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The Effect of Women's Leadership on Carbon Disclosure by the Top 100 Global Energy Leaders

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Abstract: The energy sector is one of the main sources of carbon emissions and the most significant global polluter. Women's concerns and the climate crisis were strongly associated when issues about climate change were first articulated in the United Nations Sustainable Development Goals stressing gender equality and climate mitigation actions have received very little attention in the last decade. Consequently, the primary issues raised by this study are the energy industry, and women and climate change. This study examined the effect of women's leadership on carbon disclosure among the top 100 global energy leaders from 2018 to 2020. This study unequivocally recognizes the effect of women's leadership as assessed by the number of female board members who are industry experts, serve as advisors, and pose as proxy community leaders for global energy leaders. This study's sample consisted of 291 observations of global energy leaders sourced from Thomson Reuters' database. For the panel data analysis, STATA 14 (Version 14.) software was applied as the empirical methodology. The empirical findings showed that among the top energy leaders globally, women leaders increased the degree of carbon disclosure. The findings of this study provide novel insights into the importance of women's leadership in the energy sector for enhancing and promoting carbon disclosure. The validity of hypothesized links in the findings lends support to the resource dependence theory from the viewpoint of the energy leaders. This study also provides guidance for practitioners, governments, and policymakers on how to combat climate change, encourage the inclusion of as many women as feasible on boards, the promotion of gender parity, and support efforts to achieve the net zero carbon target.

Keywords: carbon disclosure; energy industry; women's leadership; resource dependency theory

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1. Introduction

Our planet's temperature has increased as a result of greenhouse gas emissions brought on by human activity, particularly the release of carbon dioxide gas from the burning of fossil fuels. This has had an influence on the entire ecosystem [1–4]. Wide-ranging effects of climate change include increased global temperatures, harsh weather, shifting wildlife populations and habitats, rising sea levels, and other significant effects [1–4]. Governments and organizations, such as the United Nations' Intergovernmental Panel on Climate Change (IPCC), are, nevertheless, evaluating greenhouse gases, observing their effects and proposing strategies, particularly for the greatest polluters [2]. In the COP26, IEA highlighted their responsibility and their crucial role in strengthening their climate change mitigation activities and adapting their strategies and initiatives to improve climate resilience. The corporate world, particularly the energy sector, is the major contributor to climate change, accounting for more than two-thirds of all greenhouse gas emissions worldwide [5]. In 2020, the energy sector contributed the most greenhouse gas emissions in the world, approximately 24.2 percent, with the oil and gas and electricity sectors

among the top contributors [6]. In contrast to the aforementioned statements, climate change severely affects all living creatures, including humans. Surprisingly, increasing gender parity will be beneficial in reducing the impact of climate change [4]. In a poll conducted by the UN Development Program (UNDP), 1.2 million people in 50 countries were asked questions [7]. According to the poll results presented by UNDP, young people are extremely concerned about climate change and have labeled it as a global emergency [7]. Unexpectedly, the survey revealed that women were more concerned about global warming than men [7]. However, when it comes to environmental issues, and women's rights and leadership, women are persistently underrepresented [4,8]. Yet, when the proportion of women in a group rises, collective intelligence increases, resulting in a more forward-looking and successful conclusion and more sustainability-focused decision making across all sectors, particularly in the energy industry [8]. Women's empowerment and climate resilience have been prioritized by the Sustainable Development Goals since 2015 in order to achieve gender equality and a climate solution, but they have garnered little public attention [9]. Gender parity ranked second out of the 76 strategies suggested for keeping global warming to 2 degrees Celsius, particularly in industrialized nations, according to a recent assessment by the climate research group Project Drawdown [9]. As a result of their special expertise and experience, women must play a more significant part in the development and implementation of programs to address climate [10]. The success of climate action depends on their input into decision-making processes. A 2019 study found that having more women in national parliament leads to the adoption of much stricter climate change policies, which in turn lowers emissions [10]. Greater conservation and resource governance at the local level are correlated with women's participation in natural resource management [10].

Women's leadership and increased climate effect transparency in the workplace are related [10]. Higher percentages of women on company boards are positively correlated with the reporting of carbon emissions statistics [10]. Effective, collective action against climate change requires significant changes in how we produce and assess economic value [10]. As we transition away from extractives practices and fossil fuel economies, there is a possibility to generate new opportunities and up-skill female workers [10]. Incorporating different gender perspectives into comprehensive and long-lasting policies and programs for disaster and environmental and climate risk reduction is a major goal in the fight against climate change in order to achieve a sustainable future for the entire globe and an approach that considers gender parity is the answer to climate change for a more sustainable future [10]. At the COP26 climate summit, the leaders of Bangladesh, Tanzania, and Estonia were first to sign the Glasgow Women's Leadership declaration, which urged countries to support women's leadership on climate change at all societal and political levels [11]. On Gender Day at the COP, nations, including the US, UK, and Canada, pledged to further integrate gender into their climate finance arrangements. Despite there being an increase in commitments for "gender-responsive" financing, talks for climate funds garnered very little attention for gender-related issues [11]. Making the Glasgow Women's Leadership Declaration a reality is, thus, important [11]; women are crucial in meeting the COP26 climate targets. Despite these challenges and observations, gender parity in national environmental decision making is uncommon [11].

Earlier studies show a link between greater firm performance and female representation in business and on boards of directors [12]. Countries where women actively participate in politics are also more inclined to take drastic climate action [12]. There was a study conducted by using a data from a broad sample of countries were evaluated and it was shown that the presence of women in legislative bodies led to stronger climate change legislation [12]. Additionally, countries in which women have higher political and social standing, often have smaller climate footprints and emit fewer greenhouse gases. A more diversified workforce and leadership can promote more creativity and creative solutions to climate challenge [12]. In order to achieve this, the C3E International Initiative under the IEA Technology Collaboration Program and the Clean Energy Ministerial expressly aims to

promote greater gender diversity in clean energy professions [13]. Taking advantage of the distinctive and innovative viewpoints that senior women managers may provide could hasten the global transition to renewable energy [13].

Women have substantially more leadership positions in large energy-related global corporations, many of which have developed corporate strategies centered on diversity and inclusion [13]. However, women are underrepresented in senior management positions [13]. The energy industry is a stark example of this; less than 5% of applicants are chosen for executive roles, including chair of the board, CEO, and president [13]. Notably, in the energy sector, the percentage of women holding board seats and senior management positions is stubbornly low [13]. It could take years for the majority of energy corporations to fully understand the potential contribution of women [14]. Comparatively, larger businesses are more likely to have comprehensive gender employment practices since they are subject to higher investor scrutiny [14]. Gender diversity in the energy sector must be strengthened through sustained inclusionary measures [14]. The low-carbon transition will bring about unprecedented and turbulent changes, and it is obvious that businesses that encourage more gender-inclusive career paths for women in top management would be better able to manage these changes [14]. Women must, therefore, actively participate in the energy sector [13].

Bridging this gender gap will be essential because women are critical for inclusive innovation [13]. The energy industry is still one of the least gender diverse industries [13]. Despite making up 48% of the global workforce, women only make up 22% of the traditional energy sector, and their representation in management positions is much lower [13]. The difficulties are now more pressing since the energy sector is changing [13]. Transitioning to clean energy will demand innovative solutions and commercial models, as well as the increased participation of those with varied knowledge and expertise [13]. Even though the energy sector is generally dominated by men [15,16], women could play a big role in the transition to clean energy, both as consumers who can change their energy consumption and as change makers inside the sector [14]. It would have been simpler to combine environmental and gender goals had there been more gender diversity on business boards and in top management roles [14]. There would also be more "green" decisions made in the public and commercial spheres if there were more women in top management and leadership positions in the energy sector [14]. Women are essential as energy professionals, decision makers, and consumers [14]. Women and men have distinct preferences, for example, when it comes to the energy shift and the use of renewable energy [17]. Energy policy is generally gender-blind, despite the fact that women are typically underrepresented in the industry at all levels, including bottom-up approaches such as community-based solutions [18]. Therefore, there should be efforts for immediate action to remove institutional hurdles in the way of women's participation in the workforce and participation in decision making in the energy sector, while also acknowledging the benefits of a green transition for gender equality and the potential role that women could play in the clean energy sector given their behavioral preferences [19]. Correspondingly, in a communiqué that was adopted at the IEA Ministerial meeting in December, 2019, IEA Ministers specifically endorsed additional IEA efforts to raise and share knowledge to help address issues related to future human capacity demands, including equal opportunities for women and men in the energy sector, as well as the gender composition of corporate boards [13].

By creating a theoretical model based on resource dependency theory to examine the suggested relationships, this study aims to fill in gaps in the literature and increase the understanding of the impact of women's leadership on carbon disclosure from the perspective of the top 100 global energy leaders (Appendix A Table A1). More specifically, content analysis of annual reports, sustainability reports, corporate governance reports, and company websites was undertaken between the years of 2018 and 2020 to gain secondary data. This study, which was also inspired by Ramon Llorens et al. [20], expands on the findings that, from the perspective of the top 100 global energy leaders, increasing the

percentage of women board members, the percentage of women board members who are industry experts, advisors and/or are community leaders would enhance the level of carbon disclosures. The primary goal of this study is to determine the extent to which women's leadership influences carbon disclosure by the major carbon emitters who are also energy leaders. This study seeks to add to the existing body of knowledge on carbon disclosure in numerous ways, as well as provide some significant policy and practice-related insights.

Firstly, this study sheds light on how women's leadership influences how carbon disclosure practices among energy leaders might be understood. Secondly, the study encourages climate resilience among energy leaders and provides a distinctive theoretical perspective on the effect of women leaders in the corporate sector and their role in reducing the severity of the climate issue. This study lays the groundwork for better understanding the degree of carbon disclosure among energy leaders who have been influenced by female leadership. It also facilitates strategic and policy decision-making processes that aim to achieve the best possible implementation of practices, recommendations, and compliance for climate action. The remainder of this paper's discussion is as follows. Section 2 reviews the literature, discusses theoretical underpinnings, and explains the development of the hypotheses. Next, the research design and methodology are outlined in Section 3. The analysis and findings are discussed in Section 4, and the conclusion and recommendations are articulated in Section 5.

2. Literature Review and Hypotheses Development

2.1. Climate Change and Energy Sector

The health of the ecosystem is deteriorating more rapidly than ever [21], and unprecedented progress has been made in understanding climate change over the past ten years [22]. This has prompted increased efforts to limit greenhouse gas (GHG) emissions to stop global warming. Since climate change is approaching crisis proportions, our safety net is practically at breaking point and the current global reaction is deemed insufficient. Therefore, systematic transformative reforms are urgently needed to restore and defend the ecosystem [21]. The Paris Agreement, which superseded the Kyoto Protocol, urges businesses to adopt long-term strategies that strike a balance between the economy and nature [23] and establish ambitious targets for lowering GHG emissions in order to combat climate change [24]. Large-scale carbon-producing industries and businesses are one of the main sources of GHG emissions [25]. Globally, there is an urgent need for industry to play a role in combating climate change, particularly among the energy sectors, which are responsible for the majority of greenhouse gas emissions into the environment [24]. A part of the larger field of corporate social responsibility (CSR) research, which investigates the responsibilities of business towards society and the environment, is a study of climate change and the energy sector [26]. It found that the energy industry is crucial in mitigating climate change and energy corporations must take the lead in lowering emissions.

Due to climate change becoming the most recent and prominent issue that management and stakeholders are concerned about [27], regulators, investors, and other stakeholders are urging businesses to increase their transparency by disclosing non-financial information [28], including their carbon emissions [24,29,30]. Reporting related to corporate social and environmental issues is the process of informing specific social groups, and society at large, about the social and environmental effects of an organization's economic decisions; carbon disclosure processes are seen as an essential part of this process [31]. In order to demonstrate their accountability, diligence, and obligation to stakeholders [32], companies disclose information about climate change in a variety of ways [23], with carbon disclosure seen as the main strategy to address climate change concerns and reduce a company's carbon release [33]. The sustainability reporting that organizations present in their annual, standalone sustainability, corporate social responsibility, integrated, or online reports generally includes information on greenhouse gas emissions [34]. They reveal the precise amount of carbon being released into the environment by national, global or governmental organizations [25] within certain regulatory frameworks [35]. Despite the fact that

it is not required and is generally unregulated, many businesses voluntarily report their climate efforts and actions under the Carbon Disclosure Act [36]. To make measurement and reporting processes simpler, the Global Reporting Initiative (GRI), CERES, and the CDP (previously Carbon Disclosure Project) are just a few examples of the frameworks and standards for global carbon reporting that have been developed [26]. Additionally, the voluntary recommendations from the Task Force on Climate-related Financial Disclosures (TCFD) provide support for materiality evaluations that incorporate the long-term difficulties and effects of climate change [36]. They urge all groups to report on climate-related problems, regardless of the severity of the threats [36]. Concurrently, an increasing number of academic studies into carbon disclosure procedures, drivers, and consequences have been published [37]. However, there is a need to formalize and increase the amount of carbon disclosure among companies [38–40]. Additionally, despite their importance and potential benefits, there has not been much research into carbon disclosure practices in the energy sector [26].

2.2. Women's Leaderhip and Carbon Disclosure

The second stream of ESG literature defines corporate governance, in particular environmental disclosure, including carbon disclosure, as a potent tool for enhancing sustainability performance [41]. The necessity of gender diversity on the board is heavily emphasized in the body of literature already available on corporate governance [41]. Due to the positive association between board gender diversity and environmental, social, and governance performance, there is a lot of discussion regarding board gender diversity in the literature in this respect [41]. Women directors like to be involved in new topics, including addressing the effects of climate change, improving carbon disclosure measures, and developing stakeholder communication strategies [42]. More WOBs, according to prior research, enhance internal board regularity, favor board strategic control, and reduce conflicts [43–45]. Furthermore, increased corporate social responsibility (CSR) disclosure and performance [46–49], which also includes environmental reporting such as carbon disclosure, is often attributed to women's leadership. According to empirical data, women directors perform better than male directors when it comes to social and environmental issues [50–54], especially when it comes to managing corporate environmental issues [55]. For instance [32,56,57] demonstrated a link between the likelihood of disclosing carbon information and the proportion of female directors on the board. In addition, Zahid et al. [58] found that female directors have a greater awareness of their companies' corporate social and environmental duties and are more successful at monitoring management's environmental initiatives. Scholars appear to be in agreement about the importance of board characteristics in determining how corporate social responsibility is carried out but, in the literature, there is disagreement and a general lack of clarity about specific effects [59], such as the link between board gender diversity and carbon disclosures [32,33,56,60]. Some authors asserted that companies can benefit by bringing more WOB, even if they face challenges such as gender inequity and prejudice that limit their ability to contribute to carbon initiatives [58]. The specific contribution of female directors to carbon-related disclosure policies has been extensively researched at this point [56,60–62]. These researchers support the view that women contribute to a board's effectiveness in resolving environmental issues [63], but it is unclear how corporate boardroom diversity will address those concerns [64].

2.3. Theoretical Background and Hypotheses Development

Empirical data suggest that boards that intend to take environmental action may produce successful environmental outcomes when they are independent, varied in their areas of expertise, and of mixed gender [65–68]. On the other hand, Al-Qahtani and Elgharbawy [69] found that while having more female directors has a favorable impact on carbon management and disclosures, a sizable fraction of BODs with financial or industrial backgrounds have a negative effect on GHG information. They highlight that these women

directors are essential figures in ensuring more openness in climate change initiatives that stakeholders and policymakers may find significant. According to the study, having women on a board can help a company balance its non-financial and financial objectives by resolving competing stakeholder interests. However, board expertise may have a detrimental effect on GHG disclosure [69]. It was believed that the directors expressing negative views had financial knowledge and that their main concerns were related to financial matters and industrial repercussions [69]. Nevertheless, supplementary research by Elsayih, Tang and Lan [57] and Liao, Luo and Tang [56] has also determined that independent directors advocate for more transparent carbon disclosure due to their distinct backgrounds and lack of financial ties to the company. Ultimately, based on the above foregoing argument and related evidence, we hypothesized that

Hypothesis 1: *Women's inclusion as board members will positively enhance carbon disclosure. The relationship between environmental disclosure and the presence of women on a board can be predicted and vividly exposed using the resource dependence theory [70]. According to this theory, diversity on boards facilitates better resource management and access while reducing dependency on natural resources [71,72]. In addition to promoting business contacts, communication channels, and personal ties to the companies, diversity on boards also provides a diversity of perspectives, counsel, and credibility [56,73,74], efficiently guiding management to have better judgment, which might enhance business performance [43,75–79] because it offers a range of perspectives, abilities, and values [71,72,80], and is in favor of environmental legislation and policies being adopted [50,81]. RDT goes on to say that when board members present their knowledge, background, reputation, capabilities, and external connections with other organizations, they fulfill their duties and obligations more successfully. As a result, a board's human and social capital may influence strategic business decisions favorably, e.g., supporting environmental transparency, including carbon disclosure [82–84], while performing their important advisory function [85] based on each person's unique background, training, experience, and ability in their profession [84]. If they are "outsiders", they could bring reputation, outside connections, and representatives' engagement [70,86]. Therefore, according to RDT, companies with women on their boards enhance information flow by influencing the decision-making process in a positive way, providing a wider range of perspectives, which could ultimately lead to a higher degree of disclosure of environment-related matters. This may strengthen links and relationships with external stakeholders and organizations [20,87].*

In a recent comprehensive study, Ludwig and Sassen [88] emphasize the value of women directors' experience, education, and board gender diversity in promoting company sustainability. Ludwig and Sassen [88] state that increasing gender diversity and the experience of a board of directors enhances environmental influence, reporting, performance, stakeholder involvement, socially responsible orientation, and transparent growth. It encourages openness, enables greater stakeholder interaction through CSR channels, and protects against a board that is only designed to maximize shareholder value. In addition, Lahyani [89] asserts that gender diverse boards often provide a higher volume of carbon information in order to increase environmental transparency in French listed firms. According to Wang et al. [90], female directors in Chinese companies promote environmental innovation by incorporating stakeholder-oriented values and beliefs into decision making. Several scholars have backed up these claims, including Radu et al. [91], who claim that within the Canadian context, women directors on boards tend to express concerns about social and environmental issues; Jibril et al. [92] discussed how energy disclosure and board gender diversity significantly correlated in the Nigerian context. Wang, Yekini, Babajide and Kessy [87] contest that, within the UK context, board gender diversity is significantly and favorably connected with CSR disclosure, while Park et al. [93] believe that the feasibility of voluntary carbon emissions disclosure in Korea is increased by gender diversity. The distinctive abilities, experiences and attitudes of female directors should boost the board's overall corporate CSR performance, particularly in the environmental sector, according to recent research, which also emphasizes the significance of gender

diversity on the board [88,94]. This is also supported by Khan et al. [95], who support this assertion by arguing that having female directors, independent academic directors and independent politically affiliated directors improves China's disclosure of carbon information. According to Konadu et al. [96], women's characteristics, such as greater education and experience [75,97], are associated with a higher level of CSR, such as a reduction in GHG emissions. They discovered that having more women on a board increases its efficacy by bringing a diversity of viewpoints, experiences, and information to the board [96]. Diverse capability, information, and beliefs favorably influence how decisions are made [96], which in line with resource dependency theory. Firms gain from the diverse skills, perspectives, and impacts that women bring to the boardroom [98], especially when dealing with highly polluting industries, where the attributes and resources of women are particularly evident [96].

Some studies contend that decisions affecting environmental reporting, such as carbon disclosure, may be influenced by the various abilities, skills, backgrounds, professional experience, and problem-solving capacities of external directors [99]. According to the taxonomy of their resource reliance responsibilities, which took into account their background and prior experience, Hillman, Cannella and Paetzold [72] divided boards of directors into three categories—industry experts, advisors, and community leaders. This approach has also been used by scholars such as Markarian and Parbonetti [100], Bear, Rahman and Post [50], and Haynes and Hillman [101]. Industry experts are board members who bring their prior expertise, competencies, and professional background, acquired while serving as executives in other companies, to the boards on which they serve [72]. Directors with industry experience contribute valuable human capital to companies, which may influence the effectiveness of the board and the decision-making process. They might also recognize the dangers and opportunities for the company, given their background in business and the expertise they have learned from working for other companies [85,102].

Among others, this point of view has been presented by Shropshire [103] and Westphal [104]. They use the resource dependence method as the foundation of their claim that directors with industry knowledge can provide boards with superior social and human resources. This may be due to their prior work-related knowledge, experience, and professional credentials, gained from other companies, all of which may enhance environmental reporting. Prior empirical studies corroborate the aforementioned defenses and points of view [105,106]. These empirical findings show that companies with superior environmental performance tend to have boards of directors with experience, professional credentials, and knowledge. Environment-related issues in particular have a positive correlation with directors who are experts in the field. Therefore, boards made up of domain experts in the business may encourage environmental transparency, including the disclosure of carbon emissions, which would be well-regarded by stakeholders and shareholders [20].

Due to their advanced education, qualifications, prior work experience, and history outside the business sector, women directors may diversify the board and bring broader ideas and viewpoints [72]. Additionally, female directors frequently exhibit greater social and environmental awareness [20]. Boards led by women with extensive experience in the industry may be more receptive to stakeholder interests and demands and more eager to release environmental data, such as carbon disclosure. According to Giannarakis [107], past experience provided by women board members results in more diverse and unique leadership styles and perspectives in comparison to their male counterparts, which in turn leads to promoting environment-related disclosure. Shrader et al. [108] also speculate that women directors' human capital could be problem solvers on boards. We consequently predict that women directors on boards with competence, prior experience, knowledge, and credentials will be more focused on stakeholders and environment-related concerns in light of the aforementioned perspectives. As a result, they will be more inclined to favor reporting of carbon disclosure. In this regard, this study proposes the following hypothesis:

Hypothesis 2: *Women board members who are industry experts will positively enhance carbon disclosure.*

In contrast to industry experts who have general knowledge of management issues [68], female board members who serve as advisors explicitly offer to the boards specific skills, experiences, and backgrounds in fields, such as knowledge on financial issues, various sectors of environmental, and social matters [72]. These directors developed their human capital as insiders in auditing, accounting, finance, marketing, and consulting organizations, and hopefully, this will have a positive effect on strategic decisions, particularly those pertaining to environmental challenges [109–111], as well as carbon disclosure. It is abundantly clear from the research findings of Adams and Ferreira [112] and Smith and Parrotta [113] that having female board members with significant qualifications, expertise, background, and skills will enable them to have an impact on business decision-making processes, especially those who have a stronger orientation towards social and environmental issues than towards financial, business, and market issues. This could make them more likely to offer advice on environmental matters [110,111,114]. It follows that environment-related policies and practices, such as environment-related disclosure, are expected to be practiced more frequently by boards with specific resources provided by female advisors. The specific skills and viewpoints required to build empathy for the needs and expectations of many stakeholders, including those related to environmental challenges, are more likely to be championed by female directors. Because of this, female board advisors are more likely to encourage the reporting of environmental information, such as the disclosure of carbon emissions. With this in mind, the following hypothesis was formulated:

Hypothesis 3: *Women board members who act as advisors will positively enhance carbon disclosure.*

Women board members who are community leaders, in contrast to being industry experts, and advisors, have experience in working with groups or communities such as political parties or social organizations [72]. They provide resources such as connections to important stakeholders or social position, reputations, and legitimacy [115]. The contacts and relationships that community leaders on boards may have with social or non-commercial communities are vital assets for companies [20]. Community leaders who sit on boards tend to be former politicians or to have held significant positions in significant areas. In non-profit environments, these directors are highly regarded, well-known, and powerful [116]. Community leaders can be viewed as significant sources of social capital since they can provide trustworthiness, openness, and solid connections with other organizations. According to Chen [117], Hillman and Dalziel [118], and Tsai and Ghoshal [119], the purpose of community leader directors on boards is to contribute resources (social capital) from other communities and organizations. Keeping in touch with other board members allows community leaders who hold various positions to allocate a significant quantity of social capital [120–122]. Community leaders having such a high participation rate on boards is explained by the fact that anyone can be selected as a board member, regardless of their skills in business, accounting or finance [123,124].

Women community leaders will be better able to communicate with other board members and establish networks with other organizations, which might benefit their businesses in a number of ways. These benefits may include better resource acquisition, as well as greater monitoring, perspectives, and orientations towards more social and environmental challenges [45]. Women directors have more ties to non-profit or educational sectors than male directors according to Harrigan [125] and Kesner [126]. Since their experience comes from fields other than CEOs, such as government, law, and financial institutions, Hillman, Cannella and Harris [75] reveal that none of the female directors chosen to serve as community leaders had prior CEO experience. Women community leaders will, therefore, contribute non-business viewpoints and methods to the decision-

making process in addition to their influence, external connections, and expertise gained by working with major groups in the community [75]. The idea that female community leaders who sit on boards may also be environmentally conscientious people who can help boards gain a social approach to environmental disclosure seems to be supported by these explanations and data validations. Based on the above consideration, we propose testing the following hypothesis:

Hypothesis 4: *Women board members who serve as community leaders will positively enhance carbon disclosure.*

This paper primarily focused on the presence of female board members who are industry experts, who serve as advisors and/or community leaders, and who play a leading role in the energy sector. These women could assist in promoting carbon disclosure practices associated with carbon footprints and transparency, as well as contribute to the SDGs and other climate initiatives.

3. Research Design and Methodology

3.1. Data Collection and Sample Selection Database

This study employed purposive sampling, and was sourced from the top 100 global energy leaders featured in the 2017 Thomson Reuters in order to test the hypotheses and accomplish the research objectives. The top 100 global energy leaders are listed Fortune 500 list of energy companies from around the world. The top 100 global energy leaders, which Thomson Reuters also identified in 2017, served as the research's unit of analysis. Due to the implementation of the Paris Agreement, which began to take effect on 4 November, 2016, this study obtained secondary data from all these sources from the years 2018 to 2020. By looking at the top 100 global energy leaders listed in the 2017 Thomson Reuters, the development and changes of the following fiscal year can be observed. The top 100 global energy leader firms used in this study were originally based on the Thomson Reuters database; however, it was not possible to find 97 companies; the remaining three were acquired by the same corporate entities mentioned in the top 100 global energy leaders in the years 2018 to 2020. The final sample consists of 97 businesses and 291 observations made over a period of three years. The most recent sustainability or environmental reports, annual and integrated reports, and other materials available on the company websites of all the firms were examined for climate-change-related information (e.g., CDP questionnaire responses, if available, on the corporate website).

The measuring index for firms' reporting information on carbon disclosure from de Grosbois and Fennell [26], Alrazi et al. [127], and Bae Choi et al. [128] is the basis for the content analysis technique used in this work. The interpretative technique, which is based on the assessment of carbon disclosure practices by the qualitative character of the narrative and focuses on text interpretation, is used in this study and is based on the literature and content analysis [129]. Breaking down a narrative into its component parts and then explaining the contents of each disaggregated component helps us better comprehend what carbon disclosure procedures mean [130]. The retrieved panel data were statistically analyzed using STATA Software version 14.

3.2. Measurement of Variables

The carbon disclosure practice indicators used in this study as the dependent variables were taken from the carbon disclosure index created by de Grosbois and Fennell [26], Alrazi, Bahari and Husin [127], and Bae Choi, Lee and Psaros [128], which incorporates a list of characteristics for the measurement of carbon disclosure or climate-related risk disclosure. Table 1 illustrates the nine classifications and 90 indicators of carbon disclosure practices as the proxy of CD practices for the sample companies. This study purposely used the scoring methodology from which this method was developed in 2008 to calculate the CD at the initial stage [131]. Therefore, this study implemented the scoring methodology based on

the counts of scores that those sample companies may achieved during content analysis technique deployment. The scoring methodology assessed the level of CD among the energy leaders by awarding a score of 1 denoting "disclose" and a score of 0 denoting "not disclose" for each indicator, which ultimately yielded scores for each company along with the evaluation using the content analysis technique. At the end of the scoring methodology process, the number of scores for disclosing any indicators in the CD index will be divided; the maximum score that can be achieved is 90.

Table 1. Carbon disclosure index.

	Strategy and Policy
1.	Mentioning 'climate change'
2.	Mentioning 'emission reduction'
3.	Mentioning 'energy savings'
4.	Commitment to reduce GHG emissions
5.	Commitment to reduce energy use
6.	Sustainability policy
7.	Environmental supply chain policy
	Climate Change Risks and Opportunities
1.	Recognition of climate change risks
2.	Explanation of climate change risks
3.	Discussion of climate change opportunities
4.	Response to risks and opportunities
5.	Assessment of financial implications of selected risks or opportunities
	Corporate GHG Emissions Targets
1.	Target of carbon neutrality
2.	Commitment to or adoption of science-based GHG emission targets
3.	Absolute GHG emissions reduction target
4.	GHG emissions intensity reduction target
5.	GHG emissions target breakdown
	Company Wide Carbon Footprint
1.	Disclosure of total GHG emissions in absolute terms
2.	Breakdown of total GHG emissions
3.	Disclosure of Scope 1 GHG emissions
4.	Breakdown of Scope 1 GHG emissions
5.	Disclosure of Scope 2 GHG emissions
6.	Breakdown of Scope 2 GHG emissions
7.	Disclosure of Scope 3 GHG emissions
8.	Breakdown of Scope 3 GHG emissions
9.	Disclosure of GHG emissions intensity
10.	Breakdown of GHG emissions intensity
11.	Scope 1 GHG emissions intensity
12.	Scope 2 GHG emissions intensity
13.	Scope 3 GHG emissions intensity
	GHG Emissions Change Over Time
1.	Comparison of absolute GHG emissions with previous year
2.	Explanation of changes in absolute GHG emissions over time
3.	Breakdown of absolute GHG emissions change
4.	GHG emissions intensity change from last or base year
5.	Breakdown of GHG emissions intensity change over time
6.	GHG emissions saved due to a specific initiative
	Energy-Related Reporting
1.	Energy-related targets
2.	Total energy consumption
3.	Breakdown of energy consumption

Table 1. *Cont.*

4.	Energy consumption change over time
5.	Breakdown of energy consumption change
6.	Energy intensity
7.	Breakdown of energy intensity
8.	Energy intensity change over time
9.	Breakdown of energy intensity over time
10.	Targets related to renewable energy use
11.	Renewable energy consumption
	Emission Reduction Initiatives Implementation
1.	Carbon offsetting or purchase of renewable energy credits
2.	Investment in low carbon or energy R&D
3.	Sustainable building construction and renovation process
4.	Improving efficiency of everyday operations
5.	Installing energy-efficient lighting
6.	Heating and cooling systems improvements
7.	High-efficiency equipment
8.	Efforts to reduce transportation-related emissions
9.	Renewable energy use
10.	Customer engagement in emissions reduction
11.	Employee engagement in emissions reduction
12.	Supplier engagement in climate change efforts
13.	Engagement with business partners on climate change
14.	Participation in external collaborations on climate change
15.	Targets related to specific initiatives
16.	Performance related to specific initiatives
17.	Product classified as low-carbon, carbon-neutral or carbon positive
18.	Cost of future emissions factored into capital expenditure planning
19.	The contribution of renewable electricity to the company's EBITDA in the current reporting year
20.	The projected contribution of renewable electricity to the company's EBITDA at a given point in the future
	Carbon Emission Accountability
1.	Indication of which board committee/other executive body has overall responsibility for actions related to climate change
2.	Description of the mechanism by which the board/other executive body reviews the company's progress regarding climate change
3.	Carbon policy/mission/vision statement
4.	Description of stakeholder engagement programs
5.	Support for organizations promoting climate change
6.	Awards received
	Quality of Disclosure
1.	Boundaries for GHG emissions calculations are specified
2.	The reporting period which the data cover is specified
3.	Scope of total emissions is specified
4.	Scope 2 emissions are specified as either location- or market-based
5.	Both location- and market-based Scope 2 GHG emissions are reported
6.	Inclusions of emissions sources for each scope are explained
7.	Exclusions from GHG emissions calculations are explained
8.	Targets have clearly stated base year, target year, and target value
9.	Methodology for GHG emissions calculations is provided
10.	Methodology for GHG emissions calculations follows global or national standards
11.	External assurance statement in English is available
12.	Independent assurance of Scope 1 emissions
13.	Independent assurance of Scope 2 emissions
14.	Independent assurance of Scope 3 emissions
15.	Independent assurance of emissions intensity
16.	Independent assurance of energy consumption
17.	Independent assurance of energy intensity

In order to predict the independent variables, this study looked at four predictors: (1) The percentage of women board members; (2) The percentage of women board members who are industry experts (IE); (3) The percentage of women board members who act as advisors (ADV); (4) The percentage of women board member who are community leaders (CL) among the board members for each company. This paper indicates IE, ADV, and CL, as shown in Table 2, based on the taxonomy of director leadership roles proposed by Hillman, Cannella and Paetzold [72] and by adopting the study of Ramon Llorens, García-Meca and Pucheta-Martínez [20].

Table 2. Women board members classification.

No.	Woman Board Members Description	Classification
1.	- Current and former female senior officers who provide the company with their professional background, experience, advice, and alternative positions about internal business affairs. - Directors who currently serve or have served in the past as active managers, employees or owners of the firm. - Directors who are active or retired executives in other for-profit organizations and directors who serve on other large corporate boards. - Bring expertise and knowledge to the firm as a result of their experience in internal decision making in other firms. - These directors serve as executives in other organizations; they bring a working knowledge of strategic decision making and internal firm operations. - Expertise with competition, decision making, and problem solving for large firms. - Serve as sounding boards for ideas. - Provide alternative viewpoints on internal and external problems. - Channels of communication between firms legitimacy.	**Industry Expert (IE)**
2.	- The group that is made up of professionals specialized in individual fields, such as law, finance or marketing, among others, who offer companies their knowledge and expertise. - Firm's strategies but do not form the foundation on which the strategy is built. - Provide support for senior management in areas requiring specialized expertise, such as capital markets, law, insurance, and public relations, to meet the need for specialized expertise and linkages to support organizations outside the firm's product markets, such as financial institutions, law firms, public relations firms, and so forth. - They lack general management experience. - Bring specific expertise and/or access and information on environmental contingencies and provide support for the competitive strategy of the firm. - Expertise on the firm itself, general strategy and direction, as well as the current or former officers of the firm. - Specific knowledge in areas such as finance and law. - Current and former senior officers of other large for-profit firms. - Directors of other large for-profit firms. - Provide specialized expertise on law, banking, insurance, and public relations. - Provide channels of communication to large and powerful suppliers or government agencies. - Ease access to vital resources, such as financial capital and legal support. - Lawyers, bankers (commercial and investment), insurance company representatives, public relations experts.	**Advisors (ADV)**

Table 2. *Cont.*

No.	Woman Board Members Description	Classification
3.	- Non-executive directors who can be classified as politicians, heads of non-profit foundations, clerics, and other public celebrities who bring reputation opportunities and networking to the firm. - Symbolic directors. - Directors with experience and linkages relevant to the firm's environment beyond competitor firms and suppliers. - Possess knowledge about or influence over important non-business organizations, and includes retired politicians, university or other institutional representatives, and officers of social organizations. - Provide non-business perspectives on issues, problems, and ideas. - Expertise about and influence with powerful groups in the community—political leaders, university faculty, members of clergy, and leaders of social or community organizations. - Representation of interests outside competitive product or supply markets.	**Community Leaders (CL)**

The variables in this study that may have a substantial impact on the relationship between women's leadership and the level of carbon disclosure in the top 100 global energy leaders were board size, board independence, board meetings, CEO duality, firm size, company age, profitability, and leverage. Board size (BSize) is measured by the total number of directors on the board [132–134]. Board independence (BInd) is measured as the proportion of independent directors on the board [135]. Board meetings (BMeet) are measured by the number of meetings held per year [136–138]. CEO duality (CEOD) is measured through a dummy variable, which is equal to 1 if the Chairman and CEO roles are separated and 0 if otherwise [139–143]. Firm size (FSize) is measured as the natural logarithm of total assets [33,53,58,144,145]. Return on assets (ROA) is the measure of profitability. It is the quotient between the earnings before taxes and total assets [146]. Firm leverage (FLev) is measured by the ratio of total debt divided by total assets [135,147]. Additionally, firm age (Firm_Age) was measured by the years a firm has been in existence [148]. Finally, a set of dummy variables to control industry and year effects are included in the models.

3.3. Estimation Method and Models

This study uses the multiple regression models in order to examine the overall level of CD among the top 100 global energy leaders and its relationship with women's leadership and the other predictors. The purpose of this study is to assess the main and interaction effect of women's leadership predictors namely (1) women board membership; (2) women board member who are industry expert; (3) women board member who are advisor; (4) women board member who are community leader towards the level of CD practices. Equations (1)–(4) used to study the relationship between women's leadership and carbon disclosure for the top 100 global energy leaders is to be found below. In the meantime, Equation (5) will indicate the combined women's leadership indicators that contribute to the carbon disclosure score. This study uses all 5 equations for the 97 samples with 291 total observations collected.

To examine the relationship between the women board membership, women board members who are industry experts, women board members who act as advisors, women board members who are community leaders, and the level of CD practices, this study will employ the multiple regression models as follows:

$$\text{CDScore} = \alpha\_0 + \beta\_1\,\text{WBMP} + \beta\_2\,\text{BSIZE} + \beta\_3\,\text{BIND} + \beta\_4\,\text{BMEET} + \beta\_5\,\text{CEOD} + \beta\_6\,\text{FSIZE} + \beta\_7\,\text{FLEV} + \beta\_8\,\text{ROA} + \beta\_9\,\text{FAGE} + \varepsilon \quad (1)$$

$$CDScore = \alpha\_0 + \beta\_1\ WBMIEP + \beta\_2\ BSIZE + \beta\_3\ BIND + \beta\_4\ BMEET + \beta\_5\ CEOD + \beta\_6\ FSIZE + \beta\_7\ FLEV + \beta\_8\ ROA + \beta\_9\ FAGE + \varepsilon \quad (2)$$

$$CDScore = \alpha\_0 + \beta\_1\ WBMADVP + \beta\_2\ BSIZE + \beta\_3\ BIND + \beta\_4\ BMEET + \beta\_5\ CEOD + \beta\_6\ FSIZE + \beta\_7\ FLEV + \beta\_8\ ROA + \beta\_9\ FAGE + \varepsilon \quad (3)$$

$$CDScore = \alpha\_0 + \beta\_1\ WBMCLP + \beta\_2\ BSIZE + \beta\_3\ BIND + \beta\_4\ BMEET + \beta\_5\ CEOD + \beta\_6\ FSIZE + \beta\_7\ FLEV + \beta\_8\ ROA + \beta\_9\ FAGE + \varepsilon \quad (4)$$

$$CDScore = \alpha\_0 + \beta\_1\ WBMP + \beta\_2\ WBMIEP + \beta\_3\ WBMADVP + \beta\_4\ WBMCLP + \beta\_5\ BSIZE + \beta\_6\ BIND + \beta\_7\ BMEET + \beta\_8\ CEOD + \beta\_9\ FSIZE + \beta\_10\ FLEV + \beta\_11\ ROA + \beta\_12\ FAGE + \varepsilon \quad (5)$$

where CDScore represents the carbon disclosure score by using the scoring method, WBMP indicates the percentage of women board member, WBMIEP denotes the percentage of women board member who are industry experts, WBMADVP signifies the percentage of women board member who act as advisors, and WBMCLP symbolizes the percentage of women board member who represent community leaders. Meanwhile, the BSIZE represents board size, BIND represents board independence, BMEET represents board meeting for the fiscal year, CEOD represents CEO duality, FSIZE represents firm size, FLEV represents firm leverage, ROA represents return on assets, and FAGE represents firm age. The symbol $\alpha 0$ denotes the constant value, and the symbol ε indicates the error term.

4. Analysis and Results

4.1. Descriptive Statistics

Table 3 shows descriptive statistics of 97 companies from the top 100 global energy leaders after a screening process of those listed on the Thomson Reuters Database, 2017. There were a total of 291 observations. The statistics show that the mean value for the CDScore is 68.19. This result indicates that the energy leaders are reporting their carbon footprints through corporate carbon disclosure. Among the independent variables, Table 3 shows that WBMP or the percentage of women board members is 24% of the total number of the board of directors on boards. Therefore, it is relatively low. Meanwhile, the other independent variables, such as the percentage of women board member who are industry experts, serve as advisors, and community leaders, exhibit fairly similar average scores with the value of 21%, 20%, and 13% from the total number of board of directors on boards, respectively. These results indicate that the percentage of women who are on boards and with the resources they bring to the companies, for instance, they are industry experts, act as advisors and community leaders, is still relatively low among energy leaders. According to Table 3, the average BSIZE, or board size, is 11 people. With the average score being 7, it is the number of board of directors who are independent. The board meeting average is 11 times during the company's fiscal year. The energy leaders are mostly CEOs and Chairmen of their companies. The rest of the control variables, such as firm size, denote a 24.88 mean score, firm leverage indicates the average of 58% for financing their assets, 1% as an average for the energy leaders to generate profits from its total assets, and the age range of the energy companies' leaders is from 6 years to 179 years of their establishment.

The pairwise correlation matrix results for each independent director are shown in Table 4. The results demonstrate that there is not an extremely high correlation between independent variables, except for WBMIEP and WBMADVP, where the correlation values are 0.910 and 0.865. Thus, a potential multicollinearity issue is thus addressed by assessing each of these independent variables separately using various equation models, such as Equation (1) to Equation (5). Meanwhile, the statistics shown in Table 4 indicate that other variables are free from any multicollinearity since the correlation among the variables is less than 0.80 [149].

Table 3. Descriptive statistic.

Variable	N = 291			
	Mean	**Std. Dev.**	**Min**	**Max**
CDScore	68.19	15.06	0	87
WBMP	0.24	0.14	0.00	0.60
WBMIEP	0.21	0.14	0.00	0.56
WBMADVP	0.20	0.14	0.00	0.60
WBMCLP	0.13	0.12	0.00	0.50
BSIZE	11.61	3.16	0	22
BIND	7.60	3.18	0	22
BMEET	11.14	7.68	0	66
CEOD	0.84	0.37	0	1
FSIZE	24.88	3.56	0.00	32.57
FLEV	0.58	0.18	0.00	1.56
ROA	0.01	0.10	−0.53	0.50
FAGE	59.78	38.86	6	179

Table 4. Pairwise correlation matrix.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) WBMP	1.000											
(2) WBMIEP	0.910 *	1.000										
(3) WBMADVP	0.865 *	0.805 *	1.000									
(4) WBMCLP	0.631 *	0.580 *	0.472 *	1.000								
(5) BSIZE	−0.018	−0.091	0.008	0.055	1.000							
(6) BIND	0.271 *	0.197 *	0.258 *	0.280 *	0.567 *	1.000						
(7) BMEET	−0.173 *	−0.136	−0.175 *	−0.085	0.036	−0.051	1.000					
(8) CEOD	−0.016	−0.017	−0.044	−0.006	0.069	0.014	0.193 *	1.000				
(9) FSIZE	−0.091	−0.132	−0.099	−0.032	0.403 *	0.121	0.296 *	0.210 *	1.000			
(10) FLEV	0.185 *	0.198 *	0.146	0.073	0.235 *	0.140	0.010	0.080	0.074	1.000		
(11) ROA	0.006	−0.047	0.057	0.029	0.066	0.010	0.013	0.158 *	0.107	−0.385 *	1.000	
(12) FAGE	0.264 *	0.278 *	0.145	0.207 *	0.032	0.212 *	−0.061	−0.107	−0.006	0.061	−0.062	1.000

* $p < 0.10$.

4.2. Regression Analysis

Four models were regressed separately to avoid a high correlation problem involving the independent variables. Table 5 reports the regression results on the relationship between the effects of women's leadership on carbon disclosure for the top 100 global energy leaders. The F—Statistic for all women's leadership models is significant at $p < 0.01$. The R-squared for the WBMP, WBMIEP, WBMADVP, WBMCLP models are 39%, 38%, 37%, and 36%, respectively. Meanwhile, for the comprehensive model, the F—Statistic for it is 39%.

Table 5. Regression Result.

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Women Board Membership (WBMP)	32.932 ***				18.893
	(5.48)				(1.14)
Women Board Member Who Are Industry Expert (WBMIEP)		29.621 ***			1.328
		(4.96)			(0.10)
Women Board Member Who Are Advisor (WBMADVP)			28.484 ***		8.364
			(4.86)		(0.74)
Women Board Member Who Are Community Leader (WBMCLP)				28.538 ***	11.053
				(4.00)	(1.26)
Board Size (BSIZE)	0.054	0.056	−0.063	−0.197	0.045
	(0.16)	(0.16)	(−0.19)	(−0.58)	(0.13)
Board Independence (BIND)	0.716 **	0.841 ***	0.795 **	0.894 ***	0.661 **
	(2.28)	(2.70)	(2.52)	(2.81)	(2.08)

Table 5. *Cont.*

Variables	Model 1	Model 2	Model 3	Model 4	Model 5
Board Meeting (BMEET)	0.273 **	0.24 **	0.26 **	0.214 **	0.269 **
	(2.58)	(2.26)	(2.44)	(1.99)	(2.53)
CEO Duality (CEOD)	5.712 ***	5.623 **	6.226 ***	5.733 ***	5.837 ***
	(2.65)	(2.59)	(2.86)	(2.60)	(2.69)
Firm Size (FSIZE)	1.681 ***	1.718 ***	1.702 ***	1.671 ***	1.69 ***
	(6.74)	(6.82)	(6.75)	(6.55)	(6.74)
Firm Leverage (FLEV)	6.597	6.912	7.885	11.242 **	6.927
	(1.35)	(1.40)	(1.60)	(2.30)	(1.40)
Return on Assets (ROA)	22.948 **	25.399 ***	21.976 **	26.43 ***	22.268 **
	(2.56)	(2.83)	(2.42)	(2.90)	(2.46)
Firm Age (FAGE)	0.001	0	0.016	0.011	0.002
	(0.03)	(−0.02)	(0.78)	(0.52)	(0.11)
Prob > F	0.000	0.000	0.000	0.000	0.000
N	291	291	291	291	291
R-squared	0.386	0.375	0.373	0.357	0.390

*** $p < 0.01$, ** $p < 0.05$.

According to Table 5, Model 1 shows that the WBMP is positive, the coefficient (t-value) is 32.932 (5.48) and significant at a level $p < 0.01$. This finding shows that WBMP positively influences carbon disclosure. Meanwhile, Model 2 indicates that WBMIEP is also positive, the coefficient (t-value) is 29.621 (4.96), followed by Models 3 and 4, which indicate that WBMADVP and WBMCLP are positive with the coefficients (t-values) of 28.484 (4.86) and 28.538 (4.00), respectively. Therefore, the findings conclude that women's leadership, specifically, their board membership (WBMP), industry expertise (WBMIEP), acting as advisors (WBMADVP), and serving as community leaders (WBMCLP), positively influence the carbon disclosure among energy leaders. Female leadership positively influence carbon disclosure among the energy leaders if they are analyzed separately. However, if they are combined in one single model, as in Model 5, women's leadership will not significantly influence the carbon disclosure score due to their high multicollinearity issues. Therefore, Hypotheses 1–4 are supported based on separate models. This empirical evidence raises concerns about women's involvement in the energy sector, especially for those who also bring resources such as skills, expertise, knowledge, experience, influence, connection or interlocks, and industry background.

5. Conclusions and Recommendations

This study investigates the extent of carbon disclosure and women's leaderships and empirically examines whether women's leadership, such as women board members who are industry experts, act as advisors, and serve as community leaders, influences the carbon disclosure of the top 100 global energy leaders. Based on the descriptive finding, we can conclude that the carbon disclosure among the top 100 global energy leaders is acceptable with a mean score of 68 out of a total score of 90 in the scoring method procedure. However, the percentage of women board members, women board members who are industry experts, act as advisors, and/or are community leaders is relatively low. The regression analysis shows a positive interaction between women's leadership and carbon disclosure among energy leaders. The finding is aligned with the work of previous scholars and the resource dependency theory, which indicate that having women board members enhances a firm's tendency to report carbon-related disclosures. This study found that there is a positive relationship between women's leadership and their bringing of resources to the company and environmental disclosure [33,87–89,91–96,144,150–161]. On the other hands, even though this research has a similar scope of study to previous work, it is significantly different from prior scholars' findings, who have found that carbon-related disclosure and women's leadership were specifically investigated. Specifically, this study found quite similar results to those of Ramon Llorens, García-Meca and Pucheta-Martínez [20], who

argue that the experience, background, technical knowledge or political and social ties of female board members influence their decision-making processes, especially in respect to carbon disclosure or reporting.

Therefore, this study will not only encourage energy leaders, but also the energy sector across the globe, as well as other industries to incorporate women on their boards for better environment-related decision-making processes, as well as those related to carbon reporting or disclosure. In line with the Sustainable Development Goals, which were created in 2015 and which also underlined the significance of climate action, environment, and equality, particularly in terms of gender, we stress the importance of having a balance between social, economic, and environmental factors [162]. Therefore, there is a strong relationship between gender parity in the corporate world, especially in the energy industry, and climate action. This study also shed light on the energy sector as the major emitter; this study can also be a guide for other sectors to promote climate action and achieve the net zero carbon target. Therefore, as this study was implemented in the early stages of developing a conceptual framework, it succeeded in filling the gap where the role of corporate governance was being examined in a variety of institutional contexts, including the legal system, the regulatory framework, the sustainability score enforcement environment, and different institutional settings. To achieve greater assurance and reliability for the information gathered to directly or indirectly contribute to the body of knowledge for policy makers, legislation bodies, practitioners, and organizations, this study used different indicators for environmental disclosure, such as carbon-related disclosure in specific and more detail measurement.

In general, all aspects of energy planning and policy making should take gender equality into account [14]. Additionally, it is important to encourage the participation of women, particularly those from indigenous groups, in local, national, and international decision-making organizations, as well as in the energy sector itself at all stages of policy making [14]. To enable women to participate in the energy sector at all levels, it is crucial to address structural and behavioral gender inequities. Firstly, we must encourage more girls to study STEM fields in order to gain specialized knowledge; secondly, we must encourage more equal sharing of unpaid household work between men and women in order to enable women to use their skills in decision making in both the professional and community settings [14]. To enhance female participation in the green economy and diversify the workforce in the renewable energy industry, a number of initiatives need to be adopted across sectors and by the government [12]. Recruiting more women in training programs, governments and the industry should promote more opportunities for mentoring, internships, and the professional development of women. Furthermore, climate policy leaders must facilitate a paradigm shift in the definition of a green job to create female leaders in the clean energy and climate sectors [12]. Possibly the most significant social, economic, and political change of this generation is the shift to a zero-emission economy [12]. The under-representation of women in the clean energy industry is unfair and deprives the world of the various abilities and wisdom of women, especially women of color [12].

Women will play a significant role in implementing this shift and bear the consequences if this endeavor fails [12]. Women of all racial and ethnic backgrounds, from CEOs to electricians, must be equally represented in the clean energy sector due to the severity and scale of the climate catastrophe [12]. Gender equity must be a priority for the energy transition if governments and climate advocates are sincere about preventing climate catastrophe [12]. When creating and introducing technologies related to climate change adaptation, funding organizations and donors should also take into account the unique needs of women. They should also do their best to remove any economic, social, and cultural barriers that might prevent women from taking advantage of and using these technologies [163]. The creation of new technologies can be made more adaptable, acceptable, and sustainable by including women [163]. Attempts should be made at the national level to incorporate gender perspectives into national policies and strategies, as well as relevant climate change and sustainable development plans and initiatives [163].

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/su15118491/s1, Table S1. Carbon Disclosure Index. Table S2. Women Board Members Classification. Table S3: Descriptive Statistic. Table S4: Pairwise Correlation Matrix. Table S5: Regression Result.

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Appendix A

Table A1. List of top 100 global energy leaders.

No.	Organization	Industry	Country/Region
1.	Acea SpA	Multiline Utilities	Italy
2.	Aker Solutions	Oil-and-Gas-Related Equipment and Services	Norway
3.	Amec Foster Wheeler (Acquired by John Wood Group PLC)	Oil-and-Gas-Related Equipment and Services	United Kingdom
4.	Andeavor (Acquired by Marathon Petroleum)	Oil and Gas	United States of America
5.	Anadarko (Acquired by Occidental Petroleum Corporation)	Oil and Gas	United States of America
6.	Avangrid	Multiline Utilities	United States of America
7.	Bharat Petroleum	Oil and Gas	India
8.	BP	Oil and Gas	United Kingdom
9.	Cairn India	Oil and Gas	India
10.	Cameco	Uranium	Canada
11.	Canadian Natural Resources	Oil and Gas	Canada
12.	Chevron Corporation	Oil and Gas	United States of America
13.	China Petroleum & Chemical (SINOPEC)	Oil and Gas	China
14.	CMS Energy	Multiline Utilities	United States of America
15.	CNOOC Limited	Oil and Gas	China
16.	ConocoPhillips	Oil and Gas	United States of America
17.	DCC	Oil and Gas	Ireland; Republic of
18.	E.ON SE	Multiline Utilities	Germany
19.	Ecopetrol	Oil and Gas	Colombia
20.	Électricité de France	Multiline Utilities	France

Table A1. *Cont.*

No.	Organization	Industry	Country/Region
21.	Enagás	Oil-and-Gas-Related Equipment and Services	Spain
22.	Enbridge Inc.	Oil-and-Gas-Related Equipment and Services	Canada
23.	Encana	Oil and Gas	Canada
24.	Engie	Multiline Utilities	France
25.	Eni	Oil and Gas	Italy
26.	ExxonMobil	Oil and Gas	United States of America
27.	Fairmount Santrol	Oil-and-Gas-Related Equipment and Services	United States of America
28.	First Solar	Renewable Energy	United States of America
29.	Formosa Petrochemical Corporation	Oil and Gas	Taiwan
30.	Galp Energia	Oil and Gas	Portugal
31.	Gazprom	Oil and Gas	Russia
32.	Global Pvq SE i I	Renewable Energy	Germany
33.	Grupa Lotos	Oil and Gas	Poland
34.	Halliburton Company	Oil-and-Gas-Related Equipment and Services	United States of America
35.	Hellenic Petroleum	Oil and Gas	Greece
36.	Hera	Multiline Utilities	Italy
37.	Hess Corporation	Oil and Gas	United States of America
38.	Hindustan Petroleum Corporation	Oil and Gas	India
39.	Idemitsu Kosan Co., Ltd.	Oil and Gas	Japan
40.	Indian Oil Corporation	Oil and Gas	India
41.	Inpex Corporation	Oil and Gas	Japan
42.	IRPC	Oil and Gas	Thailand
43.	JXTG Holdings	Oil and Gas	Japan
44.	Mangalore Refinery and Petrochemicals Ltd.	Oil and Gas	India
45.	Marathon Oil Corporation	Oil and Gas	United States of America
46.	Marathon Petroleum Corporation	Oil and Gas	United States of America
47.	MOL	Oil and Gas	Hungary
48.	Motor Oil Hellas	Oil and Gas	Greece
49.	National Grid	Multiline Utilities	United Kingdom
50.	Neste Oyj	Oil and Gas	Finland
51.	NiSource	Multiline Utilities	United States of America
52.	Lukoil	Oil and Gas	Russia
53.	Occidental Petroleum Corporation	Oil and Gas	United States of America
54.	Oil and Natural Gas Corporation	Oil and Gas	India
55.	Oil Refineries Ltd.	Oil and Gas	Israel
56.	OMV AG	Oil and Gas	Austria
57.	Ørsted	Multiline Utilities	Denmark
58.	Pennon Group	Multiline Utilities	United Kingdom

Table A1. *Cont.*

No.	Organization	Industry	Country/Region
59.	PetroChina Co., Ltd.	Oil and Gas	China
60.	Petrofac	Oil-and-Gas-Related Equipment and Services	Jersey
61.	Petronas	Oil and Gas	Malaysia
62.	Phillips 66	Oil and Gas	United States of America
63.	PKN ORLEN	Oil and Gas	Poland
64.	PTTEP	Oil and Gas	Thailand
65.	PTT Public Company Limited	Oil and Gas	Thailand
66.	Reliance Industries	Oil and Gas	India
67.	Repsol	Oil and Gas	Spain
68.	Rosneft	Oil and Gas	Russia
69.	Royal Dutch Shell	Oil and Gas	Netherlands
70.	Rubis	Oil and Gas	France
71.	RWE	Multiline Utilities	Germany
72.	Saipem	Oil-and-Gas-Related Equipment and Services	Italy
73.	Santos	Oil and Gas	Australia
74.	Saras	Oil and Gas	Italy
75.	Sasol	Oil and Gas	South Africa
76.	Saudi Basic Industries Corporation (SABIC)	Oil and Gas	Saudi Arabia
77.	Schlumberger	Oil-and-Gas-Related Equipment and Services	United States of America
78.	Scorpio Tankers Inc.	Oil-and-Gas-Related Equipment and Services	Monaco
79.	Sempra Energy	Multiline Utilities	United States of America
80.	Showa Shell Sekiyu K.K. (Acquired by Idemitsu Kosan)	Oil and Gas	Japan
81.	Siemens Gamesa Renewable Energy	Renewable Energy	Spain
82.	SK Innovation Co., Ltd.	Oil and Gas	Korea; Republic (S. Korea)
83.	Snam	Oil-and-Gas-Related Equipment and Services	Italy
84.	S-Oil	Oil and Gas	Korea; Republic (S. Korea)
85.	Statoil	Oil and Gas	Norway
86.	Suncor Energy	Oil and Gas	Canada
87.	SunPower	Renewable Energy	United States of America
88.	Técnicas Reunidas	Oil-and-Gas-Related Equipment and Services	Spain
89.	Tenaris SA	Oil-and-Gas-Related Equipment and Services	Luxembourg
90.	ThaiOil	Oil and Gas	Thailand
91.	Total	Oil and Gas	France
92.	TransCanada	Oil-and-Gas-Related Equipment and Services	Canada

Table A1. *Cont.*

No.	Organization	Industry	Country/Region
93.	Tullow Oil	Oil and Gas	United Kingdom
94.	Tüpraş	Oil and Gas	Turkey
95.	Ultrapar Participações S.A.	Oil and Gas	Brazil
96.	Vallourec	Oil-and-Gas-Related Equipment and Services	France
97.	Vestas	Renewable Energy	Denmark
98.	Weatherford International	Oil-and-Gas-Related Equipment and Services	Switzerland
99.	Woodside Petroleum	Oil and Gas	Australia
100.	Worley Parsons	Oil-and-Gas-Related Equipment and Services	Australia

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