the fact that current governance frameworks focus more on regulatory compliance rather than on driving sustainability outcomes. For instance, countries with weak public administration experience significantly higher rates of forest loss following oil discoveries, and even foreign companies with strong ESG commitments have a limited impact on reducing forest loss in such countries [85]. Therefore, targeted policy interventions and governance reforms are needed to support sustainable practices across the industry, aligning with the broader objectives of environmental and social performance enhancement. Figure 2 outlines the findings of the correlation and multiple regression analyses within the framework of systems thinking and CSV approaches.

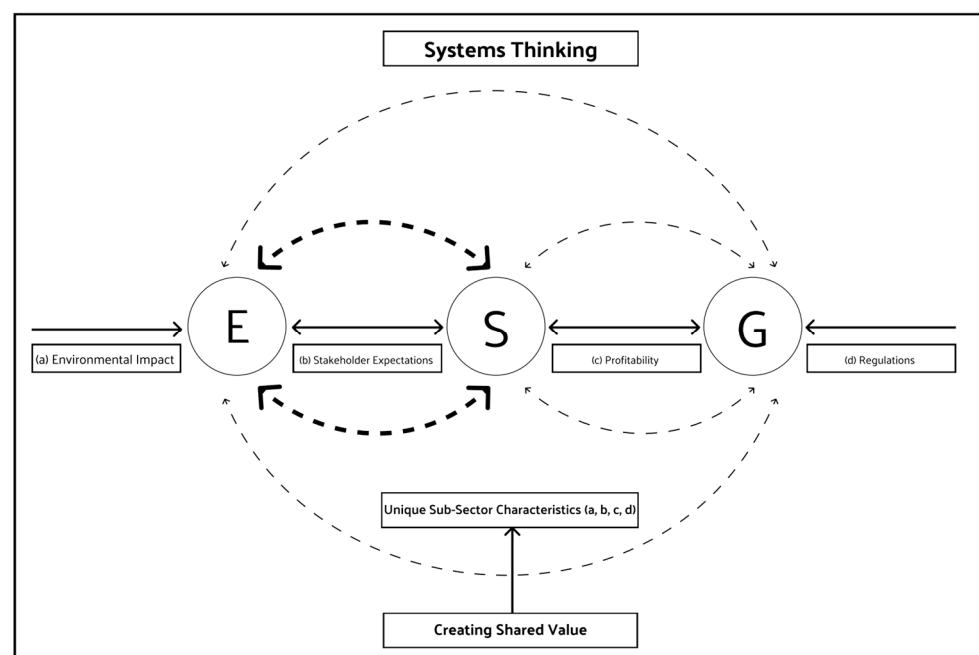


Figure 2. E, S, and G interconnections with systems thinking and CSV approaches.

In addition to the regression results, the post-hoc (Tukey's HSD) analysis for ANOVA highlighted significant differences among the sub-sectors. For instance, Integrated Oil and Services showed significantly better overall ESG performance compared to Oil and Gas Exploration and Production (mean difference = 20.53, $p = 0.000$ for ESG scores). Also, the E performance of Oil and Gas Exploration and Production was notably weaker compared to several other sub-sectors (such as Integrated Oil and Services and Renewable Energy). The results confirmed H1, which posited that sub-sectoral differences influence ESG performances. Therefore, strategies specific to the sub-sector are vital, as standardized ESG approaches may not address the unique challenges and opportunities faced by different industries, aligning with the previous industry-specific arguments [6,39,43]. Moreover, the

high scores of the Integrated Oil and Gas Sector may be attributed to the fact that companies within this sector are large corporations, operating across all phases of the supply chain. ESG factors are known to positively influence profitability in larger firms [27], and larger firms are more exposed to public scrutiny, which increases their vulnerability and drives them to be more focused on ESG-related issues [28]. For example, after eight years of construction, Shell completed a new 30 km section of flow lines, reducing operational spills [83]. Accordingly, the consistently poor performance of Oil and Gas Exploration and Production companies possibly emerged because of their invisibility compared to the Integrated Oil and Gas sector. At this point, policymakers can introduce tax benefits, financial incentives, or subsidies to encourage these companies to adopt sustainable practices and they can also apply environmental law enforcement and punitive measures against polluting companies [86,87]. On the other hand, companies in such sectors can seek stakeholder support to implement cost-effective solutions for operating in more environmentally friendly ways [88] to take advantage of creating mutual benefits, as suggested in CSV [16]. This can lead to convenient feedback loops, as argued in systems thinking [10].

The literature suggested that companies in the renewable sector, which are inherently more aligned with sustainability goals, may find it easier to implement strategies that improve E scores, which can also positively influence S scores [89]. While ANOVA and regression serve different purposes, evaluating both together provided more comprehensive insights. The regression analysis supported the literature by revealing a strong positive relationship between the E and S scores. However, the ANOVA results showed that the Renewable Energy Equipment and Services sub-sector is only superior to Oil and Gas Exploration and Production in terms of its E score, with no significant differences observed in the S and G pillars. The results suggested that the ESG performance of companies in Renewable Energy Equipment and Services may largely depend on their inherent advantage in the environmental pillar, which influences social performance indirectly. Therefore, the findings reinforced the arguments, emphasizing the need for improvements in this sub-sector, including strengthening low-carbon initiatives, enhancing employee training, building stronger relationships with local communities, and increasing transparency [41,44,45].

6. Conclusions

This study provided valuable insights into the complex interdependencies among environmental (E), social (S), and governance (G) scores across various sub-sectors of the energy industry. The findings highlighted the strong reciprocal influence of environmental and social performance across all sub-sectors, such as Uranium and Oil and Gas Exploration and Production. The relationship demonstrated feedback loops, as emphasized in the systems thinking approach, where improvements in one ESG dimension caused changes in the other. Therefore, energy companies need to adopt integrated sustainability strategies that concurrently address environmental and social dimensions, which is in line with the creating shared value (CSV) approach.

Governance performance, however, displayed a weaker and often insignificant impact on environmental and social outcomes, especially in sub-sectors such as Oil and Gas Drilling. The findings support the suggestion that governance frameworks in the energy sector may focus more on regulatory compliance than on actively pursuing sustainable outcomes. It is clear that stronger integration of governance with environmental and social practices is essential, but, of course, with sector-specific governance strategies to enhance overall ESG scores.

The study also revealed significant differences in ESG performance among the sub-sectors. Obviously, Integrated Oil and Services demonstrated superior performance, whereas Oil and Gas Exploration and Production lagged behind. Briefly, the findings supported the need for developing sub-sector-specific ESG strategies, as standardized approaches may not adequately address the distinct challenges of each industry. Policymakers are encouraged to implement targeted incentives, regulations, and enforcement to promote better ESG practices, especially in sectors where performance is weaker.

In the renewable energy sector, although companies are naturally aligned with sustainability goals, there is still room for improvement, especially in the areas of social responsibility and governance. By capitalizing on their environmental strengths, renewable energy companies can further enhance their ESG performance and make a better contribution to long-term sustainability.

In conclusion, the final recommendations of this study are as follows:

1. Given each sub-sector's distinct operational challenges and environmental risks, ESG approaches should be customized. It is especially important as the environmental impacts and stakeholder relationships vary widely across different sub-sectors within the energy industry.
2. For oil and gas producers, efforts should concentrate on reducing pollutants; contamination; and, particularly, methane emissions. Conversely, renewable energy firms could place more emphasis on efficient land use and minimize any local ecological disruption, which is a priority due to their frequent proximity to communities.
3. Energy companies should seek stronger stakeholder support to implement cost-effective environmental practices, which can enhance further social outcomes in return. For example, the Oil and Gas Drilling sub-sector should collaborate with environmental organizations to address spill prevention and habitat restoration. On the other hand, renewable energy companies should improve relations with local communities by highlighting their environmental strengths to address concerns related to land usage and visual impact.
4. Governance frameworks should be further integrated with environmental and social practices, beyond basic regulatory compliance. For the Oil and Gas Drilling sub-sector, a governance emphasis on transparency and accountability in environmental risk management is essential. Meanwhile, renewable energy companies could benefit from governance improvements in areas such as technology adoption, financial flexibility, and attracting skilled talent.
5. Governments should provide targeted incentives, tax benefits, and subsidies to encourage sustainable practices and enforce stricter environmental regulations, which mandate higher levels of compliance, particularly for the sectors with inherently low ESG performance.
6. International organizations could play a crucial role by scrutinizing the energy companies and countries with lax regulations. Establishing globally recognized ESG benchmarks to encourage the adoption of stricter environmental standards could drive accountability and help consistent practices across borders.

The study has highlighted how interconnected ESG components, when influenced by systems thinking and CSV approaches, can guide sub-sector-specific sustainability strategies in the energy industry. Additionally, these insights may have broader implications beyond the energy sector, particularly for other resource-based, sensitive industries, such as mining, chemicals, and manufacturing. Just like the energy industry, other resource-intensive industries have challenges in balancing their unique environmental and social pressures with profitability and governance requirements. Tailoring ESG strategies to address industry-specific risks, regulatory landscapes, and stakeholder expectations is crucial for achieving sustainable outcomes.

6.1. Limitations

While this study provided valuable insights into ESG interrelationships across energy sub-sectors, it had several limitations. First of all, the analysis was based on cross-sectional data from a single year to ensure clarity in typical periods and to avoid the potential distortions caused by the COVID-19 crisis. However, this approach limited the study's ability to assess changes in ESG performances over time. Moreover, the study focused on specific energy sub-sectors, worldwide, without considering potential regional or country-specific variations because of the limited availability of country-specific data. Different regions may have unique regulatory environments, stakeholder pressures, or market

conditions, which could affect ESG performance outcomes. Additionally, the filtering process excluded companies with incomplete data for 2023, which may have introduced some bias, if there were some companies with ESG practices that have not been reported yet. Finally, despite drawing from an esteemed institution, the study relied on secondary data, which may vary depending on the methodologies. Also, there was an inherent limitation in the potential for companies to disclose information primarily for favorable ESG scores rather than fully integrating ESG practices.

6.2. Further Studies

Future research could explore ESG performance over multiple years to provide a more comprehensive understanding of how these interrelationships evolve, except during crisis periods. Also, exploring specific periods to understand how external factors—such as changes in energy policies, regional or global crises, or technological innovations—affect the relationships between E, S, and G scores might be valuable. Moreover, examining regional and country-specific differences in ESG performance within the energy sector is recommended for further studies, although there may be some limitations due to sectoral imbalances, depending on the selected countries. Furthermore, expanding this research approach to other resource-intensive industries, such as mining, chemicals, and manufacturing, could offer insights into sector-specific ESG dynamics. Finally, and most importantly, further studies could investigate how various governance frameworks improve the alignment of environmental and social strategies in energy companies, particularly through country-specific data or case studies based on company information.

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