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The Influence of Renewable Energy, Carbon Emissions, and Foreign Direct Investment on Indonesia's Economic Growth 2011 - 2020

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Abstract

Research aim: *This research aims to analyze the influence of the Green Economy concept on Indonesia's economic growth from 2011 to 2020, focusing on three main pillars: environmental, social, and economic.*

Approach: *This research uses a quantitative approach with an associative design, analyzing secondary time series data from 2011 to 2020. Multiple linear regression analysis was used to examine the effect of carbon emissions (CO_2), renewable energy consumption, and Foreign Direct Investment (FDI) on economic growth as measured by Gross Domestic Product (GDP).*

Research Finding: *The study's results show that simultaneously, carbon emissions, renewable energy, and FDI significantly influence Indonesia's economic growth. However, these three variables did not show a significant effect. Dependence on fossil energy (carbon emissions) still contributes to economic growth. In contrast, the transition to renewable energy and an increase in FDI have not significantly impacted the period.*

Theoretical contribution/Originality: *This research contributes to understanding the complexity of the relationship between Green Economy indicators and economic growth in developing countries such as Indonesia, particularly highlighting the challenges of energy transition and the role of foreign investment in sustainability.*

Practical/Policy Implications: *This research implies the need for more comprehensive and long-term policies to integrate Green Economy principles into Indonesia's economic development strategy. Efforts are needed to accelerate the renewable energy transition and ensure foreign investment supports sustainable development.*

Research limitation: *This research is limited to the 2011-2020 time period and only considers three independent variables. Other factors affecting economic growth and long-term policy dynamics are not covered.*

Keywords: Economic Growth, Carbon Emissions, Renewable Energy, Foreign Direct Investment (FDI)

1. Introduction

Environmental degradation, pollution, and biodiversity loss are often considered inevitable consequences of economic growth. However, since the 1992 UN conference on Environment and Development with the main objective of protecting the environment and climate, these issues have increasingly taken center stage in global economic policy [1]. In response to this challenge, economists and policy makers introduced the concept of the Green Economy as an alternative approach that allows for increased prosperity while considering environmental limitations [2].

Realizing this concept is not easy because it still must support a country's economic growth. Low-emission development is expected to improve people's welfare without compromising environmental quality. Economic growth itself is an important aspect of macroeconomic studies and is a major concern of many parties, including politicians, scientists and researchers [3]. This is due to its association with various social, economic and environmental issues, such as poverty, inequality, slowing growth, as well as the negative impacts of climate change and environmental pollution. A country is said to have good economic growth if its growth rate is higher than its population growth rate, as this will have an impact on increasing per capita income and people's welfare. However, not all countries are able to achieve the expected level of economic growth [4]. The global economic crisis that has occurred since the beginning of 2020 has also exacerbated the challenges of economic growth for many countries [5].

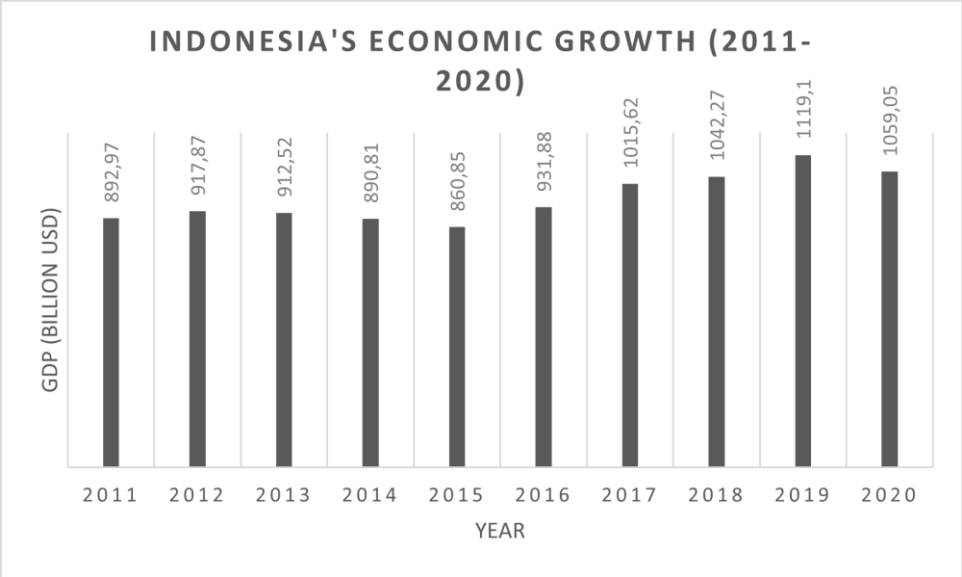

Figure 1. GDP of Indonesia Year 2011-2020
Source: World Bank (2025)

Annual Gross Domestic Product (GDP) growth (%) in Indonesia shows a mixed trend. In the period 2011 to 2015, economic growth appeared to be stagnant, with modest increases

and some slight decreases. Meanwhile, in the period 2016 to 2019, Indonesia's economic growth showed an increase before finally experiencing a decline in 2020 due to global economic challenges. The data reflects the dynamics of the Indonesian economy, which is not only faced with growth challenges, but also with ongoing economic risks, such as political instability, climate change, monetary constraints, global market uncertainty, and social and health crises triggered by the COVID-19 pandemic.

To address these challenges, it is important to consider the concept of a Green Economy, which is aligned with the principles of long-term sustainable development. The advantage of this approach lies in its holistic nature, which includes three main pillars: economic, social and environmental, and focuses on intergenerational balance [6]. This paradigm emphasizes the importance of wise use of natural resources to reduce poverty, create decent and environmentally friendly jobs, and consider environmental costs in every development process to ensure sustainable economic growth [7].

The Green Economy concept is rooted in three main pillars: environmental, social and economic. This study aims to analyze the influence of the Green Economy on Indonesia's economic growth through these three pillars. Each research indicator will be explained in this study, where the green economy variable is represented by carbon emissions (CO_2), renewable energy consumption, and Foreign Direct Investment (FDI). Meanwhile, economic growth is measured using Gross Domestic Product (GDP).

The relationship between CO_2 emissions, energy consumption and economic growth is complex, as rapid economic growth often leads to increased energy consumption, which in turn leads to higher CO_2 emissions. This is a major concern as increased CO_2 emissions can have significant negative impacts on the environment and human health [8]. However, many countries are still reluctant to reduce environmental pollution because they fear it will hamper economic growth and reduce potential income. In other words, greater energy use, despite its impact on high CO_2 emissions, is considered necessary to maintain economic growth [9].

Carbon emissions generated from various human economic activities, such as industrial activities, transportation, and the use of fossil fuels, have become one of the main issues in the discussion of sustainable economic growth. Indonesia, as a country with a high dependence on the use of natural resources in various sectors, has its own challenges in managing carbon emissions to achieve sustainable economic growth. Theoretically, economic growth is directly proportional to increased energy consumption [10]. The more industrialization activities that occur in a country, the more energy is needed, where most of the energy used is in the form of fossil fuels. This will increase the amount of carbon emissions that affect the environment and economic stability in the long term [11].

Based on data published by the Emission Database For Global Atmospheric Research (EDGAR) [12], greenhouse gas emissions produced by Indonesia have increased by 38, 77%

during 2013-2020, where Indonesia's greenhouse gas production amounted to 864.85 mt CO2eq / year, while in 2023 there was an increase at 1200.20 mt CO2eq / year, this large greenhouse gas production places Indonesia as one of the 10 largest greenhouse gas producing countries. Based on a report published by the Think Tank Energy Institute entitled Statistical Review of World Energy 2024, emissions from the energy sector in Indonesia in 2023 reached 701.4 million tons of CO2 equivalent, placing Indonesia in 6th place as a greenhouse gas emitter in the energy sector. Of the total carbon dioxide production, data in the 2020 Energy Sector Greenhouse Gas Emissions Inventory report published by the Indonesian Ministry of Economy and Mineral Resources (ESDM) shows that among the sectors that contribute the most carbon emissions are the energy sector at 43.83%, transportation at 24.64%, and manufacturing and construction at 21.46% [13]. The high carbon emissions generated from these main sectors will have various impacts, one of which is providing economic costs due to climate change, where these impacts can hamper economic growth in the long term if not balanced with the formation of appropriate policies [14].

In addition to carbon emissions, FDI also has an important influence on Indonesia's economic growth by providing funding for infrastructure development, industrial capacity building, and job creation. This foreign investment will provide financial capital, technology and innovation that will boost production efficiency and economic competitiveness. However, due to its profit-oriented nature, it will be a challenge for the transition to sustainable economic development, especially for Indonesia as a developing country. [15][16] in their research stated that FDI inflows can contribute to an increase in carbon dioxide emissions in the short term, which supports the pollution haven hypothesis, also FDI dependence on the primary sector is positively related to total CO2 emissions in developing countries. Carbon-intensive sectors or those that are the highest contributors to Indonesia's greenhouse gas emissions, such as the energy, transportation, manufacturing, and mining sectors, are the main sectors that dominate FDI receipts. These sectors are highly dependent on extractive-based industries and fossil energy. Based on a report published by the International Renewable Energy Agency (IRENA), Indonesia has great potential in renewable energy by becoming the second country with the largest renewable energy capacity in the Southeast Asia region in 2022 with renewable energy capacity reaching 12,603 MW in 2022 which is dominated by hydropower plants (PLTA) or hydropower which reaches 6,689 MW. However, despite the huge potential, the realization of investment and utilization of this new renewable energy sector is still minimal and not optimal.

To optimize investment in new renewable energy, the Indonesian government has prepared several regulations in the form of incentives, one of which is incentives provided in the development of new renewable energy power plants. This is contained in the Financial Notebook of the Draft State Budget (RAPBN) 2025. The policy prepared by the government is in the form of the formation of a comprehensive taxation policy both in terms of taxation, spending, and financing. The form of the policy is to provide import duty exemption, import VAT exemption, tax allowance, tax holiday, import VAT exemption, and Income Tax DTP for

the development of renewable energy power plants. The combination of the right investment policies, incentives for renewable energy, and strict enforcement of regulations on high-emission industries can be a solution in balancing economic growth with environmental sustainability in the future.

Energy is a major factor in economic growth and is considered a fundamental element in a country's development [17]. Renewable energy is seen as a strategic commodity and one of the key indicators in economic growth and sustainable development. Renewable energy sources include solar, wind, tidal, waste and biomass. These energies are known to be more environmentally friendly and cost-effective, as they can help mitigate the effects of climate change, reduce pollution, improve energy security, and support poverty alleviation by providing electricity in remote areas [18]. Indonesia, as one of the countries with rapid economic growth, has great potential in renewable energy development. Thus, energy consumption in Indonesia continues to increase along with the development of the industrial sector and population.

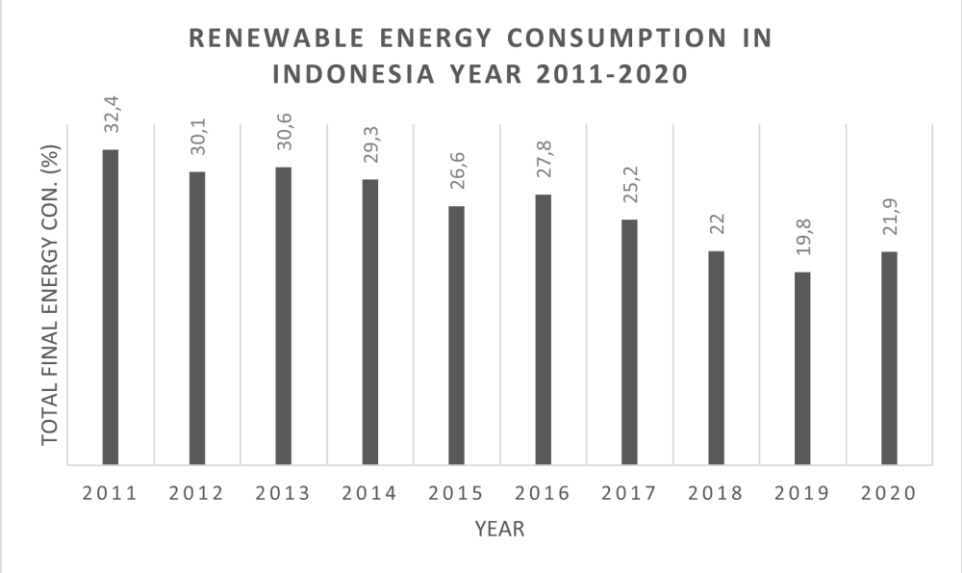

Figure 2. Renewable Energy Consumption in Indonesia Year 2011-2020
Source: World Bank (2025)

In 2019, renewable energy use in Indonesia only reached 19.8% of total energy consumption. This shows that Indonesia is still highly dependent on conventional fossil-based energy.

Efforts to achieve net-zero emission in Indonesia require a commitment that is not only limited to the budget aspect but also includes various strategic policies. The Government of Indonesia is encouraged to take concrete steps to curb the increase in emissions, as the impact on climate change is increasingly evident. Uncontrolled climate change can threaten public

safety and health. It is estimated that by 2030, the threat of climate change could reduce Indonesia's GDP by up to 3.45%, a considerable figure that cannot be ignored [19]. Therefore, quick and effective mitigation measures are needed. The government and various stakeholders must act immediately to reduce emissions and ensure greener and more sustainable economic development.

This study aims to analyze the extent to which the implementation of the Green Economy concept affects economic growth in Indonesia, using data from 2010 to 2020. Through a better understanding of the relationship between the green economy and key economic indicators, it is hoped that more effective strategies can be found to achieve sustainable and inclusive economic growth.

1.1. Statement of Problem

a. Does renewable energy variable significantly influence Indonesia's economic growth?
b. Does the carbon emission variable have a substantial effect on Indonesia's economic growth?
c. Does the FDI variable significantly contribute to Indonesia's economic growth?
d. Do the variables of renewable energy, carbon emissions, and FDI simultaneously have a significant impact on Indonesia's economic growth?

1.2. Research Objectives

a. Examine the impact of renewable energy factors on Indonesia's economic growth.
b. Assess the effect of carbon emission factors on Indonesia's economic growth.
c. Investigate the role of foreign direct investment (FDI) factors in Indonesia's economic growth.
d. Evaluate the combined impact of renewable energy, carbon emissions, and foreign direct investment (FDI) on Indonesia's economic growth.

2. Method

This study uses quantitative research with an associative technique to discover the causal relationship between two or more variables [20]. This analysis uses secondary data in the form of time series from 2011 to 2020 which includes data on economic growth, renewable energy, carbon emissions, and FDI. The data for this study were gathered from Badan Pusat Statistik (BPS) Indonesia and the World Bank. The data collection technique in this study uses the documentation method and literature study. The documentation method is carried out by collecting secondary data that has been published by Badan Pusat Statistik (BPS) Indonesia and the World Bank regarding the variables studied. Meanwhile, the literature study method was carried out to obtain information through books, journals and the internet in strengthening knowledge related to the research conducted.

This study's data analysis technique is multiple linear regression analysis, which is used to analyze the impact of renewable energy factors, carbon emissions, and foreign direct investment on economic growth. The multiple linear regression model can be written as follows:

$$Y = a + B_1X_1 + B_2X_2 + B_3X_3 + \mu$$

Description:

Y = Economic Growth (USD)
$B_1B_2B_3$ = Regression Coefficient
X1 = Renewable Energy (Percent)
X2 = Carbon Emissions (Metric tons per capita)
X3 = FDI (Percent)
m = Error

After multiple linear regression testing, the model is subjected to the standard assumption testing procedures, including autocorrelation, heteroscedasticity, multicollinearity, and normality tests. This classic assumption test ensures that the results of the tests can be used and do not contain bias.

3. Results and Discussion

Statistical Description of Variables

The statistical description of the variables includes the mean, highest observed value, lowest observed value, and standard deviation for each variable. The following are the results of the statistical description:

Table 1. Statistical Description of Variables

Variable	Observation	Mean	Maximum	Minimum	Standard Deviation
Economy Growth	10	964.29	1119.10	860.85	924.88
Renewable Energy	10	26.57	32.40	19.80	27.20
Carbon Emissions	10	1.97	2.25	1.77	1.93
FDI	10	2.06	2.82	0.49	2.27

Source: Output EViews 12

Classical Assumption Test

Normality Test

The normality test is carried out to see whether the variables in the study are normally distributed or not with the provision that if the probability value is greater than the alpha significance level of 0.05, the data is declared normally distributed.

Table 2. Normality Test Result

Jarque-Bera	1.389635
Probability	0.499166

Source: Output EViews 12

The normality test results showed that the probability was 0.499 > 0.05, so it can be concluded that the residuals are normally distributed.

Multicollinearity Test

The multicollinearity test is intended to identify the relationship between independent variables.

Table 3. Multicollinearity Test Result

Variable	Coefficient Variance	Uncentered VIF	Centered FIV
C	291165.1	1544.596	NA
X1	47.32260	181.2943	4.068391
X2	39334.58	810.3764	3.852795
X3	611.8394	15.00068	1.173541

Source: Output EViews 12

From the VIF test results, centered VIF value of carbon emissions, renewable energy, and FDI < 10, it can be concluded that carbon emissions, renewable energy, and FDI have low multicollinearity, or the data does not exhibit multicollinearity.

Heteroscedasticity Test

The heteroscedasticity test detects whether the variance of the residuals is constant for all observation variables. This test is carried out using the Glejser method, provided that if the Chi-Square probability value is greater than the alpha level of 0.05, the model is free from heteroscedasticity problems.

Table 4. Heteroscedasticity Test

F-statistic	4.405539	Prob. F (3,6)	0.0582
Obs*R-squared	6.877702	Prob. Chi-Square (3)	0.0759
Scaled explained SS	5.713470	Prob. Chi-Square (3)	0.1264

Source: Output EViews 12

Based on heteroscedasticity testing, the Prob. Chi-Square value of 0.075, this figure is greater than 0.05, it can be concluded that there is no heteroscedasticity.

Autocorrelation Test

The autocorrelation test is carried out to see whether the relationship between the independent variable and the dependent variable is linear or not. One method used to detect autocorrelation problems is the Bruesch - Godfrey method.

Table 5. Autocorrelation Test Result

F-statistic	2.128261	Prob. F (2,4)	0.2347
Obs*R-squared	5.155345	Prob. Chi-Square (2)	0.0760

Source: Output EViews 12

Based on the autocorrelation test, the Prob. Chi-Square value is 0.0760, where this figure is greater than 0.05. So, it can be concluded that the residual variable is free from autocorrelation problems.

Data Analysis Results

Table 6. Data Analysis Results

	Coefficient	**Std. Error**	**Prob.**	**Description**
C	698.5064	539.5971	0.2431	Not Significant
Renewable energy	-9.840432	6.879142	0.2025	Not Significant
Carbon Emissions	279.8861	198.3295	0.2079	Not Significant
FDI	-11.14744	24.73539	0.6681	Not Significant
R-Squared	0.835444			
F-Statistic	0.009125			

Source: Output EViews 12

To analyze the effect of independent variables, namely Renewable Energy, Carbon Emissions, and FDI on the dependent variable, namely economic growth simultaneously, the F-Statistic Test is used. Based on Table 6 above, the F-Statistic value is 0.009125, which is smaller than the probability value of 0.05. Therefore, the alternative hypothesis (H1) is accepted, while the null hypothesis (H0) is rejected. This indicates that simultaneously,

Renewable Energy, Carbon Emissions, and FDI variables have an influence on economic growth in Indonesia.

A statistical t-test is employed to examine the partial effect of the independent variable on the dependent variable. This test evaluates how much each independent variable influences the dependent variable. The test compares the probability value with a significance level of 0.05. If the probability value is lower than 0.05, the null hypothesis (H0) is rejected, while the alternative hypothesis (H1) is accepted. Based on Table 6 above, the probability values for the Renewable Energy variable, Carbon Emissions, and FDI are 0.2025, 0.2079, and 0.6681, respectively. Since all probability values of the independent variables exceed the significance level of 0.05, these results suggest that, individually, the Renewable Energy, Carbon Emissions, and FDI variables do not influence Indonesia's economic growth.

The R-square test, also known as the Coefficient of Determination, measures the extent to which the independent variable influences the dependent variable. Additionally, this test helps evaluate the quality of the used regression model. The R-square value ranges from 0 to 1, with values closer to 1 indicating a better model in explaining the dependent variable. Based on the data processing results in Table 1 above, the R-square value is 0.835444. This suggests that the Renewable Energy, Carbon Emissions, and FDI variables in the estimation model account for 83.54% of the variation in the economic growth variable, while the remaining 16.46% is influenced by other factors not included in this study.

The primary objective of economic development efforts is the promotion of economic growth. The presence of economic growth as an indicator of economic development in Indonesia is influenced by various factors, including renewable energy, carbon emissions, and FDI. The findings of the regression analysis indicate that renewable energy, carbon emissions, and foreign direct investment (FDI) simultaneously affect economic growth in Indonesia. However, partially reveals that the impact of these variables on Indonesia's economic growth during the period 2011 to 2020 is not statistically significant.

Energy input according to neo-classical economic growth theory is one of the drivers of economic growth [21]. Renewable energy consumption contributes positively to economic growth in ASEAN countries in small amounts [22]. Concurrently, research shows that renewable energy has a negative and insignificant influence on economic growth in Indonesia. Therefore, it can be concluded that the use of renewable energy sources has the potential to result in a decrease in economic growth [23]. The results are also in line with research, that renewable energy can have an impact on decreasing economic growth [24]. Government efforts to support the transition to environmentally friendly energy allow a decrease in economic growth performance due to benefits that cannot be obtained in a short period of time [23].

Economic activities in Indonesia still depend on limited natural resources. The research found that carbon emissions have a greater influence when compared to the use of renewable

energy. The use of energy sourced from fossil fuels has more impact on increasing economic growth compared to the use of renewable energy which is more environmentally friendly. Increased economic growth can be characterized by increased carbon emissions, because economic activities in Indonesia still produce high carbon emissions [25]. The research is in line with the results of the study which indicates that an increase in carbon emissions has a positive effect on Indonesia's economic growth from 2011 to 2020.

Foreign direct investment (FDI) has been identified as a driver for global economic growth, particularly in developing countries, including Indonesia. However, the findings of the study indicated that FDI had an insignificant influence on economic growth in Indonesia during the period of 2011 to 2020. The findings of this study are consistent with the conclusions of previous research indicating that investment had an insignificant impact on economic growth. [26]. Research shows that FDI has a positive and insignificant effect on economic growth in Indonesia [27]. As for the research which explains that FDI has a positive and insignificant effect on economic growth because economic growth is supported by other factors [28]. This is in line with the results of research that examines the simultaneous impact of renewable energy, carbon emissions, and foreign direct investment (FDI) on economic growth in Indonesia.

4. Conclusion

The study is aimed at analyzing the effect of green economy on economic growth in Indonesia for the period 2011 - 2020. Based on the analysis and discussion of the results of hypothesis testing conducted, it can be concluded that simultaneously, the variables of renewable energy, carbon emissions, and Foreign Direct Investment (FDI) have a significant effect on economic growth in Indonesia in 2011-2022. While partially, the three variables namely renewable energy, carbon emissions, and Foreign Direct Investment (FDI) have no effect on economic growth in Indonesia in 2011-2022.

From the research results, the use of renewable energy in Indonesia still has not influenced economic growth. The energy transition policy implemented in Indonesia in the short term has not had a positive impact on economic growth. Similarly, Foreign Direct Investment (FDI) does not have a significant effect on economic growth. On the other hand, the dependence of Indonesian society on fossil energy as indicated by carbon emissions affects economic growth.

Although the three variables have a simultaneous effect on Indonesia's economic growth, the three variables have not been able to fully explain the effect. This explains that Indonesia's economic growth is also driven by many other factors that are not used in this study. In addition, the time span of the study, which only covers the period 2011-2020, is a limiting factor as the period may be too short to observe long-term trends or broader policy impacts on the Indonesian economy.

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