

The Effect of Carbon Emission Disclosure and Environmental Costs on the Financial Performance of Energy Sector Companies on the Indonesia Stock Exchange in 2020-2024

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ABSTRACT

The increasing concerns over climate change and the growing demand for sustainable business practices have encouraged energy sector companies to enhance environmental transparency through carbon emission disclosure and environmental cost allocation. As one of the largest contributors to greenhouse gas emissions, energy companies face significant pressure from regulators, investors, and society to demonstrate their commitment to sustainability while maintaining financial performance. This study aims to examine the effect of Carbon Emission Disclosure and Environmental Costs on the Financial Performance of energy sector companies listed on the Indonesia Stock Exchange (IDX) during the 2020–2024 period. This research employed a quantitative approach with a causal research design using secondary data obtained from annual reports and sustainability reports. The sampling process utilized purposive sampling, resulting in 108 observations after the elimination of outlier data. Financial performance was measured using Return on Assets (ROA), Carbon Emission Disclosure was assessed based on the GRI 305 index, and Environmental Costs were measured using the natural logarithm of total environmental expenditures. Data were analyzed using multiple linear regression supported by classical assumption tests, coefficient of determination analysis, F-test, and t-test. The results reveal that Carbon Emission Disclosure has a negative and significant effect on financial performance ($t = -5.965$; $p < 0.001$), while Environmental Costs have a positive and significant effect on financial performance ($t = 3.584$; $p < 0.001$). The model explains 25.3% of the variation in financial performance. These findings indicate that the market still perceives carbon emission disclosure as an administrative burden that reduces short-term profitability, whereas environmental expenditures are viewed as strategic investments that enhance operational efficiency and create long-term economic value for firms.

INTRODUCTION

Climate change has become a global issue, its impacts no longer limited to the ecological dimension, but also impacting market stability, corporate strategy, and global investment direction. Increasing greenhouse gas emissions, particularly carbon dioxide, are driving global warming and placing significant pressure on high-carbon-intensity sectors, including the energy sector. In the contemporary business context, companies are no longer judged solely by their ability to generate profits, but also by the extent to which they manage environmental risks and demonstrate a concrete commitment to sustainability. This trend is reinforced by investors' increasing attention to *environmental, social, and governance* (ESG) aspects as a basis for evaluating a company's long-term prospects (Lina & Adelia, 2024; Sakinah et al., 2024).

Global sustainability reporting has shifted from mere voluntary compliance to strong market expectations for climate information disclosure. Carbon emissions disclosure is now understood as part of a company's strategic communication mechanism to investors and stakeholders (Qudsiyah & Nahar, 2025). However, there is no consensus on the relationship between *carbon emissions disclosure* and financial performance. Some studies have found that carbon emissions transparency strengthens reputation, reduces information asymmetry, and increases market trust, thus positively impacting profitability (Maryanti & Zulfah, 2025; Lina & Adelia, 2024). Conversely, other studies have shown that this disclosure is perceived as a signal of high compliance costs and environmental risks, resulting in a negative or insignificant impact, particularly in short-term-oriented emerging markets (Wahyuningrum et al., 2022; Mulia et al., 2026).

A similar debate arises regarding environmental costs, which encompass the economic sacrifices made for pollution prevention, waste management, energy efficiency, and ecological compliance. Two main schools of thought inform this literature. The first school views environmental costs as strategic investments that promote *eco-efficiency*, green innovation, and strengthen corporate legitimacy, thus positively impacting financial performance (Rahayudi & Apriwandi, 2023; Putri & Budiantara, 2025). The second school views them as operational expenses that directly depress current-period profits, particularly when the economic benefits are not immediately realized or appreciated by investors (Wulandari et al., 2025; Mulyanti et al., 2025). The key issue is not simply whether environmental costs are important, but under what conditions the market interprets them as value-creating investments or *profit-reducing expenses*.

Theoretically, the relationship between these two variables and financial performance can be explained through *signaling theory*. This theory has evolved beyond traditional financial disclosures, now explaining how non-financial information, including sustainability information, serves as a signal of corporate quality to the market. Disclosure of carbon emissions represents a signal of managerial transparency regarding climate risks, while environmental costs signal a real commitment that is difficult for low-quality companies to

replicate. Costly signals have been shown to be more credible because they demonstrate real commitment, rather than mere greenwashing (Sakinah et al., 2024; Anggriani & Syaipundin, 2025). However, their effectiveness depends heavily on market characteristics, investor ESG literacy, and sectoral context.

In the Indonesian context, the energy sector is a major contributor to national carbon emissions and a strategic sector in the economy. Energy sector companies listed on the Indonesia Stock Exchange face dual pressures: maintaining profitability amidst commodity price volatility and the energy transition, while simultaneously responding to increasingly stringent environmental regulatory and accountability demands. The characteristics of this sector—capital-intensive, high-emissions intensity, and significant exposure to ecological risks—make it a relevant context for examining how sustainability commitments translate into financial performance. Previous research in Indonesia has largely focused on the manufacturing, general mining, or cross-sector sectors, with inconsistent results (Yanti & Sofie, 2025; Dewi & Ardianingsih, 2024), resulting in limited studies specifically focused on the energy sector for the 2020–2024 period.

Methodologically, previous studies generally used multiple linear regression or panel data regression based on annual reports and sustainability reports. Carbon emission disclosure was measured using the GRI 305 index, environmental costs were measured through nominal expenditures transformed into natural logarithms, and financial performance was proxied by ROA, ROE, or ROS (Lina & Adelia, 2024; Wulandari et al., 2025). While these designs are well-established, more empirical evidence focused on the energy sector with a more recent observation period is needed.

This study identified three research gaps. First, inconsistent findings regarding the effect of carbon emission disclosure on financial performance—some positive, some negative, or insignificant. Second, research on environmental costs is also inconclusive regarding the relationship between strategic investment and profit-depressing burdens. Third, studies examining both variables simultaneously in the IDX energy sector for the 2020–2024 period are still very limited. This study presents empirical evidence focused on high-environment risk sectors, examining how carbon transparency signals and environmental cost commitments interact to influence financial performance in the post-pandemic period and the intensifying sustainability transition.

Academically, this research contributes to the enrichment of sustainability accounting literature and tests signaling theory in the context of emerging markets. Practically, the results are expected to provide a basis for evaluation for energy company management in formulating environmental disclosure and cost management strategies that significantly impact profitability. They also provide investors and regulators with insight into whether sustainability indicators truly function as signals of economic value in the Indonesian capital market.

RESEARCH METHODS

This study uses a quantitative approach with a causal research design *that* aims to examine the causal relationship between *Carbon Emission Disclosure* and Environmental Costs on the Financial Performance of energy sector companies listed on the Indonesia Stock Exchange (IDX) during the period 2020–2024. The quantitative approach was chosen because it is able to measure the relationship between variables objectively through statistical testing, while the causal design is used to explain the extent to which changes in the independent variables can affect the dependent variable (Hair et al., 2022; Sarstedt & Mooi, 2023). This design choice is in line with recent studies in the field of environmental accounting and sustainability reporting, which generally use a quantitative approach to examine the impact of environmental disclosure on company performance (Zhou et al., 2024; Ahmed et al., 2025).

The research subjects were all energy sector companies listed on the Indonesia Stock Exchange during the 2020–2024 observation period. The energy sector was selected based on its industry characteristics, which have high carbon emission intensity and face significant pressure related to the implementation of sustainable business practices. The sampling technique used purposive sampling, considering certain criteria: companies listed consecutively on the Indonesia Stock Exchange during the research period and publishing annual reports and/or sustainability reports *containing* information on carbon emission disclosure and environmental costs. The application of purposive sampling aims to obtain samples relevant to the research objectives and can produce estimates that are more representative of the population studied. This study uses secondary data obtained from annual reports and sustainability reports of energy sector companies published on the official website of the Indonesia Stock Exchange and the official websites of each company. The use of secondary data is considered appropriate because it allows researchers to obtain information that has been audited and officially published, thereby increasing the reliability of the research data. The collected data include information on the level of carbon emission disclosure, total environmental costs, net profit after tax, and total company assets. The data is then processed to produce indicators that represent each research variable.

Financial performance as the dependent variable is proxied using Return on Assets (ROA). ROA was chosen because it can illustrate a company's effectiveness in utilizing all its assets to generate profits. The use of ROA is considered highly relevant for companies in the energy sector, which is categorized as a capital- *intensive industry*. Therefore, a company's ability to manage assets is a crucial indicator in assessing financial performance success (Buallay, 2022; Wang et al., 2025). ROA is calculated by comparing net profit after tax to the company's total assets for the same period.

The first independent variable in this study is *Carbon Emission Disclosure* (CED). CED is measured using *the Global Reporting Initiative* (GRI) 305 index, which consists of seven disclosure indicators: direct GHG emissions (*Scope 1*), indirect GHG emissions from energy (Scope 2), other indirect GHG emissions (Scope 3), GHG emission intensity, GHG emission

reductions, ozone-depleting substance emissions, and other significant air emissions. Measurements are conducted using a content analysis method with a dichotomous scoring approach, giving a score of 1 if a company discloses a particular item and a score of 0 if it does not. The index value is obtained from the number of disclosed items compared to the total items available in the GRI 305 standard. This approach is widely used in carbon accounting research because it can measure the level of company transparency systematically and objectively (Luo et al., 2022; Pratama et al., 2024).

The second independent variable is Environmental Cost . This variable is measured based on the company's total expenditure allocated to environmental management activities, including costs for pollution prevention, waste treatment, emission control, environmental conservation, and other activities related to environmental protection. To reduce differences in data scale and minimize potential heteroscedasticity, environmental cost values are transformed into natural logarithms (Ln). Logarithmic transformation is a procedure commonly used in finance and accounting research to improve the normal distribution of data and produce more stable estimation models (Wooldridge, 2021; Ghozali, 2023).

Data analysis was performed using multiple linear regression to examine the effect of *Carbon Emission Disclosure* and Environmental Costs on company financial performance. Prior to hypothesis testing, the data were analyzed using descriptive statistics to provide an overview of the characteristics of each research variable. Next, classical assumption tests were performed, including normality, multicollinearity, heteroscedasticity, and autocorrelation tests, to ensure that the regression model met the requirements for good estimation. Hypothesis testing was performed using a t-test to determine the partial effect of each independent variable on financial performance and an F-test to examine the simultaneous effect of all independent variables in the research model. Furthermore, the coefficient of determination (*Adjusted R²*) was used to measure the model's ability to explain variations in the financial performance of energy sector companies. The use of multiple linear regression remains the dominant method in environmental accounting research because it can explain causal relationships between variables empirically and provides interpretations that are easily understood by academics and practitioners (Hair et al., 2022; Zhou et al., 2024).

Through this methodological design, this study is expected to be able to provide comprehensive empirical evidence regarding the influence of *Carbon Emission Disclosure* and Environmental Costs on the Financial Performance of energy sector companies in Indonesia, especially in the context of increasing demands for the implementation of sustainability principles and the transition to a low-carbon economy.

RESULTS AND DISCUSSION

Results

Descriptive Analysis

Descriptive statistical analysis was applied to provide a description, overview, and empirical characteristics of the data distribution of each variable examined in this study. Test

indicators presented in this descriptive statistics include the number of observations (\$N\$), minimum value, maximum value, average value (mean), and standard deviation. The summary of the results of descriptive statistical testing for the variables *Carbon Emission Disclosure* (CED2), *Environmental Costs* (ENV_COST2), and *Financial Performance* (LG_ROA) in energy sector companies listed on the Indonesia Stock Exchange (IDX) is as follows:

Table 1. Descriptive Test Results

	N	Min.	Max.	Mean.	Std dev.
CED2	108	-0.30	1.53	0.59	0.36
ENV_COST2	108	16.89	28.87	23.04	2.61
LG_ROA	108	-2.00	-0.24	-1.01	0.42

Based on Table 1, the Financial Performance variable (LG_ROA) has a minimum value of -2.00, a maximum of -0.24, an average of -1.0109, and a standard deviation of 0.42516. The Carbon Emission Disclosure variable (CED2) shows a minimum value of -0.30, a maximum of 1.53, an average of 0.59, and a standard deviation of 0.36. Meanwhile, the Environmental Cost variable (ENV_COST2) has a minimum value of 16.89, a maximum of 28.87, an average of 23.0400, and a standard deviation of 2.61071. In all three variables, the standard deviation value is smaller than the average value, which indicates that the data has a relatively low level of dispersion and tends to be homogeneous. These findings indicate that financial performance, the level of carbon emission disclosure, and the allocation of environmental costs in energy sector companies listed on the Indonesia Stock Exchange during the study period have a stable distribution with not too large variations between companies.

Classical Assumption Test

This test aims to ensure that the regression model used meets the *Best Linear Unbiased Estimator* (BLUE) criteria, ensuring that the resulting estimated parameters are valid, unbiased, and reliable. Classical assumption tests in this study include normality tests, multicollinearity tests, heteroscedasticity tests, and autocorrelation tests.

Normality Test

Table 2. Results of Normality Test (One-Sample Kolmogorov-Smirnov)

		<i>Unstandardized Residual</i>
N		108
Normal Parameters ^{a,b}	Mean	0.000000
	Standard Deviation	0.36407127
Most Extreme Differences	Absolute	0.053
	Positive	0.053
	Negative	-0.052
<i>Asymp. Sig. (2 – tailed) ^c</i>		0.200 ^d

a. Test distribution is Normal.

b. Calculated from data.

c. Lilliefors Significance Correction.

d. This is a lower bound of the true significance.

Based on Table 4.3 above, normality testing was conducted on 108 observation units (N = 108) that had gone through sample selection and data transformation procedures. The test results showed that *the Test Statistic value* (absolute extreme difference) was recorded at 0.053. From this statistical value, *the Asymp. Sig. (2-tailed) probability value* was obtained at 0.200. In accordance with the basis for decision making in the *Kolmogorov-Smirnov test*, if the significance probability value is greater than the specified real level, namely 0.05 (Sig. > 0.05), then this indicates that the residual data has been normally distributed. Considering that the significance value of the test results of 0.200 is much greater than 0.05 (0.200 > 0.05), it can be concluded that the normality assumption in this research model has been met. Achieving this significance value provides empirical evidence that the residual data from the 108 observations of the energy sector companies have been normally distributed. Thus, this regression model is declared valid and very suitable to be continued to the next stage of classical assumption testing and hypothesis testing.

Table 3. Multicollinearity Test

Model	<i>Unstandardized B</i>	<i>Coefficients Std. Error</i>	<i>Standardized Coefficients Beta</i>	<i>t</i>	<i>Sig.</i>	<i>Collinearity Tolerance</i>	<i>Vif Statistics</i>
1 (Constant)		-1,840	0.320		-5,747	<0.001	
CED2		-0.618	0.140	-0.531	-5,965	<0.001	0.880 1,136
ENV_COST2		0.052	0.015	0.319	-3,584	<0.001	0.880 1,136

Dependent Variable: ROA

Based on Table 4.4, the results of the Multicollinearity Test, the Carbon Emission Disclosure Variable (CED2) shows a Tolerance value of 0.880 with a VIF level of 1.136.

Identical statistical figures are also recorded by the Environment variable (ENV_COST2), where the Tolerance value is detected at 0.880 and the VIF value is 1.136. Judging from the basis for making decisions for this assumption test, all independent variables in the study have *Tolerance values* that are far above the minimum limit of 0.10. In line with this, the VIF values obtained for all variables are also proven to be much smaller than the maximum limit of 10. Through this empirical evidence, it can be concluded absolutely that this regression model is free from multicollinearity symptoms. The absence of disturbing linear correlations between these independent variables confirms that the model estimation has met the feasibility of the classical assumption standards and is ready to be operated for further hypothesis testing analysis.

Table 4. Heteroscedasticity Test Results

<i>Model</i>	<i>Understandarized</i>		<i>Standardized</i>		<i>t</i>	<i>Sig</i>
	<i>B</i>	<i>Coefficients Std. Error</i>	<i>Coefficients Beta</i>			
1 (Constant)	0.486	0.195			2,490	0.014
CED2	-0.014	0.063	-0.022	-0.217		0.828
ENV_COST2	-0.008	0.009	-0.097	-0.938		0.350

Dependent Variable: ABS_RES

Based on Table 4, the results of the heteroscedasticity test obtained a significance value that was above the minimum limit for all independent variables studied. The Carbon Emission Disclosure variable (CED2) recorded a much higher significance value, namely 0.828. Meanwhile, the Environmental Cost Variable (ENV_COST2) recorded a significance probability value of 0.350. Because the significance values of both independent variables were greater than the required probability level ($0.828 > 0.05$ and $0.350 > 0.05$), it can be confidently concluded that this regression model is free from heteroscedasticity symptoms. Thus, the estimation model in this study is proven to have a constant residual variance (homoscedastic) and is very feasible to be operated in the multiple linear regression analysis test stage.

Autocorrelation Test

Table 5. Autocorrelation Test Results

<i>Model</i>	<i>R</i>	<i>R Square</i>	<i>Adjusted R Square</i>	<i>Standard Error of the Estimate</i>	<i>Durbin-Watson</i>
1	.516 ^a	0.267	0.253	0.36752	1,054

Based on Table 4.6, the Durbin-Watson (DW) statistical value is 1.054. The DW value of 1.054 is proven to be within the safe interval limit, namely between -2 and +2. Based on these decision-making parameters, it can be concluded that the regression model in this study is free from autocorrelation interference. Thus, the regression model has met all the requirements of the classical assumptions and is very suitable to proceed to the hypothesis testing stage.

Multiple Linear Analysis

Multiple linear regression analysis was applied in this study to understand the direction and magnitude of the contribution of the independent variables, which include Environmental Costs (ENV_COST2) and Carbon Emission Disclosure (CED2), to the dependent variable, namely Profitability (LG_ROA). Based on the results of statistical data processing, the formulation of the multiple linear regression equation model can be structured as follows:

$$LG_ROA = -1.840 - 0.618 ENV_COST2 + 0.052 ENV_COST2 + \varepsilon$$

Based on the regression equation model formed, the interpretation of each coefficient value can be described as follows. The constant value of -1.840 represents that if all independent variables are zero, then the estimated Profitability value (LG_ROA) is at -1.840. The Carbon Emission Disclosure Coefficient (CED2) of -0.618 shows a negative direction, which indicates that every one unit increase in emissions disclosure will reduce the profitability value by 0.618 (assuming other variables are constant). On the other hand, the Environmental Cost coefficient (ENV_COST2) has a positive value of 0.052, which means that every one unit increase in environmental investment will contribute to an increase in profitability by 0.052, if other independent variables remain unchanged.

This hypothesis test is intended to determine whether the independent variable has a statistically convincing effect on the dependent variable, either partially or simultaneously. Therefore, the following section will present the results of the hypothesis testing using Partial Tests (t-tests) and Simultaneous Tests (F-tests).

Table 6. Results of the F, R² Test and t-test

Variables	B	Std. Error	Beta	t	Sig.	Information
(Constant)	-1.84	0.32		-5,747	0.00	
CED2	-0.618	0.104	-0.531	-5,965	<0.001	Rejected
ENV_COST2	0.052	0.015	0.319	3,584	<0.001	Accepted
F count	19.90				0.00***	Fit Model
R Square	0.26					
Adjusted R ²	0.25					
Dependent Variable: ROA						
Information: CED2: Carbon Emission Disclosure ; ENV_COST2 : Environmental Cost2						

Based on Table 4.7, the F-count value is 19.096 with a significance level of <0.001 . Because the significance value is far below the error threshold of 0.05, it can be concluded that the combination of the Carbon Emission Disclosure (CED2) and Environmental Cost (ENV_COST2) variables meets the model feasibility criteria and is valid for use in predicting company profitability.

The R^2 test ^{obtained} a correlation coefficient (R) of 0.516, indicating a strong relationship between the independent and dependent variables. The test results also recorded an Adjusted R Square value of 0.253. This figure indicates that 25.3% of the variation or fluctuations in the company's profitability level (LG_ROA) can be explained by the regression model in this study. Meanwhile, the remaining large variation, namely 74.7%, is influenced or explained by other factors not included in this research model.

Partial Test (t-Test)

Based on the results of table 6, the interpretation of the t-test results includes:

First, the Carbon Emission Disclosure (CED2) variable has a t-value of -5.965 with a significance level of <0.001 . This value is much smaller than 0.05, so it can be concluded that CED2 has a negative and significant impact on profitability (LG_ROA). These results demonstrate that the higher or more extensive the intensity of a company's carbon emission disclosure, the lower its profitability will be.

Second, the Environmental Cost variable (ENV_COST2) has a t-value of 3.584 with a significance level of <0.001 . This value is smaller than 0.05, so it can be concluded that ENV_COST2 has a positive and significant impact on profitability (LG_ROA). This condition indicates that the allocation of environmental costs incurred by the company is not merely a detrimental burden, but is able to encourage and improve the company's financial performance and profitability.

Discussion

Test results hypothesis First show that disclosure emission carbon influential negative and significant to performance finance company sector energy on the Indonesia Stock Exchange for the 2020–2024 period ($\beta = -0.618$; $p < 0.001$), so H1 is rejected. Findings This own implications theoretical and practical importance : he strengthen argument that signaling mechanisms in emerging market context No Work linearly as prediction theory signal classic (Spence, 1973). On the contrary, he demonstrate that effectiveness signal is largely determined by capacity recipient signal — in matter this investor— for interpret information sustainability as marker mark term long , not just burden compliance.

Findings This in harmony in a way partial with Bedi and Singh's (2024) research which examined 100 Indian companies in BSE index and find association negative significant between carbon emission disclosure and performance finance . Researchers the argue that the market is growing tend interpret disclosure emission as proxy on exposure risk regulation and pressure cost future compliance , right as signal governance excellence. Similar patterns were also identified in Ghose et al.'s (2025) research on companies in India, which found that in

term in short, climate change disclosure is actually pressing profitability. Because signaling cost burden exceeds benefit immediate reputation can be realized.

However, the results of this study contrast with findings of Xu et al. (2025) who studied companies' industry polluter weight in China during 2013–2023. Xu et al. (2025) found that improvement in quality of carbon disclosure in a way significant to repair performance of financial companies, especially through mechanism of decline debt costs and increase proportion of institutional investor ownership. The difference in direction of findings between this study and Xu et al.'s (2025) study can be explained by the difference in context of fundamental institutions: China has a framework of regulations more structured for carbon, including a system of trading carbon integrated nationally, as well as a wider institutional investor base. With greater ESG literacy, in the framework said, disclosure of carbon more easily translated as a positive signal that can be verified. This contrast is also in line with findings of Downar et al. (2021) which, via difference-in-differences approach to UK companies subject to the mandate of carbon disclosure, found that obligation to report precisely pushed reduction of emission by 8% relative to group control — a proof that in developed markets with strong regulations, obligation of carbon disclosure can have positive operational implications.

Difference in context of institutional factors becomes a key interpretation. Shen et al.'s (2025) research analyzed 8,547 companies from 34 countries during 2015–2022 and proves that connection between performance in environment and performance in finance is positive globally, but with variation significant between countries influenced by quality of regulations and levels of investor ESG literacy. Implications for the Indonesian context is that signal of carbon disclosure new will function optimally when supported by ecosystem policies that provide real incentives for company transparency and when domestic investors have their own capacity to read information on carbon as a determinant value. Before the condition is fulfilled, disclosure of extensive emissions tends to increase cost without reward coming back proportionally in the short term.

In a practical way, findings of this study give a warning for management of company energy that investment in system of inventory emissions, carbon audit by a third party, and the preparation of sustainability report need to be followed with an active communication strategy to investors to transform market perception of risk signals into quality signals. For regulators, the results of this study hinting the need to strengthen framework of incentives, for example through giving access to financing for green flowering or low burden tax for company with high level of carbon disclosure, so that the mechanism of signal can work in an effective way.

Different from findings on the first hypothesis, testing the second hypothesis shows that cost of environment is influential, positive and significant to performance proxied by finance with ROA ($\beta > 0$; $p < 0.001$), so H2 is accepted. This result confirms that in the Indonesian sector of energy, expenditure in real activity environment has succeeded in being transformed by management to become an investment strategy that creates added economic value, not just a burden of obedience that presses profit.

Findings This conformity with costly signaling theory prediction: when company willing sacrifice source Power economy in a way real in form investment technology friendly environment, system management waste and efficiency energy action the send signal credible commitment to the market because difficult imitated by companies with low quality of governance (Spence, 1973; Connelly et al., 2011). The mechanism This Work through at least three path. First, the expenditure environment push *eco-efficiency* which is accumulative pressing cost operational term long through savings energy, minimization waste, and reduction residue production. Second, the cost environment functioning as instrument mitigation risk legal and financial matters that prevent company from fine regulation, revocation permission operational, and conflict social that can paralyze business. Third, in the middle increasing adoption ESG principles in global and domestic capital markets, commitment financial real to environment succeed interesting sentiment positive from green investors and increase loyalty consumers.

This result consistent with Shen et al.'s (2025) findings prove that that performance a better environment Good in a way significant relate with decline cost of equity capital and ROA improvement across 34 countries. More further study based on company panel data energy and utilities by *Frontiers in Sustainability* (2024) found correlation positive significant between overall ESG score specifically component environment with ROA and ROE, and identify that investment in protection environment increase efficiency utilization source Power as the main mediator improvement profitability.

However Thus, it is necessary noted that results This different with part study that found impact neutral or negative cost environment to performance finance in term short. Nilasakti et al. (2024) in study systematic literature *carbon emission disclosure* in Indonesia recorded that inconsistency findings empirical often influenced by differences period observation, proxy performance finances used, and characteristics sectoral sample. Cross-sectional study sectors that include company with level exposure heterogeneous environment tend catch more average effect weak, whereas research that focuses on the sector intensity environment tall like sector energy more capable identify mechanism mark from expenditure environment Because pressure more regulations and social concentrated in the sector the.

In a way theoretical, research This give contribution to the testing and development of signaling theory in emerging market context. In particular, research This show that No all form signal sustainability responded to in a way symmetrical by the market: signal disclosure-based (disclosure) emission carbon) which is informative but No always need sacrifice source Power real precisely produce response negative, whereas signal expenditure-based (costs) environment) which requires commitment financial current succeed responded to positive. Findings This enrich understanding about conditionality effectiveness signal in the market with ESG literacy is still growing, in line with Xu et al.'s (2025) argument that effect positive disclosure carbon to performance new work optimally when supported by mechanisms mature market transmission.

In a way managerial, results study This give guide strategic for company sector energy : allocation source Power For cost programmed and measurable environment especially those oriented towards *eco-efficiency* and mitigation risk regulations need prioritized Because proven contribute to profitability. On the other hand, investment in disclosure emission carbon must accompanied by with investor education and strengthening strategies narrative mark sustainability so that the signaling mechanism runs effective.

For regulators and authorities of the Indonesian capital market, the findings This become base consideration For develop policies that encourage transition from disclosure as obligation administrative going to disclosure as valuable market instruments . Approach This can covers standardization indicator disclosure more granular and can emissions compared, and development index integrated sustainability with incentive fiscal or access financing.

Study This own a number of necessary limitations recognized. First, the use of ROA as the only one proxy performance finance limit coverage analysis on dimensions accountancy term short, temporary benefit expenditure environment and disclosure carbon possibility more reflected in the indicators market -based such as Tobin's Q or cost of equity capital (Shen et al., 2025). Research furthermore recommended use proxy performance more finances diverse, including market dimensions at once accounting. Second, the sample is limited to companies sector energy on the IDX during 2020–2024 limits generalization findings to sector or another period. Third, research This Not yet explore potential variables moderation like size company, quality of governance, or ownership institutions that can conditioning connection between variables independent and performance finance.

For researchers next, it is recommended For test role mediation variables like reputation company, cost of capital, or innovation green in chain connection between disclosure emission carbon, costs environment and performance finance. Use approach quasi-experimental like difference *-in-differences* used by Downar et al. (2021) can also give identification more causality strong compared to conventional panel data regression. In addition, the expansion sample to ASEAN regional scale will allows analysis a richer comparative about How difference context institutional between developing countries moderate effectiveness signal sustainability to performance finance.

CONCLUSION AND SUGGESTIONS

This study aims to analyze the influence of carbon emission disclosure and environmental costs on the financial performance of energy sector companies listed on the Indonesia Stock Exchange for the 2020–2024 period. The results indicate that carbon emission disclosure has a positive and significant impact on company financial performance. This finding confirms that transparent carbon emission disclosure serves as a credible signal to the market regarding a company's ability to manage climate risks, thereby increasing investor confidence and strengthening the company's reputation, ultimately contributing to increased profitability. Environmental costs, on the other hand, have a negative and significant impact on financial performance. This indicates that in the context of the

Indonesian energy sector, environmental expenditures are still perceived by the market as an operational expense that depresses short-term profits, rather than as a strategic investment that creates value, likely because their economic benefits have not been fully realized during the observation period. Simultaneously, carbon emission disclosure and environmental costs together significantly influence the financial performance of energy sector companies. This finding emphasizes the relevance of signaling theory in explaining the dynamic relationship between sustainability commitments and financial performance in emerging markets. For energy company management, this study's results imply that carbon emission disclosure strategies need to be strengthened as a value communication instrument to investors, while environmental cost management needs to be oriented towards programs that have a measurable long-term impact on operational efficiency. For investors and regulators, these findings suggest that sustainability indicators—particularly carbon transparency—have begun to function as relevant economic value signals in Indonesia's capital markets.

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