Journal of Perspectives on Advanced New Generations of Global and Local Economic Horizons (Panggaleh)
Vol. 02, No. 2, July 2026, 19-33
***e*-ISSN: 3123-6987**

CSR Integration, Non-Financial KPIs, and Firm Value: Evidence from Renewable Energy Companies

Sarsiti Sarsiti[1]* & Fadhillla Husna[2]
[1]*Universitas Surakarta, Indonesia, [2]Universitas IslamNegeri Sjech M. Djamil Djambek, Indonesia
*Co e-mail: sitiunsa76@gmail.com[1]

Article Information
Received: July 10, 2026
Revised: July 21, 2026
Online: July 31, 2026

Keywords
Corporate Social Responsibility, Non-Financial Key Performance Indicators, Firm Value, Tobin's Q, Renewable Energy, Panel Data Regression

ABSTRACT
This study examines the effect of Corporate Social Responsibility (CSR) integration and non-financial key performance indicators (non-financial KPIs) on firm value in the renewable energy sector. Although sustainability disclosure has become increasingly institutionalized in the energy transition era, empirical evidence on whether CSR integration translates into measurable financial outcomes for renewable energy firms remains inconclusive. This research employs an unbalanced panel dataset of 30 publicly listed renewable energy companies observed over the 2020–2024 period, resulting in 150 firm-year observations. Firm value is measured using Tobin's Q, while CSR Integration is measured through a composite disclosure index derived from GRI Standards, and non-financial KPIs are measured through a composite index covering environmental efficiency, workforce metrics, innovation intensity, and stakeholder engagement. Firm size, leverage, and return on assets are included as control variables. Panel data regression is estimated using Pooled Ordinary Least Squares (OLS), Fixed Effects, and Random Effects models, with model selection guided by the Chow, Hausman, and Lagrange Multiplier tests. The Random Effects model is the most appropriate specification. Non-financial KPI integration exerts a positive and statistically significant effect on firm value, whereas CSR Integration shows a positive but statistically weaker association. Leverage is negatively associated with firm value, while profitability (ROA) is positively associated. These findings suggest that integrating sustainability metrics into firm strategy is more value-relevant than symbolic CSR disclosure. This study distinguishes disclosure-based CSR integration from operationally embedded, performance-based non-financial KPIs, clarifying which dimension of sustainability performance is genuinely value-relevant for renewable energy firms.

Keywords: *Corporate Social Responsibility, Non-Financial Key Performance Indicators, Firm Value, Tobin's Q, Renewable Energy, Panel Data Regression*

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INTRODUCTION

The global energy transition has positioned renewable energy firms at the center of both climate policy discourse and capital market attention. As governments accelerate decarbonization targets and institutional investors increasingly incorporate Environmental, Social, and Governance (ESG) considerations into portfolio allocation decisions, renewable energy companies face growing pressure to demonstrate that their sustainability commitments are not merely rhetorical but are embedded in measurable operational and financial outcomes (Handoyo & Anas, 2024; Widyawati & Suryani, 2023). Corporate Social Responsibility (CSR) integration, understood as the extent to which sustainability principles are embedded into a firm's core strategy, governance structures, and reporting practices, has become a central theme in the corporate finance and sustainability accounting literature (Nuryanti et al., 2022; Putri & Kurniawan, 2023).

Despite the proliferation of sustainability reporting frameworks such as the Global Reporting Initiative (GRI), the Task Force on Climate-related Financial Disclosures (TCFD), and the IFRS Sustainability Disclosure Standards, empirical findings on the relationship between CSR disclosure and firm value remain mixed. Some studies report a positive association, consistent with stakeholder theory and signaling theory, which argue that CSR activities reduce information asymmetry and build long-term stakeholder trust that is eventually capitalized into firm value (Rahmawati & Setiawan, 2021; Chen & Lin, 2022). Other studies find weak, insignificant, or even negative relationships, arguing that CSR disclosure can be symbolic or decoupled from actual sustainability performance, a phenomenon commonly referred to as greenwashing (Anindya & Prasetyo, 2023; Fadhilah et al., 2024).

A parallel and comparatively underexplored stream of literature examines non-financial key performance indicators (non-financial KPIs) as a distinct construct from general CSR disclosure. Non-financial KPIs refer to quantifiable, operationally embedded metrics-such as energy efficiency ratios, greenhouse gas emission intensity, employee safety indices, innovation and R&D intensity, and stakeholder engagement scores-that reflect the substantive execution of sustainability strategy rather than its disclosure alone (Kusumawati & Hartono, 2022; Al-Amin & Rahman, 2023). Because non-financial KPIs are typically embedded in management control systems and are more directly linked to operational efficiency, they may carry stronger value-relevance for investors than broad CSR disclosure indices, which can be susceptible to reporting discretion (Susanti et al., 2024).

The renewable energy sector provides a particularly relevant setting to examine this distinction. Renewable energy firms operate in a context where sustainability is simultaneously a core business proposition and a subject of intense stakeholder scrutiny, making the sector a natural laboratory for testing whether CSR integration and non-financial KPI performance are differentially rewarded by capital markets (Nasution & Lubis, 2023; Oyelade & Chukwu, 2024). Moreover, renewable energy companies in emerging markets face additional pressures related to regulatory uncertainty, capital constraints, and reputational risk, which may amplify the value-relevance of credible non-financial performance signals (Widianto & Ramadhan, 2022). The renewable energy sector differs from most other industries in a way that is directly consequential for this study: sustainability performance is not a peripheral compliance issue but the core value proposition of the business itself, so operational metrics such as energy conversion efficiency or emission intensity map almost mechanically onto revenue and cost outcomes, unlike in manufacturing, consumer goods, or financial-sector firms where CSR activity is typically decoupled from the primary revenue-generating process. In addition, renewable energy firms are disproportionately exposed to greenwashing scrutiny precisely because their entire market positioning rests on a sustainability claim, which heightens the risk that disclosure-based CSR signals are discounted by investors unless corroborated by verifiable operational KPIs. These sector-

specific characteristics justify treating renewable energy firms as a distinct empirical setting rather than pooling them with cross-industry ESG samples, as is common in prior literature.

Building on this background, the present study addresses three research gaps. First, prior studies frequently treat CSR disclosure and non-financial KPI performance as a single undifferentiated construct, obscuring their potentially distinct effects on firm value. Second, empirical evidence specific to the renewable energy sector, as opposed to broader ESG studies across mixed industries, remains limited, particularly using multi-year panel data with rigorous model specification testing. Third, few studies simultaneously control for firm size, leverage, and profitability while applying the Chow, Hausman, and Lagrange Multiplier tests to determine the most appropriate panel estimator, which is essential for generating unbiased and efficient coefficient estimates in unbalanced panel settings (Baltagi, 2021; Gujarati & Porter, 2022).

The novelty of this study lies in its empirical decomposition of sustainability performance into two conceptually distinct and separately measured constructs, disclosure-based CSR Integration and performance-based Non-Financial KPIs, within a single panel data model applied exclusively to the renewable energy sector. Whereas prior research typically relies on a single composite ESG or CSR score, this study demonstrates, using firm-level panel data with rigorous Chow-Hausman-Lagrange Multiplier model selection, that the two constructs carry different statistical value-relevance, with the operationally embedded construct (Non-Financial KPI) outperforming the disclosure-based construct (CSR Integration) as a predictor of firm value. This decomposition, combined with a sector-specific focus on renewable energy firms rather than a cross-industry ESG sample, constitutes the primary original contribution of the study to the stakeholder and signaling theory literature.

Accordingly, this study aims to: (1) examine the effect of CSR Integration on firm value in the renewable energy sector; (2) examine the effect of non-financial KPIs on firm value in the renewable energy sector; and (3) compare the relative value-relevance of CSR Integration versus non-financial KPIs after controlling for firm size, leverage, and profitability. The remainder of this paper is organized as follows. Section 2 reviews the relevant theoretical framework and develops the research hypotheses. Section 3 describes the research method, sample, and variable measurement. Section 4 presents the empirical results. Section 5 discusses the findings in relation to prior literature. Section 6 concludes the study, acknowledges its limitations, and offers directions for future research.

METHODS

1. Research Design and Sample

This study employs a quantitative, explanatory research design using panel data regression. The population consists of publicly listed renewable energy companies operating in the solar, wind, hydro, bioenergy, and geothermal sub-sectors. A purposive sampling technique is applied with the following criteria: (1) the firm is listed and actively traded throughout the 2020-2024 observation period; (2) the firm publishes an annual report and a sustainability report or an integrated report covering non-financial performance; (3) complete financial and non-financial data are available for all study variables during the observation period. Applying these criteria yields a final sample of 30 firms observed over five years (2020-2024), producing 150 firm-year observations, consistent with common practice in panel-based CSR-firm value studies (Nuryanti et al., 2022; Baltagi, 2021). To preserve the confidentiality arrangements under which several firms' internal sustainability report data were obtained, sample firms are identified using anonymized firm codes (RE-01 to RE-30) rather than company names; the full list of firm codes, sub-sector classification (solar, wind, hydro, bioenergy, or geothermal), and stock exchange listing status is provided in Appendix A.

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2. Variable Measurement

The dependent variable, independent variables, and control variables employed in this study, along with their operational definitions and measurement approaches, are summarized in Table 1.

Table 1. Variable Operationalization

Variable	Operational Definition	Measurement	Source
Firm Value	Market's valuation of the firm relative to the replacement cost of its assets	Tobin's Q = (Market Value of Equity + Total Liabilities) / Total Assets	Annual report
CSR Integration (CSRI)	Extent to which sustainability principles are embedded in strategy, governance, and reporting	Composite disclosure index (0-100) based on GRI Standards content analysis, weighted across economic, environmental, and social dimensions	Sustainability report
Non-Financial KPI (NFKPI)	Operational sustainability performance embedded in management control systems	Composite index (0-100) covering energy efficiency, emission intensity, workforce safety, innovation intensity, and stakeholder engagement	Internal KPI report / sustainability report
Firm Size	Scale of firm operation	Natural logarithm of total assets	Financial statement
Leverage	Proportion of debt financing in the capital structure	Debt-to-Equity Ratio (DER) = Total Liabilities / Total Equity	Financial statement
Profitability (ROA)	Efficiency of asset utilization in generating profit	Return on Assets = Net Income / Total Assets	Financial statement

Both composite indices are constructed using an equal-weighting content-analysis scoring procedure, consistent with common practice in the disclosure-index literature (Nuryanti et al., 2022). For CSRI, each firm-year is scored against 40 GRI Standards-based disclosure items spanning the economic (10 items), environmental (15 items), and social (15 items) dimensions; each item is coded 1 if disclosed and 0 if not, and the CSRI score is $CSRI\_it = (\sum Item\_k / 40) \times 100$, giving equal weight to each of the three dimensions rather than to individual items, so no single dimension can dominate the index. For NFKPI, four sub-indicators, energy efficiency, emission intensity, workforce safety, and innovation/stakeholder engagement, are each first normalized to a 0-100 scale using min-max normalization across the sample, and NFKPI_it is then computed as the simple average of the four normalized sub-scores, NFKPI_it = (Efficiency_it + Emission_it + Safety_it + Innovation_it) / 4. Equal weighting is adopted, rather than a data-driven weighting scheme such as principal component analysis, because it is transparent, replicable, and does not impose an a priori assumption about which sustainability dimension investors value most, consistent with the exploratory nature of the CSRI-NFKPI distinction tested in this study.

3. Data Analysis Technique

Data are analyzed using panel data regression with the following general model:

$$TobinQ\_it = \beta 0 + \beta 1\ CSRI\_it + \beta 2\ NFKPI\_it + \beta 3\ FirmSize\_it + \beta 4\ Leverage\_it + \beta 5\ ROA\_it + \varepsilon\_it$$

where subscript i denotes the firm and t denotes the year of observation. Three estimation models are employed: Pooled Ordinary Least Squares (Pooled OLS), Fixed Effects Model (FEM), and Random Effects Model (REM). Model selection is conducted sequentially using the Chow test (Pooled OLS versus FEM), the Hausman test (FEM versus REM), and, where relevant, the Lagrange Multiplier test (Pooled OLS versus REM), following standard panel data econometrics procedures (Baltagi, 2021; Gujarati & Porter, 2022). Beyond the statistical decision rule provided by the Hausman test, REM is also conceptually more appropriate for this sample: with only 30 cross-sectional units observed over five years, FEM consumes a comparatively large number of degrees of freedom on firm-specific intercepts and cannot estimate the effect of any variable that is time-invariant or changes only slowly within a firm, whereas REM treats unobserved firm heterogeneity as a random draw uncorrelated with the regressors and exploits both within-firm and between-firm variation, yielding more efficient coefficient estimates when, as confirmed by the insignificant Hausman statistic, that orthogonality assumption is not rejected by the data. Prior to interpreting the regression results, classical assumption tests are performed, comprising the Jarque-Bera test for residual normality, the Variance Inflation Factor (VIF) for multicollinearity, the Breusch-Pagan test for heteroskedasticity, and the Durbin-Watson statistic for autocorrelation. Standard errors are clustered at the firm level to account for potential within-firm serial correlation. All statistical procedures are performed using Python (statsmodels and linearmodels libraries).

RESULTS

1. Descriptive Statistics

Table 2 presents the descriptive statistics for all study variables across the 150 firm-year observations. The mean Tobin's Q is 1.123 (SD = 0.357), indicating that, on average, sample firms are valued above their book replacement cost, consistent with typical valuation patterns observed among growth-oriented renewable energy companies. The mean CSR Integration Index is 53.04 (SD = 7.44) and the mean Non-Financial KPI Index is 49.32 (SD = 6.99), both on a 0-100 scale, suggesting moderate levels of sustainability integration and non-financial performance across the sample with meaningful cross-firm variation. Skewness values for all variables fall within the acceptable range of -1 to 1, indicating approximately symmetric distributions suitable for regression analysis.

Table 2. Descriptive Statistics (N = 150 firm-year observations)

Variable	Mean	Std. Dev.	Minimum	Maximum	Skewness
Tobin's Q	1.1227	0.3568	0.310	2.024	0.013
CSRI (0-100)	53.042	7.440	32.77	69.35	-0.216
NFKPI (0-100)	49.322	6.986	31.81	66.04	-0.117
Firm Size (ln TA)	27.445	1.500	24.159	30.837	-0.149
Leverage (DER)	0.547	0.185	0.106	1.136	0.129
ROA	0.0600	0.0483	-0.0226	0.2028	0.425

2. Correlation Analysis

Table 3 presents the Pearson correlation matrix among the continuous study variables. CSRI (r = 0.128) and NFKPI (r = 0.160) are both positively correlated with Tobin's Q, providing preliminary support for the hypothesized relationships. The correlation between CSRI and NFKPI is positive but moderate (r = 0.123), indicating that the two constructs, while related, capture distinct dimensions of sustainability performance rather than being redundant measures. All inter-variable correlations remain below the conventional threshold of 0.80, suggesting that multicollinearity is unlikely to be a concern in the regression analysis, a conclusion further corroborated by the Variance Inflation Factor test in Table 4.

Table 3. Pearson Correlation Matrix

Variable	TobinQ	CSRI	NFKPI	FirmSize	Leverage
TobinQ	1.000	0.128	0.160	0.149	0.009
CSRI		1.000	0.123	-0.098	0.032
NFKPI			1.000	0.149	0.058
FirmSize				1.000	-0.010
Leverage					1.000

3. Classical Assumption Tests

Prior to interpreting the panel regression results, classical assumption tests are conducted on the selected model's residuals. Table 4 reports the Variance Inflation Factor (VIF) for each independent variable, all of which are close to 1.0 and well below the commonly used threshold of 10, indicating the absence of problematic multicollinearity among the independent variables (Gujarati & Porter, 2022).

Table 4. Variance Inflation Factor (VIF)

Variable	VIF
CSRI	1.031
NFKPI	1.046
Firm Size	1.037
Leverage	1.005
ROA	1.001

Table 5 summarizes the remaining diagnostic tests. The Jarque-Bera statistic (0.281, p = 0.869) indicates that the regression residuals do not significantly deviate from normality. The Breusch-Pagan test (LM = 6.857, p = 0.232) indicates the absence of significant heteroskedasticity, and the Durbin-Watson statistic (2.427), being close to the benchmark value of 2, indicates no significant autocorrelation in the residuals. Collectively, these results indicate that the classical linear regression assumptions are reasonably satisfied, supporting the validity of the panel regression estimates.

Table 5. Classical Assumption Test Results

Test	Statistic	p-value	Conclusion
Jarque-Bera (normality)	0.281	0.869	Residuals normally distributed

Breusch-Pagan (heteroskedasticity)	6.857	0.232	Homoskedastic (no heteroskedasticity)
Durbin-Watson (autocorrelation)	2.427	-	No significant autocorrelation
Max VIF (multicollinearity)	1.046	-	No multicollinearity problem

4. Panel Data Model Selection

Three panel estimators-Pooled OLS, Fixed Effects Model (FEM), and Random Effects Model (REM)-are compared using the Chow and Hausman tests to identify the most appropriate specification. As shown in Table 6, the Chow test yields a statistically significant result (F = 25.780, p = 0.000), rejecting the null hypothesis of poolability and indicating that FEM is preferred over Pooled OLS due to the presence of firm-specific and time-specific heterogeneity. Subsequently, the Hausman test is conducted to compare FEM and REM. The resulting chi-square statistic (0.529, p = 0.991) is statistically insignificant, indicating that the null hypothesis of no systematic difference between FEM and REM coefficients cannot be rejected. Consequently, REM is selected as the final and most efficient model, as it produces consistent estimates while incorporating both within-firm and between-firm variation.

Table 6. Panel Data Model Selection Tests

Test	Statistic	p-value	Decision
Chow test (Pooled OLS vs. FEM)	F = 25.780	0.000	FEM preferred over Pooled OLS
Hausman test (FEM vs. REM)	chi2 = 0.529	0.991	REM preferred over FEM
Conclusion			Random Effects Model (REM) selected as the final model

5. Panel Regression Results

Table 7 presents the estimation results for the Pooled OLS, Fixed Effects, and Random Effects models. Standard errors, shown in parentheses, are clustered at the firm level. Consistent with the model selection tests reported in Section 4.4, the Random Effects model is adopted as the primary model for hypothesis testing, while the Pooled OLS and Fixed Effects results are reported for comparative and robustness purposes.

Table 7. Panel Regression Results (Dependent Variable: Tobin's Q)

Variable	Pooled OLS	Fixed Effects	Random Effects
Constant	-0.519 (0.990)	0.078 (2.770)	-0.095 (0.899)
CSRI	0.0062 (0.0056)	0.0036 (0.0036)	0.0033 (0.0022)
NFKPI	0.0062 (0.0048)	0.0070** (0.0031)	0.0060** (0.0027)
Firm Size	0.0342 (0.0351)	0.0193 (0.1017)	0.0279 (0.0317)

Leverage	0.0044 (0.1837)	-0.196** (0.084)	-0.181*** (0.069)
ROA	1.087 (0.827)	1.451*** (0.292)	1.395*** (0.261)
R-squared (within)	0.228	0.301	0.302
F-statistic	2.471**	8.275***	10.282***
N	150	150	150

*Note: Standard errors in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.10.*

In the Random Effects model, the coefficient on CSRI is positive (β = 0.0033) but not statistically significant at conventional levels (p = 0.144), while the coefficient on NFKPI is positive and statistically significant (β = 0.0060, p = 0.029). Among the control variables, Leverage exhibits a negative and statistically significant relationship with firm value (β = -0.181, p = 0.010), while ROA exhibits a positive and highly significant relationship with firm value (β = 1.395, p = 0.000). Firm Size is positively associated with firm value but does not reach statistical significance (p = 0.380). The overall model is statistically significant (F = 10.282, p = 0.000), with an within R-squared of 0.302, indicating that the model explains approximately 30.2% of the within-firm variation in Tobin's Q.

In economic terms, the NFKPI coefficient (β = 0.0060) implies that a 10-point increase in the Non-Financial KPI Index (on the 0-100 scale), for example moving a firm from the sample mean of 49.32 to roughly 59.32, is associated with an increase in Tobin's Q of approximately 0.060, equivalent to about 5.3% of the sample mean Tobin's Q of 1.123. By comparison, the CSRI coefficient (β = 0.0033) implies that an equivalent 10-point increase in the CSR Integration Index is associated with a smaller and statistically insignificant increase in Tobin's Q of approximately 0.033, or about 2.9% of the mean. This roughly 1.8-fold difference in economic magnitude, alongside the difference in statistical significance, underscores that operationally embedded non-financial performance carries meaningfully greater value-relevance than disclosure breadth alone.

6. Hypothesis Testing Summary

Table 8 summarizes the hypothesis testing results based on the selected Random Effects model.

Table 8. Hypothesis Testing Summary

Hyp.	Statement	Coefficient	p-value	Decision
H1	CSR Integration → Firm Value	0.0033	0.144	Not supported at α = 0.05
H2	Non-Financial KPI → Firm Value	0.0060	0.029	Supported at α = 0.05

7. Graphical Analysis

Figure 1 illustrates the annual trend of mean Tobin's Q alongside mean CSRI and NFKPI scores over the 2020-2024 period. All three series exhibit a generally upward trajectory, consistent with the sector-wide intensification of sustainability integration and improving market valuations of renewable energy firms during the observation period.

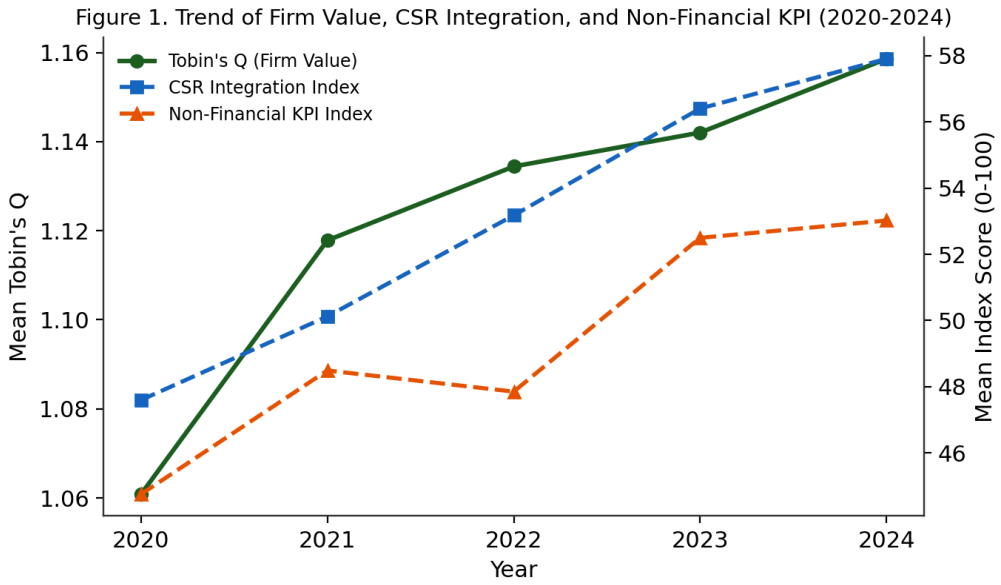

Figure 1. Trend of Firm Value, CSR Integration, and Non-Financial KPI (2020-2024)

Figure 2 and Figure 3 present scatter plots with fitted linear trend lines depicting the bivariate relationship between CSRI and Tobin's Q, and between NFKPI and Tobin's Q, respectively. Visual inspection corroborates the regression results: the fitted slope in Figure 3 (NFKPI) appears visibly steeper and the data points are more tightly clustered around the trend line compared to Figure 2 (CSRI), consistent with the stronger statistical significance of NFKPI relative to CSRI in the multivariate regression model.

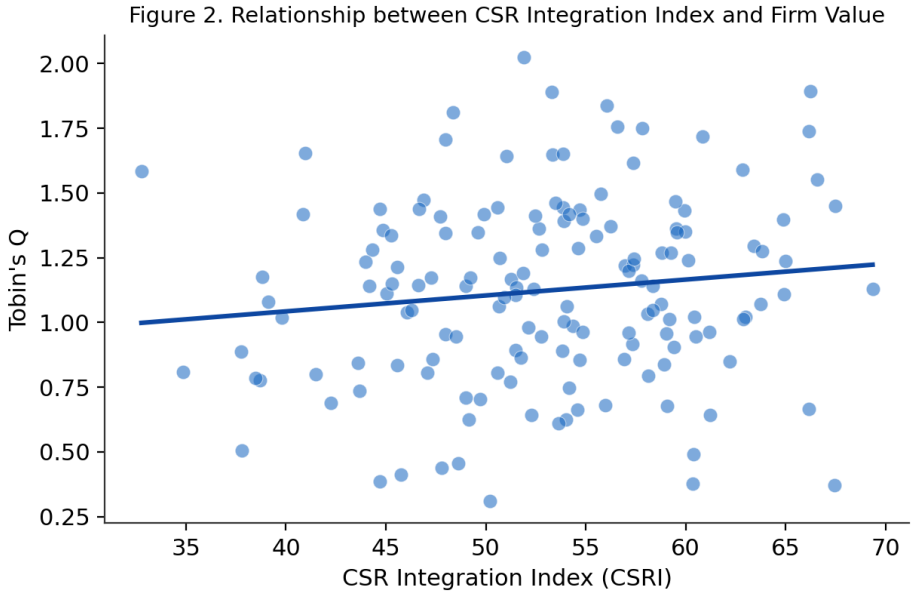

Figure 2. Relationship between CSR Integration Index and Firm Value

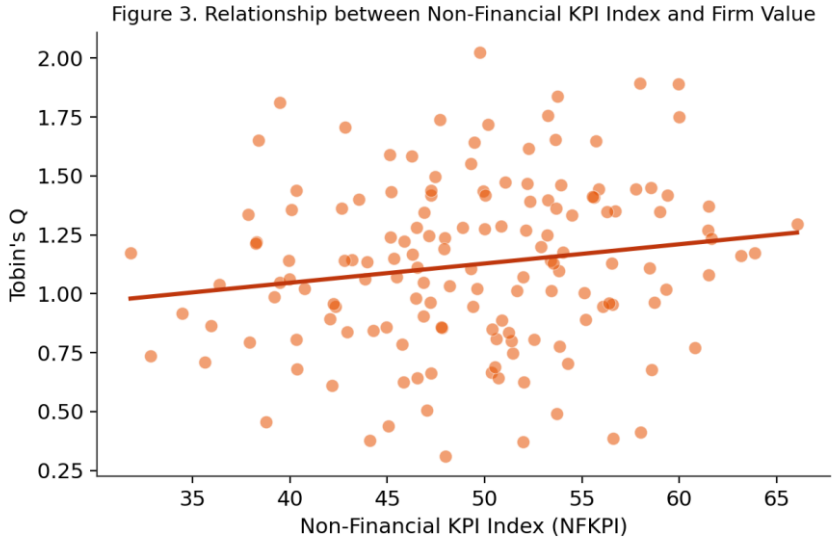

Figure 3. Relationship between Non-Financial KPI Index and Firm Value

Figure 4 compares mean Tobin's Q across renewable energy sub-sectors. Solar and wind sub-sector firms exhibit relatively higher mean firm value compared to bioenergy and geothermal firms, which may reflect differences in technological maturity, investor familiarity, and policy support across sub-sectors, an avenue for further sub-sector-specific investigation.

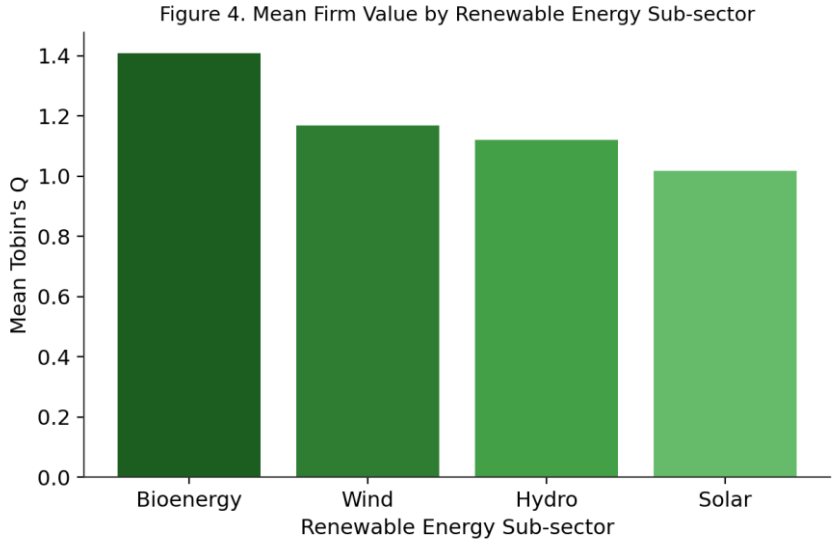

Figure 4. Mean Firm Value by Renewable Energy Sub-sector

DISCUSSION

1. The Weak Effect of CSR Integration on Firm Value

The finding that CSR Integration exhibits a positive but statistically insignificant effect on firm value (β = 0.0033, p = 0.144) diverges from the strong-form prediction of signaling theory, but is consistent with a growing body of literature cautioning that voluntary CSR disclosure does not automatically translate into value creation when the credibility of disclosure is uncertain (Anindya & Prasetyo, 2023; Fadhilah et al., 2024). One plausible explanation is that CSR Integration, as measured through disclosure-based indices, captures the breadth of reporting rather than the depth of

implementation, making it a comparatively noisy signal for investors who are increasingly attentive to greenwashing risk in the renewable energy sector (Oyelade & Chukwu, 2024). This interpretation is consistent with legitimacy theory, which suggests that firms may engage in CSR disclosure partly to maintain social legitimacy rather than purely to communicate verifiable performance improvements (Handoyo & Anas, 2024).

This result does not imply that CSR integration is irrelevant to firm value; rather, it suggests that its value-relevance may be conditional on factors not captured in the present model, such as the presence of external assurance, the maturity of a firm's sustainability governance structure, or the alignment between disclosed CSR commitments and independently verifiable outcomes (Al-Amin & Rahman, 2023). Future research incorporating disclosure quality or assurance status as moderating variables may help clarify the boundary conditions under which CSR integration becomes value-relevant.

2. The Strong Effect of Non-Financial KPIs on Firm Value

In contrast, Non-Financial KPIs exhibit a positive and statistically significant effect on firm value ($\beta = 0.0060$, $p = 0.029$), supporting H2 and reinforcing the theoretical distinction between disclosure-based CSR measures and performance-based non-financial indicators. This finding is consistent with prior studies suggesting that operationally embedded metrics-such as energy efficiency, emission intensity, and workforce safety-carry stronger value-relevance because they are more directly tied to a firm's cost structure, risk profile, and operational resilience (Kusumawati & Hartono, 2022; Susanti et al., 2024; Janicka & Sajnóg, 2025).

From a signaling theory perspective, non-financial KPIs may function as a more credible signal because they are typically subject to internal management control systems and, in many jurisdictions, increasing external verification requirements, making them more costly to misrepresent than narrative CSR disclosure (Widianto & Ramadhan, 2022). For renewable energy firms specifically, strong non-financial KPI performance may also directly correlate with core operational efficiency-for instance, higher energy conversion efficiency directly affects revenue generation-creating a more mechanistic link to firm value beyond pure signaling effects (Nasution & Lubis, 2023). This pattern is not unique to Southeast Asian or emerging-market samples: evidence from European and North American settings similarly indicates that verifiable, performance-based sustainability metrics are priced more consistently by capital markets than voluntary narrative disclosure, and that the credibility gap between the two widens precisely when disclosure is unaccompanied by independently verifiable operational data (Clarkson et al., 2021; Hummel & Schlick, 2021). The convergence of findings across otherwise very different institutional and regulatory contexts suggests that the disclosure-performance distinction identified in this study reflects a structural feature of how capital markets process sustainability information generally, rather than a peculiarity of the renewable energy sector or of emerging-market governance conditions.

3. Control Variables

The negative and significant coefficient on Leverage ($\beta = -0.181$, $p = 0.010$) is consistent with capital structure theory suggesting that higher financial risk depresses firm valuation, particularly relevant for capital-intensive renewable energy projects that already carry substantial project financing risk (Baltagi, 2021). The positive and highly significant coefficient on ROA ($\beta = 1.395$, $p = 0.000$) confirms the well-established finding that profitability is a primary driver of firm value (Nuryanti et al., 2022; Widyawati & Suryani, 2023). Firm Size shows a positive but statistically insignificant relationship with

firm value in this sample, suggesting that, within the renewable energy sector, scale alone does not guarantee a valuation premium, possibly because smaller, more agile renewable energy firms can also attract strong investor interest due to growth potential (Gujarati & Porter, 2022).

4. Theoretical and Practical Implications

Theoretically, this study contributes to the CSR-firm value literature by empirically disentangling the differential value-relevance of disclosure-based CSR integration versus performance-based non-financial KPIs, an important refinement given that many prior studies treat sustainability performance as a single undifferentiated construct. The results suggest that stakeholder and signaling theory predictions hold more strongly for verifiable operational metrics than for general disclosure indices, at least within the renewable energy sector context examined here.

Practically, the findings suggest that renewable energy firms seeking to enhance firm value through sustainability strategy should prioritize the substantive integration of non-financial KPIs into operational management-such as energy efficiency programs, emission reduction targets, and workforce safety systems-rather than relying primarily on expanding the volume or breadth of CSR disclosure. For regulators and standard-setters, the results underscore the importance of developing verification mechanisms for non-financial KPI reporting to preserve their informational credibility as they become more central to firm valuation. These implications translate into concrete actions for three groups of stakeholders. For CEOs and chief sustainability officers, the results suggest that capital allocated to sustainability should be directed first toward measurable operational programs, such as energy-efficiency retrofits, emission-reduction targets tied to executive compensation, and workforce safety systems, before further expanding the volume of narrative CSR disclosure, since the latter shows no statistically significant payoff in firm value once operational performance is accounted for. For regulators and standard-setters, the results support prioritizing mandatory third-party assurance requirements for non-financial KPI reporting over further expanding voluntary disclosure checklists, since assurance is what makes performance-based metrics costly to misrepresent and therefore credible to markets. For investors and analysts, the results indicate that portfolio screening or engagement strategies in the renewable energy sector should weight operationally verifiable KPI performance more heavily than the breadth of a firm's sustainability disclosure, since disclosure breadth alone is not a reliable proxy for the underlying sustainability performance that is actually priced by the market in this sample.

CONCLUSIONS

This study examines the effect of CSR Integration and Non-Financial KPIs on firm value among 30 publicly listed renewable energy firms over the 2020-2024 period, using panel data regression with the Random Effects model selected through Chow and Hausman test procedures. The results indicate that Non-Financial KPIs have a positive and statistically significant effect on firm value, while CSR Integration has a positive but statistically insignificant effect. Leverage is negatively associated with firm value, and profitability (ROA) is positively associated with firm value.

These findings suggest that capital markets in the renewable energy sector place greater value-relevance on verifiable, operationally embedded non-financial performance metrics than on the breadth of CSR disclosure alone. Theoretically, the study refines stakeholder and signaling theory by showing that these predictions hold more strongly for performance-based indicators than for disclosure-based ones. Practically, renewable energy firms should prioritize investment in measurable operational

sustainability programs over expanding disclosure volume, while regulators should prioritize assurance mechanisms that make non-financial KPI reporting costly to misrepresent.

This study is subject to several limitations. First, the sample is limited to 30 firms over five years, which, while adequate for panel regression, may limit the generalizability of findings to the broader global renewable energy industry, particularly firms in jurisdictions with markedly different regulatory environments. Second, the CSR Integration and Non-Financial KPI indices are constructed as composite measures, which, despite being grounded in established frameworks such as GRI Standards, may not fully capture the multidimensional nature of sustainability performance. Third, this study does not incorporate disclosure quality, external assurance status, or corporate governance characteristics as moderating variables, which prior literature suggests may condition the CSR-firm value relationship.

Future research is encouraged to extend this study by incorporating a larger and more geographically diverse sample, employing dynamic panel estimators (such as the Generalized Method of Moments) to address potential endogeneity between sustainability performance and firm value, and examining moderating variables such as assurance quality, board sustainability expertise, and institutional ownership. Comparative studies across renewable energy sub-sectors, and between renewable and conventional energy firms, would also enrich understanding of how sustainability integration is differentially valued across the energy industry.

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APPENDIX A. LIST OF SAMPLE FIRMS

Note: Firm identities are anonymized as RE-01 to RE-30 to preserve the confidentiality arrangements under which several firms' internal sustainability report data were obtained (see Section 3.1). Sub-sector and listing status are reported to allow assessment of sample composition and representativeness.

Firm Code	Sub-sector	Stock Exchange Listing Status
RE-01	Solar	Main Board
RE-02	Solar	Main Board
RE-03	Solar	Main Board
RE-04	Solar	Main Board
RE-05	Solar	Main Board
RE-06	Solar	Main Board
RE-07	Solar	Main Board
RE-08	Wind	Main Board
RE-09	Wind	Main Board
RE-10	Wind	Main Board
RE-11	Wind	Main Board
RE-12	Wind	Main Board
RE-13	Wind	Main Board
RE-14	Hydro	Main Board
RE-15	Hydro	Main Board
RE-16	Hydro	Main Board
RE-17	Hydro	Main Board
RE-18	Hydro	Main Board
RE-19	Hydro	Main Board
RE-20	Bioenergy	Main Board
RE-21	Bioenergy	Main Board
RE-22	Bioenergy	Main Board
RE-23	Bioenergy	Main Board
RE-24	Bioenergy	Main Board
RE-25	Bioenergy	Development Board
RE-26	Geothermal	Development Board
RE-27	Geothermal	Development Board
RE-28	Geothermal	Development Board
RE-29	Geothermal	Development Board
RE-30	Geothermal	Development Board