

Government Strategy in Addressing the Impact of Economic Growth and Energy Consumption on Environmental Degradation

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Abstract

The report discusses the serious environmental issues Indonesia's growing economy and rising energy use have brought about. In addition to examining government initiatives to lessen these impacts through sustainable development regulations, the goals include evaluating the connection between economic indicators and environmental results. The research employs a mixed-approaches strategy, combining quantitative and qualitative methods. The quantitative analysis, which employs time series data from 1991 to 2020, focuses on carbon dioxide emissions per capita as the dependent variable and GDP and energy consumption per capita as independent variables. Multiple linear regression using Ordinary Least Squares (OLS) evaluates these correlations. A thorough grasp of the relationship between economic growth, energy consumption, and environmental deterioration is provided by qualitative analysis, which entails a review of the literature to investigate government initiatives addressing environmental concerns. The study results show a substantial positive correlation between Indonesia's carbon dioxide (CO₂) emissions, energy consumption, and economic development. The analysis indicates that the ongoing economic activities driven by fossil fuel consumption will exacerbate environmental degradation without significant intervention, necessitating effective government policies for sustainable development and emission reduction. The study concludes that economic growth and energy consumption significantly contribute to Indonesia's environmental degradation, particularly through increased carbon dioxide (CO₂) emissions. It recommends that the government strengthen policies promoting sustainable energy use, increase investment in renewable energy technologies, and implement stricter regulations on industrial emissions. Additionally, fostering public awareness and education on environmental sustainability is crucial for effective long-term solutions.

Keywords: *economic growth, energy consumption, environmental degradation, government strategy, Indonesia.*

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INTRODUCTION

Current environmental conditions, both in the world and in Indonesia, show significant challenges related to climate change, natural resource management, and environmental degradation. Globally, the phenomenon of climate change continues to worsen ecosystem conditions, with increasing average temperatures, extreme weather, and decreasing biodiversity (IPCC, 2022). This quite extreme climate change is greatly influenced by various economic activities that cause Greenhouse Gas (GHG) emissions, ranging from transportation, industrial, or factory activities to the use of energy as a power plant. UN Secretary-General António Guterres claims that pollution and biodiversity loss have transformed fertile territory into deserts, endangered water supplies, and food security (Paino, 2024). This contributes to the deepening climate crisis, with countries worldwide being pushed to meet their commitments to restore degraded ecosystems and reduce greenhouse gas emissions.

In economic activities, especially on a large scale such as industry, transportation, and the energy sector, it frequently has an adverse effect on the quality of the environment as well. High energy consumption and extensive use of natural resources are typically the main drivers of economic expansion, most of which comes from fossil sources that produce carbon emissions and pollutants (Ekins et al., 2022). In addition, infrastructure development, agricultural land expansion, and large-scale urbanization often lead to deforestation, soil erosion, and land-use changes, all of which have negative impacts on ecosystems (World Bank, 2020). From the data UNFCCC (2022) stated that in 1990-2021, there was carbon dioxide (CO₂), which was the largest contributor to the total global volume of Greenhouse Gas (GHG) emissions, which was 79.1% in 1990 and increased to 80.1% in 2021. The UNFCCC also explained that in 2021 the total world CO₂ emissions had reached 36.3 billion tons.

World Energy Outlook (2022) stated that global CO₂ emissions increased again in 2021 and replaced 2010 as the year with the largest increase in CO₂ emissions. The dominance of CO₂ emissions makes carbon dioxide (CO₂) the main cause of global warming. Indonesia itself is in eighth place as the largest CO₂ emitter in the world, with emissions of 1002.4 MtCO₂e, making it the largest contributor of emissions in Southeast Asia. Economic growth that relies on the industrial sector and fossil fuels is a major factor, and emissions in Indonesia increased by 18% between 2012 and 2017. Without significant intervention, climate change is expected to cause the loss of around 2000 islands in Indonesia by 2030 (Kusumawardani & Dewi, 2020).

Sustainable economic growth is the main objective of economic policy in all countries, including Indonesia. However, it might have an impact on global warming and climate change. Emissions of carbon dioxide (CO₂) and other greenhouse gases (GHGs) rise in response to economic expansion (Salari et al., 2021). Industrialization without long-term planning can cause environmental damage. Pollution due to industrial activities causes environmental damage and has an impact on climate change (Soeharjoto et al., 2022). One method to determine a country's economic growth is to look at the Gross Domestic Product (GDP) level. The image below is Indonesia's GDP in 2003-2022.

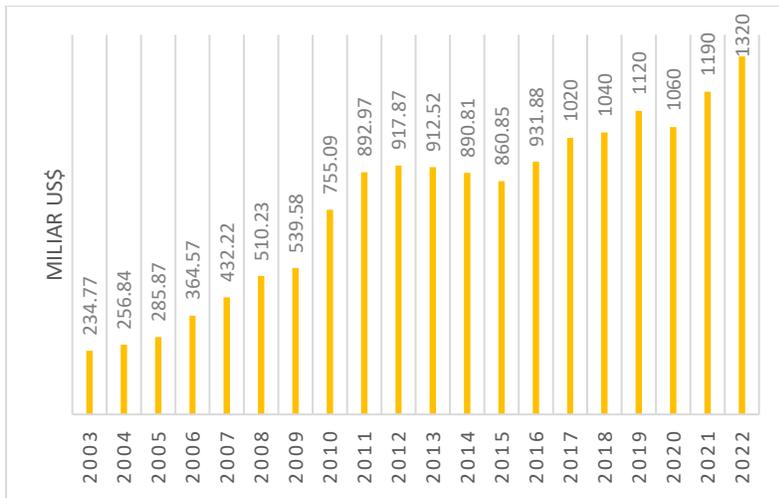


Figure 1. Indonesia GDP Level 2003-2022 (Billion US\$)

Source: The World Bank report (World Energy Outlook, 2022)

Based on Figure 1, the World Bank reported that over the past 20 years, Indonesia's GDP has continued to increase. In the case of Indonesia, rapid economic growth has led to an increase in carbon dioxide (CO₂) emissions. In 2003, Indonesia's GDP was US\$234.8 billion and increased to US\$1.3 trillion in 2022. Although COVID-19 caused a decline in 2020, Indonesia's GDP increased again in 2021. As Gross Domestic Product (GDP) increases, especially through industrialization, as shown in Figure 1, CO₂ emissions also increase due to the high use of resources in production. CO₂ emissions increased by 6% in 2021 compared to 2020, which was in line with the global economy's 5.9% expansion. There has been a high link between CO₂ emissions and GDP growth since 2010 when global emissions increased by 6.1% and economic output increased by 5.1% as the world recovered from the Global Financial Crisis. (World Energy Outlook, 2022).

Long-term increases in energy consumption in Indonesia also determine economic growth, which indicates the need for energy efficiency (Arifin et al., 2023). Over the past 20 years, there has been a notable rise in global energy use (Paramati et al., 2018). One of the factors contributing to the rise in global energy consumption is the industrial sector. The rise in industrial energy use suggests that the sector generates higher-than-normal CO₂ emissions. Excessive carbon emissions significantly impact the environment and human health. In general, excessive carbon emissions will result in greenhouse gas emissions. (Tong et al., 2020). Energy use by economic players in both rich and developing nations exacerbates carbon dioxide emissions and slows economic progress (Muhammad, 2019). The World Health Organization (WHO) states that one of the main causes of air pollution and climate change is greenhouse gas emissions from the exploitation and burning of fossil fuels (Kusuma & Wicaksono, 2023).

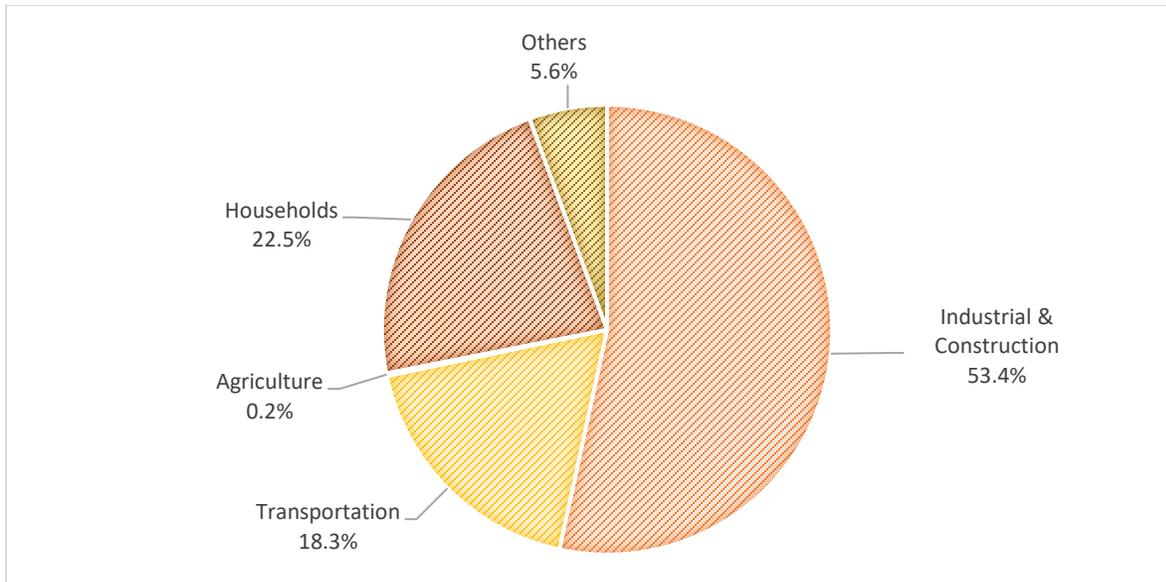


Figure 2. Indonesia's Energy Consumption by Sector

Source: The World Bank report (World Energy Outlook, 2022)

Figure 2 shows the construction and industrial sectors consume the most energy, per data from Indonesia's Central Statistics Agency for 2018–2022, as seen in the graphic above, reaching 53.4% of total consumption, followed by the household sector with 22.5%, and transportation at 18.3%. Several other sectors that have the potential to consume energy only contribute 5.6% of total consumption, while the agricultural sector records very low energy consumption compared to other sectors, using only about 0.2 percent of the total energy used. This statistic demonstrates how the transportation and industrial sectors consume the most energy, which shows the large energy needs of these sectors and the importance of energy efficiency efforts and alternative energy sources to reduce the burden on the environment.

As a worldwide framework that promotes sustainable development, the SDGs are significant in this regard. Achieving the SDGs requires addressing several crucial challenges, including climate change, which is a type of environmental deterioration brought on by economic activity that affects the environment in order to promote economic development. In an interconnected global system, sustainable development, according to Mannion, is an endeavor to strike a balance between environmental preservation, economic progress, and enhancing human well-being (Fatmawati et al., 2022). The SDGs are designed to address environmental challenges through several key interrelated goals. Among them, Sustainable Consumption and Production (SDG 12) encourages more responsible practices to reduce waste and increase resource efficiency, while Inclusive Economic Growth (SDG 8) highlights the importance of growth that not only generates economic output but also pays attention to decent job creation and environmental protection. Additionally, Affordable and Clean Energy (SDG 7) promotes the transition, although the need to

combat climate change and transition to renewable energy sources that can lessen reliance on fossil fuels and carbon emissions is emphasized by Action on Climate Change (SDG 13), thereby accelerating climate change mitigation (United Nations, 2015). By implementing these ideas, the SDGs promote sustainable global development that protects ecosystems and advances social and economic prosperity.

Ministry of Environment and Forestry (2021) said that under the Paris Agreement, Indonesia and the rest of the world have worked to combat climate change. In order to ratify the Paris Agreement, Indonesia passed Law Number 16 of 2016 (Pratiwi, 2021). Another effort made by Indonesia is through the Nationally Determined Contribution (NDC), the NDC was submitted in 2015 and revised to the First NDC in 2016, valid until 2030. In 2021, Indonesia increased the linkage between development and climate goals by including a more equitable emission reduction target in the Updated NDC. Indonesia is committed to lowering its anticipated greenhouse gas emissions from the business-as-usual (BAU) scenario by 834 MtCO_{2e} and 1,185 MtCO_{2e}, respectively, by 2030, according to the Updated NDC. This cut will be made conditionally to 41% (with international cooperation) and unconditionally to 29%. Indonesia wants to boost the use of renewable energy while simultaneously reducing deforestation and forest damage. The creation of environmentally friendly and sustainable energy, such as renewable energy and clean technology, is also important in achieving Indonesia's NDC targets involving greenhouse gas emission reductions (Indonesia Green Growth Program, 2021).

On the other side, the Indonesian government has implemented a Green Economy as one of its strategies to combat environmental deterioration, particularly through the 2020–2024 RPJMN, which includes the Low Carbon Development Initiative (LCI). The LCI aims to integrate environmental considerations into development planning, with targets for GHG reduction and resource sustainability (Suarga et al., 2024). According to the UN Environment Programme, a green economy is one that improves social justice and well-being while lowering ecological risks and shortages (UNEP, 2018). In a green economy, the main focus is on resource efficiency, carbon emission reduction, and sustainable ecosystem management. Even if green economy regulations have begun to be implemented, there are still significant challenges, especially when it comes to the need to invest in eco-friendly technologies and the transition from fossil fuels to renewable energy. Additionally, for a green economy to be implemented successfully, cross-sector participation is required.

Numerous studies have examined the connection between economic growth, energy consumption, and carbon dioxide (CO₂) emissions; however, the majority of them focus on quantitative relationships rather than delving deeply into the strategic aspects of government. Additionally, there is a lack of research, especially in the Indonesian context, that appropriately integrates quantitative and qualitative perspectives. By examining the statistical correlation between economic factors and emissions as well as the government's efforts to lessen the consequences, this study fills the gap. The mixed methods approach utilized in this study to connect scientific findings with workable policy ideas is what makes it distinctive. The primary goal of this study is to offer thorough insights into data-driven policymaking that can support the Indonesian government's implementation of environmental sustainability and low-carbon development.

Several conclusions can be drawn from research on the connection between environmental deterioration and economic growth. For instance, research conducted by Gessesse & He (2020) discovered that China's economic expansion either has a favorable effect up to a certain critical point or raises carbon dioxide emissions, a sign of environmental deterioration. Furthermore, a study by Elfaki & Heriqbaldi (2023) demonstrated how Indonesia's economic growth significantly affects the rise in carbon dioxide emissions. However, other studies suggest that economic growth has a negative impact on environmental degradation. For instance, Shahbaz et al. (2015) discovered that Australia's economic expansion negatively impacted carbon dioxide emissions, suggesting that economic growth can mitigate environmental harm even in its early stages. The idea of externalities, which describes how an economic action affects those not directly participating in the activity, lends credence to this requirement. Both positive and negative effects are possible. The impacted communities bear additional costs as a result of negative externalities, such as factory-induced air pollution (Buchanan & Stubblebine, 1962). Furthermore, this situation is also explained by the Environmental Kuznets Curve (EKC) theory. The concept states that extensive industrial operations and resource exploitation in the early stages of economic development tend to exacerbate environmental deterioration as GDP increases. However, after reaching a certain threshold, further GDP growth reduces emissions as a result of the transition to more efficient technologies and stricter environmental policies (Grossman & Krueger, 1991).

H1: Economic Growth has a positive effect on Environmental Degradation in Indonesia

Another variable that is thought to affect environmental degradation is energy consumption. Previous research by Muhammad (2019) discovered that energy use and carbon dioxide emissions are strongly correlated, particularly in emerging nations with a significant reliance on fossil fuels like Indonesia. The same research was also conducted in China by Zhang (2021), which showed that increased energy consumption results in more carbon dioxide emissions, thus worsening environmental degradation. This proves that energy use, especially from non-renewable sources, is the main factor contributing to environmental degradation. The Production Theory supports the link between energy use and environmental deterioration. According to the hypothesis, energy consumption is the primary input in the manufacturing process that results in economic output. However, using fossil fuels as the main energy source results in excessive carbon dioxide emissions (Paramati et al., 2018)

H2: Energy Consumption has a positive effect on Environmental Degradation in Indonesia

Government strategies such as renewable energy transition, sustainable forest management, and green economy implementation are expected to reduce environmental degradation, especially carbon dioxide emissions (KLHK RI, 2022). The World Energy Outlook, in its report, states that countries that adopt aggressive renewable energy policies, including investments in solar and wind energy, have succeeded in reducing carbon dioxide emissions. Implementing this policy in Indonesia can be a model for reducing dependence on fossil fuels (World Energy Outlook 2022). Research by Safriwan & Idris (2021) illustrates how effective environmental policies, such as strict

industrial emissions restrictions and the use of low-carbon technologies, can reduce the detrimental effects of economic expansion on carbon dioxide emissions. Another study by Paramati et al. (2018) investigated the effects of renewable energy-based policies on carbon emissions in the fields of agriculture, services, and industry. The study concluded that strategies involving diversification of energy sources and energy efficiency can significantly reduce emissions in various economic sectors. One theory that supports the importance of the effectiveness of these government strategies is the Policy Implementation Theory, which emphasizes the important role of policies in directing individual and collective behavior toward sustainability goals. This theory studies how policies are designed to implement and achieve the desired goals effectively. It emphasizes that policy implementation is a complex process involving various actors, resources, and socio-political dynamics. Its primary goal is comprehending the elements that affect whether a policy is implemented successfully or unsuccessfully in a given situation. In this regard, it is anticipated that government initiatives like adopting green economy policies, sustainable forest management, and the shift to renewable energy will lower carbon emissions.

H3: Government strategies can effectively reduce the impact of Economic Growth and Energy Consumption on Environmental Degradation in Indonesia

RESEARCH METHOD

This study combines quantitative and qualitative methodologies in a mixed-method approach. The quantitative influence of energy consumption and economic growth on environmental degradation is accompanied by a qualitative understanding of the government's response to these consequences. Mixed methods have several strategies in conducting research, one of which is the one that will be used in this research is known as sequential explanatory design, where the analysis is carried out in stages and then combines the data found from one method with other methods (Creswell & Plano, 2018).

In this research, the sequential explanatory strategy consists of two stages. To determine whether a government strategy successfully resolves the issue, the second stage involves gathering and analyzing qualitative data in this case to address the third hypothesis, which is how government strategies in Indonesia address the relationship between environmental degradation and economic growth and energy consumption. This is done by reviewing existing literature on laws or government regulations, prior research, official government reports, or official government websites.

Data Source and Data Collection Techniques

This research focuses on Indonesia because it is a developing country that is pursuing sustainable growth and industrialization and has a high economic level. In addition, Indonesia contributes significantly to the total carbon dioxide emissions (CO₂) worldwide. In the quantitative approach, Indonesia's GDP per capita, energy consumption per capita, and carbon dioxide emissions per capita are all time series data from 1991 to 2020. The sample is all time series data that has been collected, namely 30 years (1991-2020).

Purposive sampling, a sample strategy chosen according to specific standards pertinent to the study's goals, is employed in this study. This method is frequently employed in studies that call for particular data. For example, this one uses both quantitative and qualitative methods to analyze the relationship between economic growth, energy use, and environmental deterioration while looking at government measures to mitigate the effects.

Time series data (1991–2020) on GDP per capita, energy consumption, and carbon emissions per capita were purposively sampled from credible sources like the World Bank and Our World in Data for multiple linear regression analysis. The Nationally Determined Contributions (NDC), the National Energy General Plan (RUEN), and low-carbon development strategies that the Indonesian government has put into place are just a few examples of the pertinent policy documents and literature that were chosen using purposive sampling in the qualitative approach. These resources discussed how energy use and economic expansion affect environmental deterioration. Among the selection criteria was the relevance to environmental challenges and mitigation strategies and connections to Sustainable Development Goals (SDGs) targets. This makes it possible for the study to investigate government tactics in a more focused and precise way.

In the qualitative approach, the population comprises policy documents, government reports, and academic literature on government strategies for addressing environmental impacts. Relevant policies like the National General Energy Plan (RUEN), the Nationally Determined Contribution (NDC), and low carbon development strategies are cited as examples. Purposive sampling was effective in this study as it helped to ensure that the data used had direct relevance to the research focus and analytical objectives, as well as allowing the researcher to utilize resources efficiently without losing the validity of the findings (Creswell & Plano, 2018).

Data collection techniques include documentation and literature study. The documentation in question is obtained by obtaining documents from various sources and citing the data contained in these documents. In the meantime, theoretical and empirical reviews pertaining to the issue being studied are also used in the literature study for data collection.

Data Analysis Technique

In order to comprehend the difficulties and approaches of sustainable development, this study integrates a thorough desk study of pertinent literature with the quantitative analysis of statistical data on the use of natural resources. Using this method, researchers can find discrepancies between the figures and the actual situation on the ground. Dependent and independent variables are the two categories of variables used in this study. Environmental degradation is the dependent variable, and carbon dioxide (CO₂) emissions are the explanatory variable or research object. Carbon dioxide emissions, a key driver of greenhouse gases and climate change, were analyzed using per capita data from Indonesia (1991–2020) in Metric Tonnes (MtCO_e), sourced from the World Bank's World Development Indicators.

Next, there are two independent variables: energy use and economic growth. GDP per capita is used to calculate the Economic Growth variable. The data used is Indonesia's 2015 constant

GDP per capita, expressed in United States Dollars (US\$) for 30 years, from 1991 to 2020. The data was obtained from the World Bank. The second variable, Energy Consumption, uses data on primary energy consumption per capita. Primary energy includes resources such as coal, oil, natural gas, geothermal energy, and uranium (nuclear energy), all of which can be used directly without additional processing. This variable is calculated using units of Gigajoules per capita; the data used is for 30 years from 1991 to 2020, obtained from Our World in Data. The data analysis technique is divided into 2, namely *quantitative* and *qualitative analysis*, which is explained in detail below.

Quantitative Analysis

The quantitative method examined how economic expansion and energy use impact Indonesia's environmental deterioration. Energy consumption per capita and GDP per capita are the independent variables in this study, whilst carbon emissions per capita are the dependent variables. Multiple linear regression using the Ordinary Least Squares (OLS) method is the analysis method employed in the quantitative approach. The following is the equation for the multiple linear regression model utilized in this investigation:

$$CO2_t = \alpha + \beta_1GDP_t + \beta_2EC_t + \varepsilon_t \dots\dots\dots 1$$

Where:

- CO2 : Carbon Dioxide Emissions per capita
- GDP : GDP per capita
- EC : Energy Consumption per capita
- $\beta_{1,2}$: Regression coefficient of each independent variable
- α : Constant
- ε : Residual
- t : Time

The impact of GDP and energy consumption on carbon emissions per capita will be determined using this regression model. To make sure the model utilized satisfies the assumptions of normality, lack of multicollinearity, autocorrelation, and heteroscedasticity, a traditional assumption test will be performed before the regression analysis (Ghozali, 2018). In addition to offering policy suggestions based on research findings, the analysis's conclusions will give a general picture of Indonesia's economic growth, energy consumption, and carbon emissions.

The T-test evaluates the impact of each independent variable on the dependent variable, with significance determined if the t-count exceeds the t-table value and the p-value is below 5%. The F-test assesses whether all independent variables collectively influence the dependent variable, indicating significance if the result exceeds the 5% threshold. Lastly, the R-test measures how effectively the independent variables explain variations in the dependent variable, with values near 1 indicating strong explanatory power (Widarjono, 2018).

Qualitative Analysis

The study examines government efforts to address the environmental impacts of economic growth and energy consumption through qualitative analysis and relevant literature. It employs a literature review method, focusing on library data and previous research aligned with the study's objectives (Alfiansyah et al., 2023). This research involved collecting and synthesizing existing research, journal articles, government policy reports, official government websites related to government strategies in addressing environmental degradation, and previous research relevant to environmental and energy policies. The aim was to gather insights from various sources to understand the current state, challenges of policy practices, and government strategies related to the environment in the country.

The mapping of literature studies is carried out based on certain criteria. The literature selection criteria used are published within the last five years (2019-2024) to ensure that the data used is still relevant to existing conditions, as well as literature from journals indexed by Sinta 2, Sinta 3, or international journals, which are indicators of scientific publications. After mapping based on the criteria applied, the next step was to analyze the selected literature sources. The analysis included identifying key findings from previous studies. The results of this literature analysis were then used to formulate the conclusions and discussion in this study. The conclusions drawn are based on various findings from the literature study. Using this literature study approach, it is intended that the research would present a thorough picture of Indonesian government strategies for addressing the effects of energy consumption and economic growth on environmental degradation.

RESULTS AND DISCUSSION

Result of the Quantitative Approach

Table 1 summarizes descriptive statistics for 30 observations of energy consumption (EC), GDP, and CO₂ emissions. CO₂ emissions range from 0.88 to 2.25, with a mean of 1.54, a median of 1.54, and a standard deviation of 0.374, indicating minor variability. GDP ranges from 1556.8 to 3892.4, with a mean of 2484.64, a median of 2219.9, and a higher variability shown by a standard deviation of 725.46. Energy consumption varies between 12.68 and 30.51, with a mean of 22.03, a median of 22.39, and a standard deviation of 4.95. These insights provide a foundation for understanding the data's distribution and variability before further analysis.

Table 1. Descriptive Statistics

Variables	N	Minimum	Maximum	Mean	Median	Std. Deviation
CO2	30	0.880000	2.250000	1.543333	1.540000	0.374252
GDP	30	1556.800	3892.400	2484.637	2219.900	725.4560
EC	30	12.68000	30.51000	22.02833	22.38500	4.948795

Regression Test

When all independent variables are maintained constant or equal to zero, the baseline level of CO2 emissions is represented by the constant coefficient (C) of -0.051627, according to the equation findings in Table 2. Furthermore, the GDP coefficient of 0.000125 means that for every unit rise in GDP per capita, there will be a 0.000125 metric ton increase in carbon emissions per capita. In contrast, the coefficient of energy consumption (EC) of 0.058265 means that for every unit increase in energy consumption per person, there is a 0.058265 metric ton potential increase in carbon emissions per person.

Table 2. Model Regression Test Results

Variables	Coefficient	Std. Error	t-Statistic	Prob
C	-0.051627	0.036537	-1.413011	0.1691
GDP	0.000125	2.41E-05	5.210633	0.0000
EC	0.058265	0.003527	16.51999	0.0000

Source: Data processed (2023)

Based on the regression test results in Table 2, the following is the equation model.

$$CO2_t = -0.051627 + 0.000125GDP_t + 0.058265KE_t \dots \dots \dots 2$$

Test Hypothesis

Table 3's t-test results highlight the significant impact of independent variables on carbon emissions per capita. At a 1% significance level, GDP has a strong positive effect, with a t-statistic of 5.211 and a p-value of 0.0000, indicating a 0.000125 increase in emissions per capita for each one-unit GDP rise. Similarly, energy consumption shows a significant positive effect, with a t-statistic of 16.520 and a p-value of 0.0000, leading to a 0.058265 increase in emissions per capita for each additional energy consumption unit.

Table 3. t-Test Results

Variables	Coefficient	Std. Error	t-Statistic	Prob
C	-0.051627	0.036537	-1.413011	0.1691
GDP	0.000125	2.41E-05	5.210633	0.0000
EC	0.058265	0.003527	16.51999	0.0000

Source: Data processed (2023)

Table 4 shows an F-statistic of 1163.261 with a probability of 0.0000, indicating the regression model effectively explains carbon emissions per capita. The statistically significant F-statistic confirms that GDP per capita and energy consumption per capita collectively substantially impact carbon emissions per capita.

Table 4. F Test Results

F-statistic	Prob(F-statistic)
1163.261	0.000000

Source: Data processed (2023)

Table 5 shows that GDP per capita and energy consumption per capita explain 98.85% of the variation in CO₂ emissions per capita in Indonesia, with a coefficient of determination of 0.988528. The regression model effectively captures the relationship between the variables. After adjusting for the number of independent variables, the Adjusted R-squared value of 0.987678 indicates that 98.77% of the variation in CO₂ emissions is still explained.

Table 5. Coefficient of Determination (R²)

R-squared	Adjusted R-squared
0.988528	0.987678

Source: Data processed (2023)

Result of the Qualitative Approach

The Indonesian government has implemented various sustainable strategies and policies to reduce the impact of energy consumption and economic growth on environmental degradation. The results of the literature study highlight some of these actions (see Table 6).

Table 6. Literature Study Results

No.	Research	Objectives	Methods	Results
1.	Dampak Regulasi Ekonomi Hijau dan Penggunaan Teknologi Energi Terbarukan Terhadap Efisiensi Energi Listrik di Indonesia Loso Judijanto, Nanny Mayasari, Gabriel Amadeus Sitompul (2024)	This study aims to analyze the impact of green economy regulations and renewable energy technologies on Indonesia's electrical energy efficiency while offering policy recommendations to promote energy sustainability.	This research uses a descriptive design to understand respondents' perceptions and an explanatory design to investigate causal relationships between variables, with data collected through a structured questionnaire to professionals and stakeholders in Indonesia's energy sector.	The research shows that green economy regulations and renewable energy technology adoption significantly improve electrical energy efficiency in Indonesia, particularly through their interaction, and emphasizes the importance of policy support, technological innovation, and continued research to support energy sustainability.
2.	Potential Carbon Tax in Indonesia: A Literature Review	This research aims to explore and analyze carbon tax policies that effectively	This research uses the literature review method by synthesizing, identifying, and	The findings indicate that enacting a carbon tax in Indonesia has the potential to significantly aid in the reduction

No.	Research	Objectives	Methods	Results
	Komang Adi Kurniawan Saputra, Nyoman Ari Surya Dharmawan, Putu Gede Wisnu Permana Kawisana, Gde Deny Larasdiputra (2023)	reduce emissions, increase state revenue, and support Indonesia's move toward Net Zero Emissions by 2060 and a low-carbon economy.	analyzing relevant conceptual or empirical articles to provide structured insights into Indonesia's carbon pricing policy. This method comprises study categorization, relevance analysis, and references to previous publications to support the arguments presented.	of emissions and the country's transition to Net Zero Emissions by 2060, although it still faces challenges such as regulatory harmonization, public acceptance, and tax collection mechanisms. A carbon tax focused on high-emission sectors, supported by IDX Carbon's role in carbon trading, can potentially increase state revenue to support a low-carbon economy.
3.	Implementation of a Sustainable Green Economy in Indonesia: A Literature Review R. Masdar, Husna, Jurana, R. Amborowatie, L. Meldawaty, Tenripada, M. I. Mursali, N. Naida (2022)	This study aims to determine and comprehend the level of sustainable green economy implementation development in Indonesia, including the challenges, policies, and strategies needed to support sustainable development and low-carbon development.	The research method involved data collection from various sources, classification and analysis of green economy-related reports, literature review of existing policies and initiatives, and analysis of the findings to offer descriptive and analytical insights into Indonesia's adoption of a sustainable green economy.	The findings indicate that although Indonesia has made strides in implementing the green economy, its implementation is still constrained by challenges such as poverty. Various policies and initiatives from the government have been implemented in the forestry, transport, fisheries, and tourism sectors, but further research and policy development are still needed to improve their effectiveness. To achieve sustainable development, this study also highlights the significance of a well-rounded strategy considering social, economic, and environmental factors.
4.	Analisis Kebijakan Blue Economy di Indonesia Muhammad Faisal Abdul Latif, Salma Nu'aina Wafa, Siti Alia (2023)	Based on the ideas of natural efficiency and zero waste, this study intends to analyze Indonesia's blue economy implementation and its difficulties while offering suggestions for the sustainable management of marine resources.	This study combines a literature review approach with a qualitative descriptive method. Using the PRISMA method to filter pertinent papers that address the factors influencing Indonesia's blue economy, data was gathered through article analysis from the Directory of Open Access Journals (DOAJ) database.	The findings indicate that the fisheries industry is the primary focus of Indonesia's blue economy implementation, which adheres to the concepts of natural efficiency and zero waste. Damage to marine habitats, disputes between sectors, overlapping regulations, a lack of finance, and restricted technology are some of the difficulties. Comprehensive policies, technology investment, and cross-sector partnerships are needed to support the

No.	Research	Objectives	Methods	Results
				development of a sustainable blue economy.
5.	Implementation of the Paris Agreement in Handling Climate Change Due to Forest Fires in Indonesia (2015-2019) Kinanthi Ahimsaning Gandhi, Roberto Octavianus Cornelis Seba, Suryo Sakti Handiwijoyo (2024)	This study aims to assess the Indonesian government's response to forest fire incidents throughout 2015–2019 in light of the Paris Agreement's implementation. The goal of this study is to give a general summary of how well the government is doing at meeting international pledges to reduce emissions and mitigate climate change, particularly by managing forest fires in a more organized and responsible manner.	This study used qualitative methods to understand attitudes, behaviors, and experiences related to Indonesia's forest fires and haze pollution. Data was collected through observation, visual analysis, desk research, and interviews. Desk research techniques were used to analyze cases, answer research questions, identify research gaps, and develop theories related to forest fire management in Indonesia.	According to research on Indonesia's implementation of the Paris Agreement, the government's attempts to address forest fires and climate change are still failing (2015–2019). The main obstacles are weak law enforcement, suboptimal policies, and poor inter-agency coordination. Environmental, health and economic impacts of forest fires have not been adequately addressed. Public consultation on national contributions (NDCs) is limited, and international collaboration is needed for better adaptation strategies. The research recommends more serious actions, such as strengthening law enforcement, improving policies, and expanding public participation.

Source: Literature study based on the Indonesian Government's strategy of economic growth and environmental degradation.

Discussion

The Effect of Economic Growth on Environmental Degradation in Indonesia

According to the findings of the researchers' Ordinary Least Squares (OLS) analysis (Table 2), the economic growth variable (GDP per capita) significantly improves environmental degradation, which is explained by the carbon dioxide emissions variable. This effect has a probability of 0.0000, meaning the value is higher than the significance level of 5% (0,05). Using the regression approach, this study demonstrates that Indonesia's carbon emissions rise dramatically with each increase in GDP per capita. Thus, it may be concluded that the results support the theory that Indonesia's environmental degradation is positively impacted by economic expansion.

The study's findings are consistent with Buchanan & Stubblebine's (1962) Negative Externalities theory, where heightened economic activity frequently leads to adverse environmental effects, including elevated CO₂ emissions. Furthermore, according to Grossman and Krueger's (1991) Environmental Kuznets Curve (EKC) theory, environmental deterioration rises throughout the early phases of economic development but improves after income levels are reached. This suggests that Indonesia is still in the early stages of the EKC curve when

environmental degradation and economic growth are still linked. This result is in line with several other investigations, including those carried out by Gessesse & He (2020) and Elfaki & Heriqbaldi (2023), which claimed that a major factor in the rise in carbon dioxide emissions is economic expansion. The research is relevant as it highlights the need for a low-carbon development and energy efficiency approach in Indonesia to reduce GHG emissions without hampering economic growth.

The Effect of Energy Consumption on Environmental Degradation in Indonesia

As demonstrated in Table 2, the analysis of the energy consumption variable using the Ordinary Least Squares (OLS) method revealed that, with a probability of 0.0000, which is higher than the 5% (0.05) significance level, the energy consumption variable (energy consumption per capita) has a significant positive impact on environmental degradation explained by the carbon dioxide emission variable. Using the regression method, this study demonstrates that every increase in energy use or consumption significantly raises carbon emissions in Indonesia. Thus, it can be said that the results support the theory that energy use in Indonesia reduces environmental deterioration.

This result is supported by the Production Theory, which states that energy consumption is the main input in the production process that produces economic output. However, excessive carbon dioxide emissions are caused by reliance on fossil fuels as the primary energy source. This result is also consistent with earlier studies by Muhammad (2019) dan Zhang (2021) high energy consumption leads to greater carbon dioxide emissions, contributing to environmental degradation and climate change. This result follows data from the Kementerian Energi dan Sumber Daya Mineral (2019). One of the biggest causes of environmental degradation is that the energy demand continues to rise, as do the carbon dioxide (CO₂) emissions caused by energy usage.

Government strategies to address the impact of Economic Growth and Energy Consumption on Environmental Degradation in Indonesia

Indonesia's environmental deterioration due to economic expansion and energy use needs a government plan that balances sustainability and development. Fossil fuel-based activities and industrialization increase CO₂ emissions and damage ecosystems. The government is implementing policies such as the green economy, carbon tax, and Paris Agreement commitments to address this. Other initiatives include renewable energy development and sustainable infrastructure investment. This sub-section reviews the government's strategic steps, challenges, and opportunities in these endeavors.

Green Energy Regulation and Policy.

The application of renewable energy technologies, such as solar and wind power, as well as the application of green economy principles through regulations, has been widely recognized as an effective strategy for increasing electrical energy efficiency. This policy reduces dependence on fossil fuels and contributes to climate change mitigation efforts by reducing greenhouse gas emissions. Real examples can be seen in global and national initiatives that show the positive impact of investment in renewable energy technology. Judijanto et al.'s research (2024), specifically highlight Indonesia's potential to achieve greater energy sustainability by utilizing

abundant renewable energy resources. These findings underscore the important role of government in strengthening regulations and encouraging the adoption of environmentally friendly technologies as part of the transition towards a sustainable green economy. Furthermore, integrating this technology can create multiplier effects, such as increasing access to electricity in remote areas, reducing energy costs in the long term, and stimulating green economic growth by creating new jobs in the renewable energy sector.

Carbon taxation.

Carbon emissions are controlled by international regulations in order to combat climate change as well as in trade relations. Through a carbon price, polluters are penalized and it forced companies to shift toward cleaner practices. Saputra et al. (2023) pointed out that the carbon tax regime in Indonesia would assist the country in meeting its vision of achieving net zero emissions by 2060 and even improving its standing in combating global warming. This model can assist in developing a market for cutting-edge green technologies and attracting investors to renewable sources. Nevertheless, findings showed that the policy has been far from successful due to a number of factors and these include legislation and the public receptiveness to the policy. Stakeholders' engagement and education is critical in rallying the masses to support the idea as well as the carbon tax policy. Further, the revenue generated by the carbon tax could be used for eco-friendly investments such as solar energy installations, waste management systems, or environmental conservation. Considering sectors, the idea will facilitate the transition to sustainable production as well as enhance the competitiveness of the country's sectors in the global market.

Green and Blue Economy

A blue and green economy is necessary to promote economic growth and at the same time tackle the existing environmental problems. A carbon-green economy is oriented towards minimizing carbon emissions and ensuring optimal utilization of resources, while a blue economy articulates the need for enhancing the sustainable use of marine and coastal ecosystems in support of human life. Masdar and others (2022) supported sectors like transportation and forestry as being critical in the realization of the green economy but emphasized that such sectors have constraints including technological barriers and socio-economic factors like poverty. In transportation, the policies could for example include the use of greener technologies in vehicles, and in the forestry sector, for instance, induced policies such as afforestation and conservation of trees can bring down carbon waste by a lot. Many people however have argued that to implement the blue economy, the aim should be to enhance Natural efficiency with the goal of achieving minimum waste hence the concept of zero waste value chain. Utilising this strategy importantly enabled research by Wahyuddin et al. (2022) and Latif et al. (2023) who demonstrated that the fisheries sector, an integral component of the blue economy in economic orientation, is an area which this strategy is

likely to yield positive gains. Because of waste management technology and the optimized supply chain, the fishing sector will be able to improve its impacts on marine ecosystems negatively.

Implementation of the Paris Agreement.

In line with the Paris Agreement, Indonesia has announced NDCs which will facilitate low-carbon development by reducing greenhouse gas emissions. This includes restoring land, conserving forest areas, and moving towards cleaner energy sources. But while these initiatives signify significant advancement, research by Gandhi et al. (2024) point out a number of key issues, for instance in the fields of law enforcement and inter-agency cooperation. One of the main reasons why forest fires, which can destroy the ecosystem and emit high carbon emissions, are poorly controlled is ineffective enforcement of laws and regulations. Inadequate control, lack of strong penalties towards perpetrators, and corrupt practices worsen this scenario, making it impossible to attain emission reduction goals. Moreover, inadequate cooperation among ministries, regional authorities and the private sector leads to gaps in policy enactment. For instance, failure to harmonize policies from the center and local governments, or duplication of functions is a common challenge towards effective resource utilization and management. To address this barrier, strategic measures must be undertaken such as enhancing the legal framework implementation, expanding use of satellite technology in monitoring, and promotion of environmental integrity and responsibility.

CONCLUSION

According to this study, Indonesia's economic expansion, energy use, and environmental deterioration are all significantly correlated. According to the data, carbon dioxide (CO₂) emissions, a crucial sign of environmental deterioration, rise sharply with increases in GDP and energy consumption per capita. While various government strategies, such as renewable energy development, green economy implementation, and carbon taxation policies, have helped reduce these negative impacts, further efforts are needed to improve their effectiveness. This study has limitations, including quantitative data coverage that only covers the period 1991-2020, which does not include recent policy or technology changes, a qualitative approach that still relies on a literature review, and a limited variable focus on energy consumption and economic growth without including other factors such as urbanization and land use change.

Future studies should consider additional factors such as urbanization and green technology investments to provide a more comprehensive view. It is also recommended that the government enforce stricter carbon taxes, expand renewable energy subsidies, and promote public education through national campaigns to raise environmental awareness. This study supports the Environmental Kuznets Curve (EKC) and the theory of negative externalities, highlighting that environmental degradation initially rises during development before decreasing. The findings offer policymakers insights into reducing carbon emissions through energy efficiency and renewable energy investments while providing data for businesses and society to encourage sustainable practices.

This research contributes to policy by advising the government to improve legislation and investment in low-carbon technologies to meet Indonesia's Nationally Determined Contribution (NDC) targets. It also emphasizes that unplanned economic growth could worsen environmental conditions without stronger interventions. Cross-sector collaboration and stakeholder commitment are essential for successful sustainable development that balances economic growth and environmental preservation.

List of Abbreviations

CO₂: Carbon Dioxide, GDP: Gross Domestic Product, GHG: Greenhouse Gas, IPCC: Intergovernmental Panel on Climate Change, NDC: Nationally Determined Contribution, SDG: Sustainable Development Goal, UN: United Nations, UNEP: United Nations Environment Program, UNFCCC: United Nations Framework Convention on Climate Change, WHO: World Health Organization, RPJMN: Rencana Pembangunan Jangka Menengah Nasional (National Medium-Term Development Plan), LCI: Low Carbon Development Initiative, EKC: Environmental Kuznets Curve, BPS: Badan Pusat Statistik (Statistics Indonesia), OECD: Organization for Economic Co-operation and Development, IEA: International Energy Agency, MtCO₂e: Metric Tons of Carbon Dioxide Equivalent, KLHK: Kementerian Lingkungan Hidup dan Kehutanan (Ministry of Environment and Forestry).

Authors' Contribution

Both authors made equal contributions to the study. *RISS* was responsible for the study design, writing the first draft, data analysis, interpretation of results, and correspondence with the publisher. *FI* was involved in data collection, data analysis, formulation of methodology, finalizing the manuscript, final editing of the manuscript, and revision.

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Availability of Data and Materials

The research data collected has been described in the research methods section, all literature used in the research is listed in the bibliography. Data can also be requested via email to the corresponding author with a clear purpose.

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