



# Exploring Macroeconomic Factors and Sustainability Practices in the Technology Sector: A Global Perspective

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**Abstract:** This study explores sustainability practices within the technology sector, focusing on how macroeconomic factors and corporate sustainability practices affect renewable energy consumption. The dependent variable is renewable energy consumption, while the independent variables include macroeconomic factors (foreign direct investment, GDP growth, and inflation) and sustainability practices (energy commitment, environmental teams, resource use score, ESG score, carbon emission performance, and board oversight of climate change risks). The results indicate that energy commitment, resource use score, and carbon emission performance positively and significantly influence renewable energy consumption. Conversely, the ESG score negatively affects renewable energy consumption. Although carbon emission performance has been widely studied in various industries, there is limited empirical research on its impact within the technology sector. This research contributes to the existing literature in several ways. It bridges this gap by investigating the effect of macroeconomic factors on renewable energy consumption in the technology sector. Further, it explores the impact of several sustainability factors on renewable energy consumption.

**Keywords:** Economic Factors, Sustainability Practices, Renewable Energy Consumption, Technology Sector

## 1. Introduction

Renewable energy (RE) comes from a variety of sustainable and clean sources (Baloch et al., 2022). In order to address the rapidly increasing demand for energy and the environmental issues related to fossil fuels, the switch to renewable energy is crucial (Ang et al., 2022). The world is concerned about energy security and economic growth because of the substantial detrimental emissions released by the reliance on non-renewable energy sources (Olabi & Abdelkareem, 2022). Hence, recently, companies have been under increasing pressure to adopt methods that result in long-term environmental and economic success as a result of the global focus on environmental sustainability and responsibility. Integrating renewable energy into organizational operations is one such approach that can help a company achieve sustainability goals and boost its competitive edge (Fatima et al., 2021; Batool et al., 2024; Mio et al., 2020). Fatima et al. (2021) believe that renewable energy adoption by firms in their operations is an important component of firms' sustainability planning to decrease the usage of fossil fuels and environmental pollution. Hence, firms are gaining a competitive advantage when adopting renewable energy, as they contribute to the decrease in carbon emissions (Zhao et al., 2024; Batool et al., 2024). In addition,

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using renewable energy helps businesses become greener by improving their reputation and enabling them to adhere to more stringent sustainability standards (Ofori et al., 2022).

It is observed that previous research has examined the individual association between innovation, oil prices, carbon emissions, economic growth, and renewable energy. There remains a substantial gap in the existing literature regarding their combined impact, particularly within the context of the technology sector. Several sustainable factors and economic factors were neglected in previous research. Hence, this research attempts to address this gap by providing a holistic analysis that examines how economic and sustainability factors affect renewable energy consumption.

Despite the importance of this research, it has made several contributions to the existing literature. Firstly, most previous studies are based on time series analysis, with only a few using panel cointegration models. Furthermore, there is a lack of studies in the field of renewable energy consumption that use panel data for a large number of firms. This research seeks to address this gap by investigating the effect of macroeconomic factors on renewable energy consumption in the technology sector. Secondly, most researchers have focused primarily on carbon emissions and environmental sustainability in relation to renewable energy consumption. Few studies have included a broader range of sustainability factors in their analysis to examine the determinants of renewable energy consumption. Therefore, this research explores the impact of several sustainability factors, such as energy commitment, environmental management teams, resource use scores, environmental, social, and governance (ESG) factors, carbon emission performance, and board oversight of climate change risks. Thirdly, the majority of previous research has focused on specific regions, such as Asia or the MENA region. In contrast, this research examines technology firms from around the world.

The remainder of the study is organized as follows: the second part focuses on the theoretical and empirical literature, the third part presents the research design, the fourth part presents the data analysis followed by the findings and discussion, and the final part concludes the study. Based on existing gaps, the current study assesses the effects of macroeconomic factors and sustainability practices on the technology sector.

## **2. Literature Review**

This section reviews previous studies in the field of renewable energy. The first sub-section presents previous research related to the association between macroeconomic factors and renewable energy consumption; the second sub-section presents reviewed research related to sustainability practices and renewable energy consumption.

### **2.1. Studies Related to Macroeconomic Factors and Renewable Energy Consumption**

It is believed that improved production, economic development, household compliance, and population growth have increased energy consumption (Amin, Khandaker, & Khan, 2024). Several studies have investigated the determinants of renewable energy consumption. Sadorsky (2009) examined the impact of economic factors such as gross domestic product and oil price on renewable energy consumption in G7 countries for the period from 1980 to 2005. The results revealed a positive association between gross domestic product, oil price, and renewable energy consumption. Similarly, Payne (2012) investigated the impact of oil prices and gross domestic product on renewable energy consumption in the USA, using data from 1949 to 2009. The findings

revealed the absence of causality; renewable energy consumption was initially muted but later increased following a one standard deviation shock to gross domestic product. Apergis and Payne (2014) utilised the FMOLS model to examine the association between gross domestic product and renewable energy consumption in OECD countries. They found that gross domestic product positively affects renewable energy consumption. In other words, a 1% increase in gross domestic product leads to a 0.352% increase in renewable energy consumption. Using a Vector Error Correction Model, Karacan et al. (2021) investigated the effect of carbon emissions, oil prices, and gross domestic product on renewable energy consumption in Russia for the period 1990–2015. The results revealed that a 1% rise in gross domestic product leads to a 0.99% increase in renewable energy consumption. Conversely, renewable energy consumption decreases by 0.43% for every 1% increase in the price of oil. Using the System and Difference Generalised Method of Moments, Omri et al. (2015) examined the association between real oil prices, international trade, and gross domestic product. They found that renewable energy consumption increases by 0.26%, 0.17%, and 0.20% for every 1% increase in real oil prices, international trade, and GDP, respectively. In the Tunisian context, Brini et al. (2017) examined the relationship between international trade, gross domestic product, oil prices, and renewable energy consumption. The results showed a two-way causal relationship between renewable energy consumption and gross domestic product. Similarly, Zeren and Akkus (2020) used a panel dataset of 14 emerging countries to examine the association between trade openness and renewable energy consumption. Their findings indicated a unidirectional causal relationship between renewable energy consumption and trade openness. Using panel heterogeneous estimators, Amin et al. (2022) examined the impact of financial development on renewable energy consumption. Results revealed that a 0.07–0.15% decrease in renewable energy consumption is caused by greater financial development. Similarly, Kazemzadeh et al. (2023) evaluated the association between renewable energy consumption and financial development using a dataset spanning 1985–2017 and a sample of 49 countries. A robust Granger causal relationship between renewable energy consumption and financial development was identified using a Panel VAR (PVAR) framework. Furthermore, variance decomposition showed that financial development in the long run accounts for 13.75 percent of renewable energy consumption. Ike et al. (2020) utilised panel cointegration analysis to examine the association between renewable energy consumption and economic growth. It was found that there is a positive long-term relationship between the two.

It is evident that most of the reviewed studies are based on time series analysis using several models, and only a few studies have used panel cointegration models. Furthermore, there is a lack of studies in the field of renewable energy consumption that use panel data for a large number of firms. Hence, this research attempts to bridge this gap in the literature by investigating the effect of macroeconomic factors on renewable energy consumption in the technology sector. Based on the above discussion, the following hypothesis is formulated:

**H1: Macroeconomic factors have a significant impact on renewable energy consumption.**

This hypothesis is divided into the following sub-hypotheses:

H1a: Gross domestic product has a significant impact on renewable energy consumption.

H1b: Foreign direct investment has a significant impact on renewable energy consumption.

H1c: Inflation has a significant impact on renewable energy consumption.

## **2.2. Studies Related to Sustainability Practices and Renewable Energy Consumption**

This section presents previous studies related to sustainability practices and renewable energy consumption. Several researchers have highlighted the association between sustainability and

renewable energy consumption. Pata et al. (2023) examined the association between environmental quality and renewable energy consumption using panel data for the period from 1995 to 2018. Results revealed that there is an insignificant association between environmental quality and renewable energy consumption. Sadorsky (2009) examined the impact of carbon emissions on renewable energy consumption and revealed that carbon emissions positively associate with renewable energy consumption. Utilising patent data, Duran et al. (2024) investigated the impact of environmental innovation on renewable energy consumption, but they ignored more comprehensive innovation metrics such as R&D spending and technology developments (Doytch & Narayan, 2016; Duran et al., 2024). Xuan (2025) investigated the association between innovation and environmental sustainability and renewable energy consumption. It was found that a 1% increase in innovation leads to a 0.35% rise in renewable energy consumption. Khadidos et al. (2025) argue that reducing the rising demand and regularly raising the number of potential generations are crucial because the expanding population requires inexpensive, sustainable electricity. Amleh et al. (2025) investigated how much the use of renewable energy helps Jordanian SMEs gain a sustainable competitive edge through improved sustainability practices. Using information gathered from 467 administrative staff members in 43 SMEs, a quantitative study design was employed. By increasing operational efficiency, cutting expenses, and boosting company reputation, the results show that incorporating renewable energy into business operations greatly strengthens sustainable competitive advantage. Terkes et al. (2025) believe that increasing environmental concerns and regulations on carbon emissions necessitate the development of economically viable and sustainable renewable energy systems. Given that switching to renewable energy sources could have major positive effects on the environment, society, and economy throughout the energy supply chain, more research should be conducted on this topic (Mondal & Khalil, 2012). Using multi-criteria decision-making analysis, Zubairu et al. (2025) examined and evaluated the effect of several sustainability factors on renewable energy consumption. It was found that the most cost-effective, ecologically friendly, and socially desirable cleaner energy with the fewest obstacles was solar energy, followed by wind, biomass, geothermal, and hydroelectric energy.

In light of the preceding discussion, it can be concluded that most researchers have focused heavily on carbon emissions and environmental sustainability in relation to renewable energy consumption. Few studies have attempted to include a broader range of sustainability factors in their analysis to examine the determinants of renewable energy consumption. Thus, this research explores the impact of several sustainability factors such as energy commitment, environmental management team, resource use score, environmental, social, and governance (ESG) score, carbon emission performance, and board oversight of climate change risks. Furthermore, the majority of previous research has focused on specific regions such as Asia and the MENA region; this research focuses on technology firms from around the world. Based on the above discussion, the following hypothesis is formulated:

**H2: Sustainability factors have a significant impact on renewable energy consumption.**

This hypothesis is divided into the following sub-hypotheses:

H2a: Energy commitment has a significant impact on renewable energy consumption.

H2b: Environmental management team has a significant impact on renewable energy consumption.

H2c: Resource use score has a significant impact on renewable energy consumption.

H2d: Environmental, social, and governance (ESG) score has a significant impact on renewable energy consumption.

H2e: Carbon emission performance has a significant impact on renewable energy consumption.

H2f: Board oversight of climate change risks has a significant impact on renewable energy consumption.

### 3. Research Methodology

#### 3.1. Data Source and Sampling

The study targeted all listed technology firms in the world. The motivation behind targeting the technology sector is due to its crucial contribution to sustainability by providing sustainable and innovative technologies that integrate manufacturing technologies and operational processes to promote sustainability and labor conditions. The study retrieved data from the Refinitiv database for 10,006 technology-listed firms for the period from 2013 to 2024. After filtering the data, it was found that most firms do not have data for the years 2013 to 2019; hence, 9,206 firms were eliminated. Further, it was found that 118 firms did not have data for most of the variables to cover the period from 2020 to 2023; these firms were deleted. The final sample consists of 682 firms. Table 1 demonstrates country representation in the sample, which reveals that the United States has the highest representation with 704 observations, accounting for 25.81% of the total sample, followed by Taiwan with 424 observations, accounting for 15.54% of the total sample. On the other hand, Argentina, Bahrain, Bermuda, Colombia, Greece, Hungary, Kenya, Kuwait, Lithuania, Mexico, New Zealand, Portugal, Qatar, and Uruguay are the least represented countries in the sample.

Table 1: Country Tabulation in the Sample

Country	Freq.	Percent	Cum.	Country	Freq.	Percent	Cum.
Argentina	4	0.15	0.15	Kuwait	4	0.15	41.64
Australia	40	1.47	1.61	Lithuania	4	0.15	41.79
Austria	16	0.59	2.20	Luxembourg	20	0.73	42.52
Bahrain	4	0.15	2.35	Malaysia	24	0.88	43.40
Belgium	24	0.88	3.23	Mexico	4	0.15	43.55
Bermuda	4	0.15	3.37	Netherlands	44	1.61	45.16
Brazil	12	0.44	3.81	New Zealand	4	0.15	45.31
Canada	40	1.47	5.28	Norway	20	0.73	46.04
Cayman Islands	12	0.44	5.72	Oman	8	0.29	46.33
Chile	8	0.29	6.01	Philippines	8	0.29	46.63
China	252	9.24	15.25	Poland	12	0.44	47.07
Colombia	4	0.15	15.40	Portugal	4	0.15	47.21
Denmark	12	0.44	15.84	Qatar	4	0.15	47.36
Finland	24	0.88	16.72	Russia	8	0.29	47.65
France	40	1.47	18.18	Saudi Arabia	8	0.29	47.95
Germany	108	3.96	22.14	Singapore	20	0.73	48.68
Greece	4	0.15	22.29	South Africa	20	0.73	49.41

Country	Freq.	Percent	Cum.	Country	Freq.	Percent	Cum.
Hong Kong	24	0.88	23.17	Spain	16	0.59	50.00
Hungary	4	0.15	23.31	Sweden	64	2.35	52.35
India	68	2.49	25.81	Switzerland	52	1.91	54.25
Indonesia	16	0.59	26.39	Taiwan	424	15.54	69.79
Ireland	12	0.44	26.83	Thailand	24	0.88	70.67
Italy	44	1.61	28.45	Turkey	12	0.44	71.11
Japan	200	7.33	35.78	United Arab Emirates	8	0.29	71.41
Kenya	4	0.15	35.92	United Kingdom	72	2.64	74.05
Korea, Rep.	152	5.57	41.50	United States	704	25.81	99.85
				Uruguay	4	0.15	100.00
Total	2,728						

### 3.2. Variables of the Study

The dependent variable in the study is renewable energy consumption. The independent variables are two groups: the first is macroeconomic factors, including foreign direct investment, GDP growth, and inflation. The second is sustainability practices, represented by energy commitment, environmental management team, resource use score, ESG score, carbon emission performance, and board oversight of climate change risks. Table 2 shows the definition of the variables and their expected effects.

Table 2: Variables' Definitions

Variable	Code	Definition	Expected Results
Renewable Energy Consumption	REC	Total amount of energy consumed that is derived from renewable sources	
Gross Domestic Product	GDP	The percentage increase in the total value of goods and services produced in a country's economy over one year	Sig.
Foreign Direct Investment	FDI	The sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital, as shown in the balance of payments	Sig.
Inflation	Inf	The rate of increase in prices over one year	Sig.

Variable	Code	Definition	Expected Results
Energy Commitment	EC	A binary variable assigned 0 if the company demonstrates a strong commitment to energy efficiency and 1 otherwise	Sig.
Environmental Management Team	ENMT	A binary variable assigned 0 if the company has established an environmental management team and 1 otherwise	Sig.
Resource Use Score	RUS	Measures firms' efficiency in resource consumption and eco-conscious operational practices. Scaled from 0 to 100; a higher score indicates stronger resource management practices	Sig.
Environmental, Social, and Governance	ESG	A percentile-ranked composite score (0–100) derived from a curated subset of ESG metrics across environmental, social, and governance themes—adjusted for controversies—to evaluate a company's relative ESG performance based on publicly available data	Sig.
Carbon Emission Performance	CES	Measures firms' effectiveness in reducing carbon emissions. Scaled from 0 to 100; a higher score indicates a strong commitment and performance in emissions reduction	Sig.
Board Oversight of Climate Change Risks	BOOFCL	A binary variable assigned 0 if the firm has board oversight of climate change risks and 1 otherwise	Sig.

### 3.3. Model Specification

This section outlines the econometric specification of the model. The study ran one model using fixed-effect regression with the robust function, in which the study examined the direct effect of macroeconomic factors and sustainability practices on renewable energy consumption.

To achieve the research objectives, the following equation for empirical testing is formulated:

$$REC_{it} = \alpha + \beta_1 GDP_{it} + \beta_2 FDI_{it} + \beta_3 INFL_{it} + \beta_4 EC_{it} + \beta_5 ENMT_{it} + \beta_6 RUS_{it} + \beta_7 ESG_{it} + \beta_8 CES_{it} + \beta_9 BOOFCL_{it} + \varepsilon_{it} \quad (1)$$

## 4. Results and Discussion

### 4.1. Descriptive Statistics

Table 3 shows the central tendencies for the variables under study. It presents the mean, standard deviation, minimum, and maximum values. Results reveal that the mean value for energy consumption is 1,154,134.5 with a standard deviation of 3,713,618.5. Regarding gross domestic



Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(2) GDP	-0.013	1.000								
p-value	(0.500)									
(3) FDI	-0.037	0.029	1.000							
p-value	(0.054)	(0.130)								
(4) Inf	-0.003	0.179*	-0.007	1.000						
p-value	(0.859)	(0.000)	(0.725)							
(5) EC	-0.084*	-0.100*	0.023	0.052*	1.000					
p-value	(0.000)	(0.000)	(0.228)	(0.006)						
(6) ENMT	-0.075*	-0.050*	0.048*	0.057*	0.223*	1.000				
p-value	(0.000)	(0.009)	(0.012)	(0.003)	(0.000)					
(7) RUS	0.120*	0.016	-0.045*	-0.023	-0.223*	-0.560*	1.000			
p-value	(0.000)	(0.416)	(0.019)	(0.229)	(0.000)	(0.000)				
(8) ESGS	0.133*	0.033	-0.040*	-0.027	-0.213*	-0.494*	0.759*	1.000		
p-value	(0.000)	(0.089)	(0.035)	(0.152)	(0.000)	(0.000)	(0.000)			
(9) ESIN	0.107*	0.030	-0.054*	-0.035	-0.158*	-0.472*	0.740*	0.724*	1.000	
p-value	(0.000)	(0.116)	(0.004)	(0.067)	(0.000)	(0.000)	(0.000)	(0.000)		
(10) BOOFCL I	-0.085*	-0.071*	0.050*	0.026	0.234*	0.264*	-0.324*	-0.326*	-0.313*	1.000
p-value	(0.000)	(0.000)	(0.009)	(0.176)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
VIF		1.01	1.04	1.05	1.11	1.19	1.52	2.60	2.79	3.14

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

### 4.3. Regression Analysis Results

Regression analysis results in Table 5 reveal that the economic factor represented by gross domestic product has an insignificant impact on renewable energy consumption (p-value > 0.10, coefficient = 0.003). This result suggests that economic growth alone might not guarantee a shift towards reliance on renewable energy, as economic expansion may heavily rely on fossil fuels. Many tools could be used alongside economic growth to facilitate a shift towards renewable energy, including but not limited to regulatory frameworks, technology development, and subsidies. Similarly, foreign direct investment has an insignificant impact on renewable energy consumption (p-value > 0.10, coefficient = 0.001). This result may be explained by the fact that foreign direct investment is directed towards manufacturing industries, traditional energy projects, and other non-energy sectors. This indicates that renewable energy adoption is more associated with government policies and incentives. In the same vein, inflation has an insignificant impact on renewable energy consumption (p-value > 0.10, coefficient = 0.003). This finding implies that demand for and investment in renewable energy are not significantly influenced by changes in the price level. Generally speaking, renewable energy projects have extended investment horizons that are less susceptible to transient inflationary pressures. Furthermore, individuals and businesses may change their energy choices in reaction to energy policies, environmental concerns, and technological advancements rather than inflation. This demonstrates that the use of renewable energy is not primarily driven by inflation.

Regarding sustainable practices, the results in Table 5 show that energy commitment positively and significantly affects renewable energy consumption (p-value < 0.05, coefficient = 0.172). This indicates that the greater the energy commitment, the more reliance on renewable energy. This suggests that increased usage of renewable energy is a direct result of governments, organizations, or societies demonstrating greater commitment to clean energy policies and projects. This implies that the shift to sustainable energy sources is mostly driven by regulatory frameworks, strategic planning, and well-defined goals.

Similarly, the resource use score positively and significantly affects renewable energy consumption (p-value < 0.01, coefficient = 0.008). This suggests that the prudent and efficient use of resources encourages the adoption of renewable energy. Sustainable practices that prioritize long-term energy security are frequently reflected in higher resource efficiency, which makes it easier to incorporate renewables into the energy mix. This emphasizes the critical role of sustainability-focused management in influencing energy decisions.

In the same vein, the carbon emission score positively and significantly affects renewable energy consumption (p-value < 0.1, coefficient = 0.004). The positive and significant impact of the carbon emission score demonstrates how efforts to track, disclose, and reduce carbon emissions encourage the use of renewable energy. The relationship between environmental responsibility and the use of renewable energy is strengthened when emission performance improves, as there is greater motivation to switch to cleaner alternatives to fossil fuels. This outcome emphasizes how carbon reduction strategies can spur the growth of renewable energy.

On the contrary, the ESG score negatively and significantly affects renewable energy consumption (p-value < 0.1, coefficient = -0.005). This indicates that businesses or nations with higher overall ESG ratings may not necessarily prioritize the use of renewable energy as part of their sustainability strategy. Rather, advances in social responsibility, governance, or other environmental measures unrelated to renewable energy may have contributed to their high rankings. Accordingly, while ESG practices often encourage sustainability, they may not always

result in a greater reliance on renewable energy sources; in certain situations, businesses may achieve strong ESG performance while continuing to rely on traditional energy sources.

Table 5: Regression Analysis Results

	(1)	(2)
VARIABLES	REC_Fixed	REC_Robust
GDP	0.008	0.003
	(0.006)	(0.006)
FDI	-0.000	-0.000
	(0.001)	(0.001)
Inf	-0.000	0.003
	(0.006)	(0.007)
EC	0.302***	0.172**
	(0.078)	(0.071)
ENMT	0.102	0.142*
	(0.095)	(0.079)
RUS	0.011***	0.008***
	(0.002)	(0.002)
ESGS	-0.004	-0.005*
	(0.004)	(0.003)
ESIN	0.006***	0.004*
	(0.002)	(0.002)
BOOFCLI	0.051	0.121*
	(0.067)	(0.064)
Constant	4.153***	4.534***
	(0.193)	(0.165)
Observations	2,728	2,728
R-squared	0.049	
Number of FirmID	682	682

Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5. Conclusion and Policy Implications

The study aimed to explore sustainability practices in the technology sector. Further, it aimed to examine the impact of macroeconomic factors and firms' sustainability practices on renewable energy consumption. To achieve these objectives, the study targeted all listed technology firms in the world. The study retrieved data from the Refinitiv database for 10,006 technology-listed firms

for the period from 2013 to 2024. The final sample consists of 682 firms. The study ran one model using fixed-effect regression with the robust function to estimate the results. Results reveal that energy commitment, resource use score, and carbon emission score positively and significantly affect renewable energy consumption. On the contrary, the ESG score negatively and significantly affects renewable energy consumption. The study extends previous research that examined the board of directors' effectiveness on carbon emission performance, with a special focus on the technology sector due to its crucial contribution to sustainability through the provision of sustainable and innovative technologies that integrate manufacturing technologies and operational processes to promote sustainability and labor conditions. However, it is evident that although carbon emission performance has been widely studied in various industries, there is limited empirical evidence in the context of the technology sector. Despite the importance of the study's contributions, its results must be interpreted taking into consideration the following limitations. Firstly, this study relied on secondary data; hence, future researchers could incorporate primary data to confirm the results. Secondly, the study period spans from 2013 to 2023 due to non-availability of data; therefore, future research might expand the period to 2025.

The findings of this study provide important policy implications for governments, regulators, technology firms, and sustainability stakeholders. First, the positive relationship between energy commitment, resource use score, carbon emission score, and renewable energy consumption suggests that firms with stronger sustainability practices are more likely to adopt renewable energy initiatives. Therefore, policymakers should encourage technology firms to strengthen their environmental management systems through sustainability regulations, incentives, and reporting requirements. Governments may introduce tax incentives, subsidies, or green financing mechanisms to support firms investing in renewable energy technologies and sustainable operational practices.

Second, the significant impact of carbon emission performance on renewable energy consumption highlights the importance of stricter environmental regulations and carbon disclosure frameworks within the technology sector. Regulatory authorities should develop industry-specific sustainability standards and require transparent disclosure of carbon emissions and renewable energy usage.

Furthermore, the study underscores the strategic role of the technology sector in achieving global sustainability goals. Since technology firms contribute significantly to innovation and sustainable transformation, governments should support research and development activities related to clean technologies, energy-efficient systems, and green digital transformation.

Finally, international organizations and sustainability standard-setting bodies should encourage cross-country collaboration to improve sustainability disclosure quality and renewable energy adoption among global technology firms. Harmonizing sustainability reporting standards may help investors, regulators, and stakeholders better evaluate firms' environmental performance and support the transition towards a low-carbon economy.

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