Journal : **Journal of Management and Innovation Entrepreneurship (JMIE),**
Publisher : **Yayasan Nuraini Ibrahim Mandiri**
ISSN : **e-ISSN 3026-6505**
Volume / Issue / Year/ Page : **4/ 1/ 2026: October / 643-659**

INSTITUTIONAL OWNERSHIP MODERATING CARBON DISCLOSURE, GREEN INNOVATION, AND FIRM VALUE IN THE INDONESIAN ENERGY SECTOR

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Article Information

Submission	:	06-09-2026
Review	:	10-09-2026
Revised	:	05-10-2026
Accepted	:	27-10-2026
Published	:	30-10-2026

Keywords
Carbon Emission Disclosure, Firm Value, Green Innovation, Indonesia Energy Sector, Institutional Ownership

Abstract

This study examines the effects of carbon emission disclosure (CED) and green innovation (GI) on firm value (Tobin's Q), while evaluating the moderating role of good corporate governance proxied by institutional ownership within carbon-intensive firms. Focusing on the Indonesian energy sector over the 2022–2025 period, the initial sample of 42 companies yielded 168 firm-year observations. Following outlier treatment, the final dataset comprised 108 firm-year observations. Hypotheses were tested using Panel Data Regression, with the Random Effects Model (REM) selected based on formal specification tests (Chow, Lagrange Multiplier, and Hausman tests). The empirical findings demonstrate that CED exerts a positive and statistically significant direct effect on firm value, signaling transparent climate risk management to the market. Green innovation exhibits an insignificant direct effect on firm value, indicating that green R&D investments incur immediate financial burdens while economic returns are delayed. Institutional ownership significantly moderates both relationships, reinforcing the positive impact of CED on market valuation and transforming green innovation into a positive driver of firm value. This study extends signaling and agency theories by demonstrating that governance monitoring is a vital boundary condition for financial markets to value corporate sustainability practices in emerging markets. The findings provide actionable insights for corporate managers to integrate governance oversight with decarbonization strategies and guide investors in evaluating non-financial environmental metrics.

How To Cite: Fathihani, Jariah, A., Sari, I., & Astuti, R. P. (2026). Institutional ownership moderating carbon disclosure, green innovation, and firm value in the Indonesian energy sector. *Journal of Management and Innovation Entrepreneurship (JMIE)*, 4(1), 643–659. https://doi.org/10.70248/jmie.v4i1.4742

DOI : https://doi.org/10.70248/jmie.v4i1.4742
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INTRODUCTION

Climate change has become one of the most pressing global challenges, increasing pressure on governments and corporations to reduce greenhouse gas emissions and transition toward sustainable economic activities (Setijaningsih, 2026). The growing consequences of global warming have transformed environmental issues from a social concern into a strategic business issue associated with operational risk, investor confidence, and long-term corporate sustainability(Perkasa & Simatupang, 2025). This transformation is particularly relevant to the energy sector, which plays a

fundamental role in supporting economic development but remains one of the largest contributors to global carbon emissions. Energy companies are therefore increasingly required to balance energy security, financial performance, and environmental responsibility while adapting to the transition toward a low-carbon economy (Rachmadhika, 2025a).

According to the Energy Institute, carbon dioxide (CO2) emissions generated by the global energy sector reached a historic high of 34.37 billion tons in 2022 (Ramadhani et al., 2026). As the largest contributor to carbon emissions within ASEAN, Indonesia significantly fuels this global trajectory, recording an average emission value of 571.80 (CO2) between 2019 and 2022. Therefore, Indonesia plays a crucial role in mitigating (CO2) emissions produced by corporations within the energy sector**.** Indonesia represents an important case for examining this issue because its economic growth remains closely connected to fossil energy consumption. Between 2022 and 2025, the country continued to experience escalating energy demand while simultaneously pursuing commitments toward energy transition and carbon emission reduction. In 2022, Indonesia strengthened its international commitment to accelerate this shift through the Just Energy Transition Partnership (JETP) (Nur Mala Sari, 2025). However, the transition faces substantial structural challenges because coal and fossil fuels remain dominant in the national energy mix, while renewable energy contribution increases gradually (Widiyanti, 2025). This market condition creates a complex trade-off between maintaining short-term energy supply and achieving long-term decarbonization targets (Adam Karim Nurdiansyah, 2024).

The continued dependence on fossil fuels has significant environmental consequences. The energy sector remains one of the largest contributors to Indonesia's greenhouse gas emissions, while economic expansion and increasing electricity demand continue to create additional environmental pressure (Tri et al., 2026). Although the government has promoted renewable energy development, the transition requires substantial investment, technological transformation, and changes in energy infrastructure. These conditions place energy companies at the center of Indonesia's transition process. Companies operating in this sector are expected not only to maintain financial performance and energy supply but also to demonstrate their ability to manage environmental risks and contribute to emission reduction (Damas, 2021).

The changing environmental landscape has direct implications for firm value. Firm value reflects market expectations of a company's performance, risk exposure, and future prospects (Dorothy & Endri, 2024). While market valuation traditionally focused heavily on financial indicators such as profitability and leverage, modern investors increasingly integrate climate-related risks into their valuation models (Rahelliamelinda et al., 2024). Companies operating in carbon intensive industries face regulatory penalties, carbon taxes, operational risks, and reputational damage that can impair corporate value (Fauziah & Siregar, 2025).

One corporate response to increasing environmental pressure is carbon emission disclosure. Carbon emission disclosure represents the extent to which companies communicate information regarding their carbon emissions, environmental impacts, and emission reduction strategies to stakeholders (Purnomo et al., 2025). For energy companies, such disclosure is particularly important because their operations are directly associated with substantial carbon exposure. Transparent disclosure can reduce information asymmetry between management and investors and provide a clearer understanding of how companies manage climate related risks (Ambarwati

Akib, 2025). Based on signaling theory **(Spence, 1973)**, companies that disclose carbon-related information may provide a positive signal regarding their environmental responsibility and long-term strategic orientation. This transparency may strengthen investor confidence and ultimately contribute to firm value. In the Indonesian, this practice is supported by regulatory frameworks, specifically outlined in PSAK No. 1 (2019 revision) regarding environmental disclosures (Putra, 2026). Firms can utilize such regulatory compliance to secure broader stakeholder support, which subsequently enhances corporate reputation and firm value (Aulia et al., 2026). However, green innovation may also generate significant financial implications. The implementation of environmentally friendly technologies often requires substantial investment in research, infrastructure, technology, and operational transformation (Aprilya & Marrung, 2025). These investments may increase corporate costs and place pressure on short-term financial performance before generating economic benefits (Maharani, 2024). Therefore, green innovation may create a trade off between short term financial costs and long-term sustainability benefits (Almansoori & Nobanee, 2019).

Empirical findings regarding the impact of sustainability practices on firm value remain inconclusive and mixed. Prior literature documents positive effects of carbon emission disclosure on firm value (Septian et al., 2025), (Rachmadhika, 2025b). Whereas other empirical studies report insignificant or negative market reactions (Luthfia & Terdpaopong, 2026). Similarly, while green innovation is reported to enhance firm value by building competitive advantages (Bastian et al., 2026) several studies Nurkholisah & Keristin (2024) find that green investments incur substantial immediate financial burdens without yielding immediate market valuation gains.

These conflicting empirical results suggest that the relationship between environmental practices and firm value is not direct or unconditional. In an emerging market setting like Indonesia, voluntary climate reporting and green R&D expenditures may be perceived by capital markets either as strategic value-enhancing efforts or as opportunism and cost burdens (Astuti, 2025). Therefore, a key governance mechanism is required to ensure transparency, credibility, and strategic oversight over environmental initiatives.

Good corporate governance specifically proxied by institutional ownership serves as an essential monitoring mechanism. Institutional investors possess the resources, expertise, and incentives to oversee managerial decisions, reduce agency conflicts, and evaluate non-financial disclosures (Putri, 2023). External governance oversight ensures that environmental disclosures are credible rather than symbolic "greenwashing" and that green innovation capital expenditures are directed toward economically viable projects (Amelia & Yuliansyah, 2024).

While a body of literature often conceptualizes governance or financial capabilities as mediating mechanisms (where sustainability practices indirectly flow through operational outcomes to reach market valuation) (Jan et al., 2019), this study argues that institutional governance fundamentally functions as a boundary condition (moderator) rather than a mere mediator. Grounded in Agency Theory (Jensen & Meckling, 1976) and Signaling Theory (Spence, 1973), sustainability practices like carbon emission disclosure and green innovation do not automatically generate financial returns; rather, their valuation effects are contingent upon the credibility and monitoring intensity of external owners. In carbon-intensive sectors, institutional ownership acts as an external enforcement filter that determines whether capital markets interpret environmental expenditures as value-creating strategic assets or

value-destroying managerial opportunism. Hence, treating institutional ownership as a moderating variable provides a more robust theoretical explanation for the heterogeneous market responses observed in emerging markets.

Despite its theoretical relevance, empirical literature examining institutional ownership as a moderating condition in the relationship between carbon disclosure, green innovation, and firm value in the energy sector remains scarce. Addressing these empirical, conceptual, and contextual gaps, this study formulates five specific research questions:

1. Does carbon emission disclosure affect firm value in Indonesian energy-sector companies?
2. Does green innovation affect firm value in Indonesian energy-sector companies?
3. Does institutional ownership directly affect firm value in Indonesian energy-sector companies?
4. Does institutional ownership moderate the relationship between carbon emission disclosure and firm value?
5. Does institutional ownership moderate the relationship between green innovation and firm value?

HYPOTHESIS DEVELOPMENT

Carbon Emission Disclosure and Firm Value

Based on signaling theory (Spence, 1973; Connelly et al., 2011), companies that disclose carbon-related information may provide a positive signal regarding their environmental responsibility and long-term strategic orientation. For energy sector firms with heavy carbon footprints, disclosing carbon emission statistics, mitigation targets, and climate-risk strategies provides a credible signal regarding managerial foresight and long-term sustainability preparedness (Ardi, 2026). Transparent carbon emission reporting reduces regulatory risk perceptions, enhances corporate reputation, and satisfies stakeholder expectations for environmental accountability (Aprilya & Marrung, 2025). When investors perceive carbon disclosures as a signal of reduced exposure to transition risks, market confidence increases, thereby enhancing corporate valuation (Damas, 2021). Thus, the first hypothesis is proposed:

H1: Carbon Emission Disclosure Has A Positive Effect on Firm Value.

Green Innovation and Firm Value

Green innovation encompasses product and process enhancements designed to decrease environmental impacts, reduce waste, and improve resource efficiency (Setijaningsih, 2026). Based on the Resource-Based View (RBV) and signaling theory, green innovation allows firms to develop rare, non-substitutable environmental capabilities that foster long-term competitive advantages and strengthen corporate reputation (Nurkhasanah et al., 2024). However, implementing green technologies requires substantial financial investments in research, technology adoption, and operational reconfiguration (Nabila & Wardhani, 2026). In carbon-intensive industries, capital markets may view short-term green expenditure as financial burdens that pressure cash flows before economic benefits materialize (Bastian et al., 2026). Consequently, without immediate financial returns, the direct effect of green innovation on short-term market valuation can be constrained. To empirically test this direct link, the second hypothesis is formulated:

H2: Green Innovation Has A Positive Effect on Firm Value.

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ISSN : e-ISSN 3026-6505
Volume / Issue / Year/ Page : 4/ 1/ 2026: October / 643-659

Institutional Ownership and Firm Value

Institutional investors play a crucial role in corporate governance by acting as sophisticated monitoring agents with substantial financial stakes, technical expertise, and fiduciary duties (Luthfia & Terdpaopong, 2026). Grounded in agency theory, institutional ownership directly mitigates agency costs by curbing managerial opportunistic behavior and enforcing financial discipline (Kulsum et al., 2025). In the energy sector, high institutional shareholding signals to capital markets that managerial decision-making is subject to continuous professional oversight, thereby reducing risk premiums and enhancing investor confidence (Kurniasih, 2026). Effective monitoring by institutional owners ensures optimal capital allocation and operational transparency, directly elevating market valuation as reflected in Tobin's Q (Putra, 2026). Therefore, the third hypothesis is stated as follows:

H3: Institutional ownership has a positive effect on firm value.

The Moderating Role of Institutional Ownership on Carbon Emission Disclosure and Firm Value

Agency theory emphasizes that information asymmetry and conflicts of interest between agents (managers) and principals (shareholders) can lead to opportunistic behavior, such as superficial environmental reporting or greenwashing (Maharani, 2024). Institutional shareholders act as powerful sophisticated monitors capable of mitigating agency costs due to their large shareholding stakes and technical capability (Dianti, 2024). When institutional ownership is high, managers are subjected to rigorous oversight, ensuring that corporate carbon disclosures reflect genuine climate risk management rather than symbolic reporting (Nur Mala Sari, 2025). Strong institutional monitoring increases the market credibility of carbon disclosures, reassuring prospective investors that climate strategies align with shareholder value creation (Nurkhasanah et al., 2024). Hence, higher institutional ownership reinforces the positive impact of carbon transparency on firm valuation. The third hypothesis is stated as follows:

H4: Institutional Ownership Strengthens The Positive Effect of Carbon Emission Disclosure on Firm Value.

The Moderating Role of Institutional Ownership on Green Innovation and Firm Value

Green innovation projects entail strategic uncertainty and capital allocation risks (Febrian et al., 2026). Grounded in agency theory and resource allocation principles, managerial choices regarding green investments require strict external governance monitoring to prevent inefficient capital spending (Nabila & Wardhani, 2026). Institutional investors provide effective corporate governance oversight, ensuring that managers select green innovation projects that offer measurable financial returns, cost savings, and operational efficiencies rather than engaging in value-destroying initiatives (Zatira et al., 2026). With active institutional oversight, market participants are more confident that green capital expenditures will generate long-term economic value, transforming potential short-term cost burdens into positive market valuation drivers (Ambarwati Akib, 2025). Thus, the fourth hypothesis is proposed:

H5: Institutional Ownership Strengthens The Positive Effect of Green Innovation on Firm Value.

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Volume / Issue / Year/ Page : 4/ 1/ 2026: October / 643-659

RESEARCH METHODS

This study utilizes secondary data collected from the annual reports and sustainability reports of energy-sector companies listed on the Indonesia Stock Exchange (IDX) for the period 2022–2025. The research sample was selected using a purposive sampling method based on two main criteria: (1) companies classified under the energy sector and consistently listed on the IDX during the 2022–2025 period; and (2) companies that published complete annual reports, financial statements, and sustainability reports containing the required environmental disclosure and governance data throughout the four-year observation period Initially, 42 energy-sector companies were identified (168 potential firm-year observations). After applying standard sample selection criteria and trimming extreme outliers ($Z > 3.0$), the final dataset comprises a balanced panel of 27 companies over 4 years, yielding 108 firm-year observations. Continuous variables were winsorized at the 1st and 99th percentiles to ensure data normality. The study uses quantitative panel data. In this study, carbon-emission disclosure, and green innovation are treated as independent variables(X). Firm value is the dependent variable (Y), while good corporate governance is included as the moderating variable. This study specifically utilizes Institutional Ownership (INST) as the proxy for corporate governance monitoring intensity. While corporate governance encompasses multiple dimensions (such as board independence, audit committee effectiveness, and managerial ownership), institutional investors represent the primary external oversight mechanism with sufficient voting power and analytical capacity to monitor environmental strategies in emerging markets. To ensure conceptual clarity, the study limits its theoretical claims specifically to institutional governance monitoring rather than broad corporate governance. Detailed operational definitions of the variables are presented in Table 1.

Table 1. Operational Definition of Research Variables

Variable	Operational Measurement / Formula	Theoretical Reference
Firm Value (Y)	Tobin's Q = $\frac{\text{Total shares outstanding} \times \text{closing price} + \text{total debt}}{\text{Total Asset}}$	(Febrian et al., 2026)
Carbon Emission Disclosure (X1)	CED = $\frac{\text{GRI 305 (Emissions)}}{\text{Total Disclosure Items}} \times 100\%$	(Purnomo et al., 2025)
Green Innovation (X2)	GI = $\frac{\text{Number of Items Disclosure}}{\text{Total Disclosure Items}} \times 100\%$	(Maharani, 2024)
Institutional Ownership (Z)	Institusional Owned = $\frac{\text{Shares Owned by Institutional Investor}}{\text{Total Outstanding Shares}} \times 100\%$	(Rachmadhika, 2025b)

Source: Data processed by researchers (2026).

Econometric Model and Panel Regression Specification

To test the direct effects and moderating role of institutional ownership, panel data regression modeling is employed. Panel data analysis is selected because it accounts for cross-sectional heterogeneity across energy firms and temporal dynamics over the four-year period.

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ISSN : e-ISSN 3026-6505
Volume / Issue / Year/ Page : 4/ 1/ 2026: October / 643-659

The unmoderated baseline panel regression model (Model 1) is specified as:
$Tobin's\ Q_{it} = \alpha+\beta_1 CED_{it}+\beta_2 GI_{it}+\varepsilon_{it}$ ……………………………………………………………………..(1)

The moderated regression analysis (MRA) panel model (Model 2) incorporating institutional ownership and interaction terms is specified as:
$Tobin's\ Q_{it} = \alpha+\beta_1 CED_{it}+\beta_2 GI_{it}+\beta_3 INST_{it}+\beta_4(CED_{it}\times INST_{it}) +\beta_5(GI_{it}\times INST_{it}) +\varepsilon_{it}$………(2)
Where:
$Tobin's\ Q_{it}$ = Firm Value of firm i in year t
CED = Carbon Emission Disclosure
GI = Green Innovation
INST = Institutional Ownership
α = Constant term
β = Regression coefficients
ε = Error term

The determination of the appropriate panel estimation technique—among Common Effects Model (CEM), Fixed Effects Model (FEM), and Random Effects Model (REM)—is evaluated using standard statistical tests: the Chow test, Lagrange Multiplier (LM) test, and Hausman test.

RESULTS AND DISCUSSION

Descriptive Statistic Test

Table 2 presents the descriptive statistics for all research variables across the final sample of 108 firm-year observations in the Indonesian energy sector.

Table 2. Descriptive Statistics of Research Variables (N=108)

Variable	Mean	Std.Dev	Minimum	Maximum
Firm Value	1.085	0.344	0.563	2.150
Carbon Emission Disclosure	0.877	0.068	0.682	0.970
Green Innovation	0.891	0.125	0.471	1.000
Institutional Ownership	0.685	0.186	0.149	0.964

Source: Data processed (2026).

As shown in Table 2, Tobin's Q registers a mean value of 1.085 with a standard deviation of 0.644, indicating that energy firms in Indonesia generally maintain a market value close to their asset replacement cost, with moderate dispersion. Carbon Emission Disclosure (CED) achieves an average index of 0.877, though its higher standard deviation (0.280) indicates notable variation in carbon reporting completeness among firms. Green Innovation (GI) exhibits a high average score of 0.891 and a narrow standard deviation (0.157), demonstrating consistent adoption of basic eco-friendly initiatives across the sector. Institutional Ownership (INST), representing corporate governance monitoring, averages 68.5% (0.685) with a standard deviation of 0.346, confirming substantial variation in governance oversight across the sample.

Panel Regression Model Selection

To determine the optimal panel estimation technique among Common Effects Model (CEM), Fixed Effects Model (FEM), and Random Effects Model (REM), formal specification tests were performed sequentially.

Chow Test

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Volume / Issue / Year/ Page : 4/ 1/ 2026: October / 643-659

The Chow test is used to determine whether the common effects model (CEM) or the fixed effects model (FEM) is more appropriate. The test result shows Prob > F = 0.0000, which is below 0.05. This indicates significant firm specific heterogeneity, meaning that the fixed effects model (FEM**)** is preferred over the common effects model.

Lagrange Multiplier (LM) Test

The Lagrange Multiplier (LM) test is employed to compare the common effects model (CEM) with the random effects model (REM). The LM result reports Prob > Chi^2 = 0.0000, which is below 0.05, indicating significant cross-sectional (firm level) effects. Therefore, the random effects model (REM) is preferred to the common effects model.

Hausman Test

The Hausman test is used to determine whether the fixed effects model (FEM) or the random effects model (REM) provides the more appropriate specification. The test result shows Prob > Chi-bar^2 = 0.571, which exceeds 0.05. This suggests that the firm specific effects are not systematically correlated with the regressors. Hence, the random effects model (REM**)** is considered more efficient and is selected as the final panel regression model for this study.

Table 3. Summary of Panel Model Selection Tests

Test Method	Hypotheses / Comparison	Statistical Result	Selected Model
Chow Test	CEM vs. FEM	Prob > F = 0.0000	Fixed Effects Model (FEM)
Lagrange Multiplier (LM)	CEM vs. REM	Prob > X^2= 0.0000	Random Effects Model (REM)
Hausman Test	FEM vs. REM	Prob > X^2= 0.5710	Random Effects Model (REM)

Source: Data processed (2026).

Classic Assumption Test

Normality Test

The Kolmogorov-Smirnov test yields an asymptotic significance (2-tailed) of 0.200 for both baseline and moderated panel models, exceeding the 0.05 threshold and confirming normal error distribution

Table 4. Normality Test Results

Panel Model	Significance Level	Asymp. Sig. (2-tailed)	Conclusion
Model 1 (Direct Effect)	0.05	0.200	Normally Distributed
Model 2 (Moderated Effect)	0.05	0.200	Normally Distributed

Source: Data processed (2026).

Based on the two-tailed asymptotic significance (Asymp. Sig. 2-tailed) test, a value greater than 0.05 (Sig > 5%) indicates that the data are normally distributed. In this study, both Panel Model 1 and Panel Model 2 obtained an Asymp. Sig. value of 0.200, which exceeds the 0.05 threshold. Therefore, it can be concluded that both Panel Model 1 and Panel Model 2 are normally distributed.

Multicollinearity Test

Multicollinearity is evaluated using Tolerance and Variance Inflation Factor (VIF) criteria. All independent and moderating terms exhibit VIF values well below 10.0 and Tolerance values above 0.10, confirming the absence of severe multicollinearity.

Table 5. Multicollinearity Test Results

Variabel	Collinearity Statistics		
Independen	Tolerance	VIF	Description
CED	0.946	1.057	No Multicollinearity
GI	0.617	1.620	No Multicollinearity
INST	0.591	1.692	No Multicollinearity
CED X INST	0.549	1.821	No Multicollinearity
GI X INST	0.513	1.950	No Multicollinearity

Source: Data processed (2026).
Notes: CED: Carbon Emission Disclosure, GI: Green Innovation, INST: Institutional Ownership

Multicollinearity was evaluated using Tolerance and Variance Inflation Factor (VIF) criteria for all research variables and interaction terms. A model is considered free from harmful multicollinearity if the Tolerance values exceed 0.10 and the VIF values remain below 10.0. As presented in Table 5, all independent, moderating, and interaction terms exhibit Tolerance values well above 0.10 (ranging from 0.513 to 0.946) and VIF values significantly lower than 10.0 (ranging from 1.057 to 1.950). Furthermore, to avoid multi-collinearity generated by product terms in moderated regression, continuous variables were mean-centered before constructing the interaction terms. These empirical results confirm the absence of multicollinearity in the specified panel regression model.

Heteroscedasticity Test

Table 6. Heteroscedasticity Test Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey				
Null hypothesis: Homoskedasticity				Conclusion
F-statistic	0.519	Prob. F(5,102)	0.725	Homoscedastic
Obs*R-squared	1.528	Prob. Chi-Square(4)	0.857	Homoscedastic
Scaled explained SS	1.165	Prob. Chi-Square(4)	0.862	

Source: Data processed (2026).

The heteroscedasticity test produces a Prob > Chi^2 value of 0.857, which exceeds the 0.05 significance level. This indicates that the panel regression model does not suffer from heteroscedasticity. Accordingly, the homoskedasticity assumption is satisfied, and the coefficient estimates can be considered appropriate and reliable for subsequent analyses.

Hypotheses Testing and Panel Regression Results

Table 7 reports the panel data Generalized Least Squares (GLS) Random Effects estimation results for Equation (2), incorporating direct and interaction effects.

Table 7. Regression Analysis Test Results

Variabel	B	Std. Error	t -Statistic	p-Value (Sig.)	Hypothesis Decision
(Constant)	0.951	0.090	10.567	0.000	-
CED	0.715	0.301	2.375	0.019	Supported
GI	-0.420	0.380	-1.105	0.272	Not Supported
INST	0.512	0.245	2.090	0.039	Supported

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Volume / Issue / Year/ Page : 4/ 1/ 2026: October / 643-659

Variabel	B	Std. Error	t -Statistic	p-Value (Sig.)	Hypothesis Decision
CED*INST	1.702	0.803	2.119	0.036	Supported
GI*INST	1.840	0.781	2.356	0.012	Supported

Source: Data processed (2026).

$Tobins'Q_{it}$ = 0.951 + 0.715 $(CED)_{it}$ -0,420 $(GI)_{it}$ + 0.512 $(INST)_{it}$ + 1.702 $(CEDxINST)_{it}$ + 1.840 $(GIxINST)_{it}$ + e_{it}

The constant value of 0.951 indicates that if all independent and moderating variables are equal to zero, the baseline firm value stands at 0.951. The individual and interaction effects are interpreted as follows:

1. Carbon Emission Disclosure (CED): The direct effect of CED on firm value is positive, with a coefficient of 0.715 and a significance value of 0.019 ($p < 0.05$). This statistically proves that greater transparency in carbon emission reporting significantly enhances the firm value.
2. Green Innovation (GI): Conversely, GI exhibits a negative coefficient of -0.420. However, with a significance level of 0.272 ($p > 0.05$), this direct relationship is statistically insignificant, meaning that green innovation initiatives do not impact on firm value.
3. GCG as a Moderator on CED (CEDXGCG). The interaction between CED and good corporate governance yields a positive coefficient of 1.702 and is statistically significant at 0.036 ($p < 0.05$). This confirms that GCG acts as a positive moderator, significantly strengthening the favorable impact of carbon emission disclosure on firm value.
4. GCG as a Moderator on GI (GI X GCG). The interaction between GI and GCG produces a strong positive coefficient of 1.840 with a high significance level of 0.012 ($p < 0.05$). This reveals that GCG successfully moderates and drives the potential of green innovation to significantly on firm value.

Coefficient of Determination (R^2) Test

Table 8. Model Summary and Goodness-of-Fit Test

Model Summary[b]					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.688[a]	.473	.458	1.72551	1.882

a. Predictors: (Constant), Carbon Emission Disclosure (X1), Green Innovation (X2)
b. Dependent Variable: Firm Value (Y)
Source: Data processed (2026).

The coefficient of determination results presented in the Model Summary indicate that the regression model has an R Square value of 0.473 and an Adjusted R Square value of 0.458. This result indicates that carbon emission disclosure and green innovation jointly explain 45.8% of the variation in firm value after adjusting for the number of predictors included in the model. Meanwhile, the remaining 54.2% of the variation in firm value is explained by other factors that are not included in the model. Overall, the results suggest that carbon emission disclosure and green innovation provide a relatively substantial contribution to explaining variations in firm value.

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DISCUSSION

Theoretical Mapping of Research Hypotheses

To address the theoretical gap, Table 9 explicitly maps each research hypothesis to its underlying theoretical foundation, variable constructs, empirical findings, and substantive interpretations

Table 9. Theoretical Mapping and Hypothesis Testing Summary

Hypothesis	Relationship / Specification	Underlying Theoretical Framework	Empirical Result	Substantive Interpretation
H1	CED -> Firm Value	Signaling Theory & Legitimacy Theory	Supported	Carbon emission disclosures provide a credible positive signal that reduces information asymmetry and regulatory risk perceptions.
H2	GI -> Firm Value	Resource-Based View (RBV) & Cost-Benefit Trade-off	Not Supported	Capital markets perceive standalone green R&D expenditures as financial cost burdens before economic returns materialize.
H3	INST-> Firm Value	Agency Theory (Direct Monitoring Mechanism)	Supported	Institutional ownership provides direct external governance monitoring, reducing agency costs and increasing market valuation.
H4	(CED X INST) -> Firm Value	Agency Theory (Disclosure Credibility)	Supported	Institutional oversight eliminates opportunistic greenwashing, increasing the market credibility of carbon disclosures.
H5	(GI X INST) -> Firm Value	Agency Theory & Strategic Capital Oversight	Supported	Strict governance monitoring ensures green capital expenditures align with economic efficiency and long-term shareholder value.

The Effect Carbon Emission Disclosure on Firm Value

The findings indicate that carbon emission disclosure has a positive and statistically significant effect on firm value. In practice, carbon emission disclosure reflects the company's efforts to plan and report emission reduction initiatives, including tracking and comparing annual carbon emission levels generated through operational activities, which may reduce investor hesitation toward investing in energy sector firms (Rachmadhika, 2025a). This suggests that more extensive disclosure attracts investor attention the more management discloses information regarding environmental responsibility particularly carbon emission disclosure the higher the firm value tends to be (Yuliandhari et al., 2023). This finding can be explained through signalling theory, which suggests that corporate disclosure provides information to external parties regarding management's actions and future prospects. Carbon emission disclosure allows companies to communicate their environmental policies, carbon-related risks, emission management practices, and efforts to address climate change (Yuliandhari et al., 2023). For companies in the energy sector, such information is particularly relevant because their operations are closely associated with carbon emissions and environmental risks. Greater transparency can therefore reduce information asymmetry and provide investors with a clearer understanding of how the company manages climate-related risks.

From a legitimacy perspective, carbon emission disclosure may also help energy

companies demonstrate their responsiveness to increasing environmental expectations. Disclosure can indicate that the company recognises its environmental responsibilities and is taking steps to manage the consequences of its business activities. When such information is perceived positively by investors, it may strengthen market confidence and consequently increase firm value.

Empirically, this finding aligns with studies reporting that carbon emission disclosure significantly affects firm value (Damanik et al., 2025), (Adam Karim Nurdiansyah, 2024). Overall, the present results suggest that carbon emission disclosure can increase firm value by strengthening investor confidence and supporting long term business sustainability in the energy sector.

The Effect Green Innovation on Firm Value

The results also show that green innovation has a negative and statistically insignificant effect on firm value. This pattern suggests that investment and implementation of green innovation among energy-sector companies may not immediately be reflected in market valuation. Green innovation generally requires substantial financial resources for research and development, technological adaptation, production modification, and the implementation of environmentally friendly processes (Setijaningsih, 2026). These investments may generate benefits over a longer period, whereas the associated costs may be recognised or perceived by investors in the short term. This finding can also be understood from the perspective of signalling theory. Although green innovation may potentially signal a company's environmental commitment and long-term adaptability, investors may not immediately regard such innovation as a source of economic value (Yuliandhari et al., 2023). The market may require more observable evidence that green innovation can generate financial returns, improve operational efficiency, reduce costs, or create competitive advantages.

This negative relationship may also reflect investor behavior in emerging markets, where market participants tend to prioritize short term profitability, dividend expectations, and cash flow stability over long term sustainability gains. As a result, green innovation expenditures may be interpreted as cost burdens rather than strategic investments, creating a market mispricing in which sustainability initiatives are not yet fully capitalized into firm value (Ambarwati Akib, 2025). For energy-sector companies, the insignificant result may also reflect the structural characteristics of the industry. The transition toward environmentally friendly technologies requires significant capital investment, while the financial returns from such investments may not be immediately observable. Therefore, green innovation alone may be insufficient to increase firm value unless it is supported by effective governance, strategic implementation, and clear communication of its economic benefits to investors. This finding is consistent with studies (Sari, 2025), (Samhadi, 2024) reporting no significant effects of green innovation on firm value

The Effect of Institutional Ownership on Firm Value

The findings demonstrate that institutional ownership has a positive and statistically significant direct effect on firm value. In corporate governance, institutional investors act as sophisticated monitoring agents with substantial financial stakes, fiduciary responsibilities, and analytical capabilities (Dianti, 2024). Grounded in agency theory, institutional ownership directly mitigates agency problems by curbing opportunistic managerial behavior, enforcing financial discipline, and ensuring that corporate resources are managed efficiently (Nurkholisah & Keristin, 2024). High institutional

shareholding signals to capital markets that management is subject to strict external oversight, which lowers perceived investment risk, reduces agency costs, and elevates investor confidence. In the Indonesian energy sector, where operations involve substantial capital allocation and regulatory risks, strong monitoring by institutional owners reassures investors regarding managerial accountability, directly elevating corporate valuation as reflected in Tobin's Q (Putri, 2023).

Institutional Ownership Moderating on the Relationship Between Carbon Emission Disclosure and Firm Value

The results indicate the interaction between carbon emission disclosure and institutional ownership has a positive and significant effect on firm value. This finding indicates that institutional ownership strengthens the relationship between carbon emission disclosure and firm value. Accordingly, the third hypothesis is supported. This finding is consistent with agency theory, which emphasises the importance of monitoring mechanisms in reducing conflicts of interest between managers and shareholders. Strong institutional ownership can encourage managers to provide more transparent information and reduce the possibility of opportunistic disclosure. In this context, institutional ownership can increase the credibility of carbon emission disclosure and enhance the likelihood that investors will respond positively to such information (Nurhayati et al., 2026).

The result is particularly relevant for energy companies because environmental information can have significant implications for future regulatory, reputational, and transition risks. Effective institutional ownership may ensure that carbon-related risks are incorporated into strategic decision-making and that environmental commitments are appropriately monitored. Carbon emission disclosure accompanied by stronger institutional ownership may provide a more credible signal to investors. Therefore, the present finding contributes to the literature by suggesting that environmental disclosure is more valuable when supported by effective institutional ownership. Carbon disclosure may provide information, but governance determines, to some extent, whether that information is perceived as credible and whether environmental commitments are effectively implemented (Samhadi, 2024). In the Indonesian energy sector, strengthening governance may consequently increase the market value generated from carbon transparency.

Institutional Ownership Moderating On The Relationship Between Green Innovation And Firm Value

The results show that institutional ownership significantly moderates the relationship between green innovation and firm value. The positive interaction suggests that the presence of stronger governance mechanisms can improve the extent to which green innovation contributes to firm value. This result can be explained through agency theory and resource-based reasoning. Green innovation requires substantial resources and involves uncertainty regarding its economic returns (Setijaningsih, 2026). Without effective monitoring, managers may allocate resources to environmental innovation without sufficient consideration of its strategic and financial consequences. Institutional ownership can help ensure that green innovation investments are aligned with the company's long-term strategy, monitored appropriately, and directed toward initiatives capable of generating sustainable competitive advantages (Maharani, 2024).

Ownership may also increase investor confidence in management's ability to convert environmental investments into future economic benefits. When investors

observe that green innovation is supported by effective oversight and accountability, they may perceive such investments as strategic rather than merely costly environmental initiatives. For energy companies, this result has important implications because the transition toward greener technologies involves considerable capital expenditure and strategic uncertainty (Dianti, 2024). Strong governance can improve investment discipline, monitoring, accountability, and strategic alignment, thereby increasing the likelihood that green innovation will contribute positively to firm value. This result is consistent with studies reporting that governance moderates the green innovation firm value relationship (Samhadi, 2024), (Aprilya & Marrung, 2025). Overall, the findings suggest that institutional ownership play a key role in shaping the value implications of green innovation in the energy sector.

CONCLUSION

This study investigates the impact of carbon emission disclosure (CED) and green innovation (GI) on firm value (Tobin's Q), as well as the moderating role of institutional ownership across Indonesian energy companies listed on the IDX from 2022 to 2025. The empirical analysis using the Random Effects Model (REM) reveals that CED and institutional ownership exert direct positive and statistically significant impacts on firm value, whereas direct green innovation investments do not immediately yield market valuation gains. Crucially, institutional ownership significantly moderates both relationships, reinforcing the positive market response to CED and transforming green innovation into a value-creating asset. Theoretically, this research extends signaling theory (Spence, 1973) and agency theory (Jensen & Meckling, 1976) by demonstrating that governance monitoring acts as an essential boundary condition in carbon-intensive emerging markets. Voluntary carbon disclosures and green R&D expenditures require institutional oversight to overcome market skepticism regarding greenwashing and capital misallocation. Managerially, energy sector executives should not execute green innovation in isolation; green capital investments must be paired with stringent institutional monitoring and transparent carbon accounting to assure equity investors of their financial viability.

Corporate boards must actively engage institutional shareholders during the transition to low-carbon operations. This study is subject to limitations, including its focus on a single proxy for governance (institutional ownership) and a four-year time horizon (2022–2025). Future research should expand the governance construct by incorporating multi-dimensional proxies (e.g., board independence, ESG committees) and extend the sampling framework to cross-country energy sectors in ASEAN

Statement on the Use of Artificial Intelligence.

AI was used in the preparation of this manuscript. The authors used artificial intelligence tools solely to assist with language improvement, grammar checking, and editing for clarity and readability. The authors remain fully responsible for the accuracy, originality, integrity, and academic content of the manuscript. All AI-assisted content was reviewed and verified by the authors before submission.

Conflicts of interest

The authors declare no conflict of interest regarding the publication of this research, its findings, or the institutions involved in the energy sector under study.

Author contributions

Conceptualization of the study was carried out by Author 1 and Author 2. Data collection was conducted by Author 1 and Author 3, while data validation was handled by Author 2. Formal analysis was performed by Author 1 and Author 2, and the methodology was developed by Author 3. The original draft of the manuscript was prepared by Author 1, and the review and editing process was completed by Author 2 and Author 3. Visualization was managed by Author 3. All authors have read and approved the final version of the manuscript.

Acknowledgments

This research was supported by the Faculty of Business and Social Sciences and the Research and Community Service Institute of Dian Nusantara University and Institute Technology and Business Widya Gama Lumajang. The authors gratefully acknowledge the financial support, database facilities, and resources provided to facilitate the completion of this research on carbon emission disclosure and governance in the energy sector.

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