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THE ROLE OF RENEWABLE ENERGY IN ACHIEVING SUSTAINABLE ECONOMIC GROWTH

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Abstract
Indonesia must transition to sustainable economic development immediately, given the problems of climate change and environmental degradation caused by carbon dioxide (CO2) emissions. This study investigates the impact of renewable energy use on sustainable economic growth in Indonesia. This research used a quantitative method and secondary data from 2010-2024 from the World Bank and the Green Growth Index. The analysis used a simple linear regression. The results demonstrate that renewable energy plays a vital role in achieving sustainable economic development. Increasing renewable energy consumption will reduce carbon emissions and encourage sustainable economic growth, thereby enhancing sustainable development in Indonesia. These findings underscore the importance of policy consistency in advancing the energy transition to renewable sources and balancing economic growth with environmental preservation in Indonesia. This study also has practical implications for national energy policy. This underscores the significance of sustainable economic and environmental strategies.
Keywords*: renewable energy, carbon emissions, sustainable economic growth, simple linear regression, sustainable development.*

1. Introduction

Climate change and environmental degradation are currently becoming increasingly serious global challenges. One of the main factors driving these problems is the increase in carbon dioxide (CO_2) emissions generated by industrial activity and the use of fossil-based energy. Environmentally unfriendly energy consumption can worsen environmental conditions and hinder sustainable development (Bhuiyan et al., 2022).

Within the framework of sustainable development, energy plays a very important role as a primary driver of economic activity. However, dependence on fossil energy not only harms the environment but also increases the risk to long-term economic sustainability. Therefore, a transition to cleaner, more sustainable energy sources is needed (Xie et al., 2023).

Indonesia has considerable potential to enable sustainable economic growth and minimise dependence on fossil fuels by utilising renewable energy (Firmansyah et al., 2024). Renewable energy also positively impacts the economy by creating jobs, increasing added value, and contributing to Gross Domestic Product (GDP). Increased investment and the use of renewable energy technology offer a chance to improve national energy security and promote more environmentally sustainable economic growth.

In this case, implementing renewable energy in Indonesia still faces numerous barriers. Major challenges include high initial investment costs, reliance on fossil energy subsidies, and inconsistent policy execution. This results in a relatively low share of renewable energy in overall national energy consumption (Solikah & Bramastia, 2024).

Relatedly, increased industrial activity is also a substantial contributor to carbon emissions. High carbon emissions from the industrial sector may hinder sustainable economic growth. Hence, a strategy is needed to reconcile economic growth and environmental preservation through a green growth approach.

Moreover, renewable energy use is positively related to and helps achieve sustainable

economic development. This implies that deploying renewable energy is not only beneficial to the environment but also conducive to stronger economic growth. The transition to renewable energy is a deliberate move toward achieving sustainable development.

Based on the above description, it is vital to study the effect of renewable energy consumption on sustainable economic growth. The analysis uses time series data for the period 2010-2024. The study provides an empirical picture of the interaction between factors and supports the creation of a sustainable energy strategy. This work is expected to contribute to the literature on sustainable economics and be used as a reference to promote more targeted policy formation, especially in boosting the use of clean energy and regulating carbon emissions.

2. Research Methods

2.1 *Research Design*

This study uses a quantitative approach to analyse the relationship between renewable energy use and sustainable economic growth in Indonesia. The research steps include methodical data collection, processing, and analysis using appropriate statistical techniques. The data are sourced from a reliable organisation (World Bank), ensuring high validity and trustworthiness. The data are processed according to the study objectives to ensure accurate and objective results.

2.2 *Data and Data Sources*

The current analysis employs secondary time-series data for the observation period between 2010 and 2024. Secondary data were selected since they come from official entities whose legitimacy and validity have been verified, supporting the research analysis objectively and properly. The data sources for this analysis were the World Bank and the Green Growth Index, both of which provide detailed data on economic and environmental indices. The data used are sustainable economic growth (green growth) and renewable energy usage.

Table 1. Data Source Description

Variable	Name	Description	Expected sign	Source
LGG	Green Growth	The role of government in formulating and implementing policies related to the environment. In this study, green growth data is expressed in natural logarithms.	-	Green Growth Index
LRET	Renewable Energy Consumption	The use of energy derived from renewable sources within a country. In this study, renewable energy consumption data is expressed in natural logarithms.	Positive	World Bank

Source: Research data, processed by the authors (2026)

2.3 *Data Analysis Technique*

The data analysis technique used in this study is based on grouping the research variables, along with their explanations, descriptions, and data sources. The variables used are green growth (LGG) as an indicator of sustainable economic growth and renewable energy consumption (LRET), which reflects the level of energy use from renewable sources associated with emissions from economic activity. Each variable is explained operationally to facilitate the analysis process, with data sourced from trusted institutions to support accurate and relevant research results.

2.3.1 Classical Assumption Test

The classical assumption test is an important stage for interpreting and validating the analysis model (Hutagaol, 2025). The purpose of this classical assumption test is to ensure that the resulting regression equation is estimated accurately, free from bias, and optimally consistent (Sholihah et al., 2023). Therefore, to ensure the results were accurate and trustworthy, a classical assumption test was conducted to meet the BLUE standards. This involved checking for heteroscedasticity and autocorrelation. As a result, the analysis results held up and were considered valid and reliable.

Heteroscedasticity Test: The heteroscedasticity test was carried out using the Breusch-Pagan-Godfrey method to determine whether the variance of the residuals in the regression model is constant. The testing process compared the Obs*R-Squared probability value with the predetermined significance level of $\alpha = 5\%$ (Rizki et al., 2023). A good regression model does not experience heteroscedasticity. If the Heteroskedasticity Test: Breusch-Pagan-Godfrey probability value is > 0.05, it can be concluded that there is no heteroscedasticity problem in the regression model, meaning that the model satisfies the assumption of homoscedasticity.

Autocorrelation Test: The autocorrelation test aims to determine whether there is a relationship between the residuals in the current period (t) and the residuals in the previous period (t-1) in the regression model. A good regression model is free from autocorrelation because the residuals must be independent across time. The test was carried out using the Breusch-Godfrey Serial Correlation LM Test, which aims to determine whether residuals are correlated across periods (Azielia & Darmawati, 2026). If the probability value of the Breusch-Godfrey Serial Correlation LM Test is > 0.05, it can be concluded that there is no autocorrelation in the regression model, meaning that the residuals across periods are not correlated with one another.

2.3.2 ***Simple Linear Regression***

Simple linear regression is a statistical method used to examine the extent of the causal relationship between a predictor variable and its response variable. The causal factor is generally denoted by X, or also referred to as the Predictor, while Y denotes the resulting variable, or also referred to as the Response. Simple linear regression is also a statistical method used in production to forecast or predict qualitative or quantitative characteristics (Ningsih et al., 2024).

The data in this study are presented numerically and analysed using simple linear regression. The data are sourced from the Green Growth Index and the World Bank and therefore fall into the category of secondary data. These quantitative data allow for a more systematic and measurable analysis of the relationship between the research variables.

The purpose of this method is to determine whether there is an effect of the independent variable on the dependent variable, as expressed in the following formula:

$$LGG_t = \beta_0 + \beta\ LRET_t + \varepsilon_t$$

Where: LGG_t is Sustainable Economic Growth in period t, β_0 is the constant, β is the regression coefficient of the independent variable, $LRET_t$ is Renewable Energy Consumption in period t, and ε is the error term.

This study uses data on sustainable economic growth for the years 2010–2024. The data are sourced from the Green Growth Index and World Bank renewable energy consumption data. The independent variable is renewable energy consumption, and the dependent variable is Green Growth.

2.3.3 *Hypothesis Testing (t-Test)*

The t-test is used to determine the effect of the independent variable on the dependent variable. The t-test examines the extent to which renewable energy consumption partially affects green growth by comparing the calculated t-value with the t-table value or the significance value. This test aims to assess whether the independent variable has a significant effect within the regression model (Zuhriadi, 2026). The hypotheses are H_0, which states that renewable energy consumption has no significant effect on green growth, and H_a, which states that it does. The decision-making criteria are based on the p-value: if $p < 0.05$, H_0 is rejected; if $p > 0.05$, H_0 cannot be rejected.

3. Research Findings and Discussion

3.1 *Results*

This section presents the results of the data analysis and the empirical interpretation regarding the effect of the independent variable on the dependent variable. The method used is a quantitative approach with a simple linear regression model, which aims to explain the role of the independent variable in predicting the dependent variable. Through this analysis, it is expected that a clearer picture can be obtained regarding the direction and strength of the relationship between the variables under study.

3.1.1 *Descriptive Statistics*

Descriptive statistics is a way to examine data and understand what it tells us. It helps us summarise and describe the data without drawing big conclusions (Maharani & Merina, 2025). This type of analysis shows us what the data looks like, without trying to interpret what it means. By using descriptive statistics, we can get a sense of what's going on with the data we've collected and see what's typical for each variable we're studying. It's like taking a snapshot of the data to see what it looks like, and it can help us identify patterns or trends worth exploring further.

Table 2. Descriptive Statistics Results

	LGG	LRET
Mean	3.867166	1.86062
Median	3.852910	1.759581
Maximum	3.970669	2.405142
Minimum	3.827554	1.266948
Std. Dev.	0.037527	0.443586
Skewness	1.368837	-0.006833
Kurtosis	4.762549	1.367696
Jarque-Bera	6.625902	1.665376
Probability	0.036409	0.434879
Sum	58.00749	28.03593
Sum Sq. Dev.	0.019716	2.754757
Observations	15	15

Source: Data processed by the authors (2026)

Based on the descriptive statistics in Table 2, the sustainable economic growth variable (LGG) has a mean of 3.867166% and a median of 3.852910%, indicating that the data distribution is centred around this value, with some values below and some above the median. The maximum LGG value is 3.970669%, and the minimum is 3.8275%. In comparison, the standard deviation of 0.037527% indicates relatively low dispersion, so the data tend to be stable. Meanwhile, the renewable energy consumption variable (LRET) has a mean of 1.86062%, a median of 1.759581%, a maximum of

2.405142%, and a minimum of 1.266948%. The standard deviation of LRET (0.443586%) indicates that this variable has greater variation than LGG. Overall, LGG tends to be more stable than LRET, and the relatively small difference between the mean and median values for both variables indicates that the data distribution is relatively normal, without significant skewness.

3.1.2 *Classical Assumption Test Results*

The heteroscedasticity test examines whether the variance of the residuals is constant across the entire range of values of the independent variable; if it is not constant, the estimation becomes biased and inefficient.

Table 3. Heteroscedasticity Test Results

Heteroscedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoscedasticity			
F-statistic	0.069530	Prob. F(1,13)	0.7963
Obs*R-Squared	0.079800	Prob. Chi-Square(1)	0.7776
Scaled explained SS	0.286596	Prob. Chi-Square(1)	0.5924

Source: Research data, processed by the authors (2026)

Based on the results presented in Table 3 above, the Obs*R-Squared probability value is 0.079800 (> 0.05); therefore, the heteroscedasticity assumption is satisfied, and the data pass the heteroscedasticity test.

The autocorrelation test is a classical assumption test in linear regression and aims to detect correlation between residuals across periods.

Table 4. Autocorrelation Test Results

Breusch-Godfrey Serial Correlation LM Test			
Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	0.493092	Prob. F(2,11)	0.6236
Obs*R-Squared	1.234150	Prob. Chi-Square(2)	0.5395

Source: Research data, processed by the authors (2026)

Based on the results presented in Table 4 above, the Obs*R-Squared value of 1.234150 has an associated probability greater than 0.05, so it can be concluded that the assumption of no autocorrelation is satisfied.

Simple Linear Regression is used to analyse the effect of the independent variable on the dependent variable. This method is used to make predictions or estimates of a value, whether qualitative or quantitative. The results show that LRET has a positive and significant effect on LGG, as indicated by a probability value of 0.0396, which is below the 0.05 significance threshold.

Table 5. Simple Linear Regression Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.782466	0.037993	99.55592	0.0000
LRET	0.045317	0.019813	2.287182	0.0396
R-squared	0.286937	Mean dependent var		3.867166
Adjusted R-squared	0.232086	S.D. dependent var		0.037527
S.E. of regression	0.032885	Akaike info criterion		-3.868024
Sum squared resid	0.014059	Schwarz criterion		-3.773617
Log likelihood	31.010118	Hannan-Quinn criter.		-3.869029
F-statistic	5.231204	Durbin-Watson stat		1.985504
Prob(F-statistic)	0.039589			

Source: Research data, processed by the authors (2026)

These results indicate a positive and significant effect of renewable energy consumption (LRET) on sustainable economic growth (LGG). The coefficient value of 0.045317 indicates that every increase in renewable energy will be followed by an increase in sustainable economic growth, assuming other variables remain constant. The significance of this relationship is reinforced by the probability value of 0.0396 < 0.05, which means that the LRET variable has a statistically significant effect on LGG. In addition, the t-statistic value of 2.287182, which is greater than the t-table value, also indicates that this effect can be accepted empirically.

More broadly, the findings suggest that greater dependence on renewable energy can promote higher-quality and more sustainable economic growth. This is because renewable energy not only reduces negative environmental impacts but also improves energy efficiency and creates new economic opportunities. Renewable energy is therefore one of the main variables in promoting sustainable economic development.

3.2 *Discussion*

Based on the simple linear regression results, the LRET variable has a positive coefficient of 0.045317 with respect to LGG. This finding indicates that an increase in the use or contribution of renewable energy is associated with an increase in sustainable economic growth. In other words, the effect of renewable energy on economic growth is unidirectional (positive), indicating that the higher the utilization of renewable energy, the better the quality of economic growth achieved. This is consistent with the concept of sustainable development, which stresses the importance of balancing economic progress, environmental protection, and social welfare.

In fact, renewable energy is employed in many forms, for example, biodiesel as a replacement for diesel fuel, solar energy via photovoltaic panels, and wind and hydro power to generate electricity. For instance, biodiesel decreases dependence on fossil fuels, but it also stimulates economic activity in the agricultural and raw material processing sectors, generating a multiplier impact in the economy. Conversely, fossil energy use such as coal and petroleum tends to generate negative externalities, including environmental pollution, natural resource degradation, and increased greenhouse gas emissions, which can hinder the sustainability of development in the long term (Wuri et al., 2024).

The test results show that the LRET variable has a positive and significant effect on LGG, with a probability value of 0.0396, which is below the 5% significance level. This indicates that an increase in renewable energy has a statistically significant contribution to sustainable economic growth. Theoretically, this can be explained by renewable energy's ability to increase energy-use efficiency, reduce environmental costs, and create new economic opportunities, such as job creation in the renewable energy sector and innovation in environmentally friendly technology. Increased utilisation of renewable energy therefore not only impacts the

environment but also provides sustainable economic benefits.

These findings align with Khoirunnisa et al. (2024), who explain that the utilisation of renewable energy helps reduce carbon emissions and is significantly related to economic variables, thereby supporting more sustainable development. Solikah & Bramastia (2024) also explain that renewable energy has great potential to support sustainable economic development by increasing energy security and reducing dependence on fossil fuels. These results support the empirical findings that the rising use of renewable energy is one of the main drivers of sustainable economic growth in Indonesia, either through energy efficiency, reduced environmental consequences, or the creation of new economic opportunities.

However, the coefficient of determination (R^2) of 0.286937 implies that renewable energy explains only a moderate share of the variation in sustainable economic growth. Thus, while renewable energy has an important impact, many other elements not included in the model also affect economic growth, such as fiscal and monetary policy, investment levels, technological progress, and the state of the global economy. The comparatively low value of Adjusted R^2 also implies that this research model is still limited in properly capturing the complexity of the interaction between variables.

Classical assumption testing shows that the regression model meets the required criteria. The heteroscedasticity test reveals that residual variance is constant and there is no bias in the estimation. Moreover, the autocorrelation test shows no correlation between residuals; therefore, the model does not suffer from autocorrelation. These assumptions are met, so the regression model is appropriate and the estimation results can be trusted.

The findings of this study generally validate the favourable and considerable contribution of greater utilisation of renewable energy, such as biodiesel, solar energy, wind energy, and hydropower, in supporting sustainable economic growth. Conversely, dependence may be detrimental to economic sustainability because of its environmental impact and the limited availability of resources. Therefore, renewable energy development should be supported through suitable regulations, greater investment, and technological innovation to build a more sustainable, efficient, and environmentally friendly economic system in the future.

4. Conclusion

This study shows that the utilisation of renewable energy plays an important role in driving sustainable economic growth. Based on the simple linear regression results, the renewable energy variable has a positive and significant effect on sustainable economic growth. These findings indicate that a linear increase in renewable energy utilisation can improve the quality of economic growth in line with the principles of sustainable development. These results also confirm the importance of policies that support increased investment and the use of renewable energy in Indonesia.

The model's credibility is supported by the fulfilment of all classical assumption criteria, so the estimation model can be categorised as a Best Linear Unbiased Estimator (BLUE). Theoretically and practically, these findings reinforce the urgency of the energy transition from fossil-based resources to renewable energy, such as biodiesel, solar, wind, and hydropower. This structural transformation not only mitigates negative environmental externalities but also creates economic value through increased energy efficiency and new economic opportunities. In addition, this energy transition also has the potential to increase national economic competitiveness in facing global challenges related to climate change.

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