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ENERGY TRANSFORMATION AND ECONOMIC GROWTH IN INDONESIA: TO MEASURE THE IMPACT OF RENEWABLE AND NON-RENEWABLE ENERGY

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Abstract

The research aims to see the impact of renewable energy, if it is compared to non-renewable energy in increasing economic growth in Indonesia, over the last few decades, find out the impact of the energy transition that is designated to support sustainable economic growth, and to identify whether non-renewable energy still has a more favorable impact on growth of Indonesian economy. The research employs Indonesian secondary data from 2000 – 2022 that illustrates economic growth, biomass energy, natural gas, oil, fuel, and electricity variables. Data obtained from the publication released by Statistics Indonesia and the Ministry of Energy and Mineral Resources. Error Correction Model (ECM) is utilized as the analysis tool. The findings suggest that traditional biomass renewable energy has no impact on achieving the expected economic growth in Indonesia as a result of the minimal availability of biomass waste. Meanwhile, natural gas does not have the potential to increase economic growth due to the lack of infrastructure and management of this energy. Oil fuel contributes to reducing economic growth as a result of dwindling availability, fluctuating prices, and high subsidy costs. While electricity drives economic growth, its availability is still far from meeting people's consumption needs. Government policy needs to target the availability of this energy, especially encouraging the production of electricity sourced from available natural resources (renewable).

Keywords: *renewable energy, economic growth, ECM*

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INTRODUCTION

Indonesia's economic growth from 2019 to 2023 continues to increase. In 2019, economic growth was recorded at -2.07%, while in 2023 it was recorded at 5.05% (World Bank, 2023). The increase in economic growth cannot be separated from the role of energy. All economic sector mobilities that cover infrastructure, industrial activities, and other economic activities require energy to run well. However, in 2012, the UN launched a "green economy" program by prioritizing energy transformation towards renewable energy to increase sustainable development that is more environmentally friendly (United Nations, 2012). The importance of energy transformation in encouraging sustainable and environmentally friendly economic growth has also been an essential urgency for Indonesia for a long time, with the passing of Energy Law No. 30 of 2007, which focuses on energy diversification and renewable energy development. Another effort is to launch the General National Energy Plan (RUEN) in Presidential Regulation Number 22 of 2017. This plan focuses on using renewable and non-renewable energy simultaneously but explicitly seeks to increase renewable energy by 23% by 2025.

The use of non-renewable energy in Indonesia still dominates at 86.92%, including coal at 40.46%, petroleum at 30.18%, and natural gas at 16.28%. The proportion of renewable energy use is still far from the target (by 23% in 2025), namely 13.08% in 2023 (Ahdiat, 2023). Undoubtedly, the urgency of achieving the energy transformation target does not override the economic growth that Indonesia wants to achieve. An in-depth analysis regarding the influence of renewable and non-renewable energy on economic growth in Indonesia needs to be carried out, especially in the context of energy transformation. It aims to see the extent to which the influence of renewable energy is compared to non-renewable energy in increasing economic growth in Indonesia over the last few decades. Does the planned energy transition goal give a better contribution to sustainable economic growth in line with the concept of a "green economy", or does non-renewable energy still have a more favorable impact on Indonesia's economic growth?

THEORETICAL BACKGROUND

Neoclassical theory basically reveals the relationship between capital, total factor productivity, and technology on economic growth. Energy use plays a role in the production process and is part of capital. Solow stated that these factors could influence economic growth in the long term. Energy efficiency in the context of renewable energy is one of the factors of total factor productivity proposed by Solow. The transformation towards renewable energy involves quite large investments, so it requires efficiency in its utilization. However, this efficiency also leads to a rebound effect. Efficiency in using renewable energy will result in cheaper usage

costs and more energy will be saved. It encourages more energy consumption. This condition will have an impact on economic growth as described by Solow (Boediono, 2012; Cicea, Ciocoiu, & Marinescu, 2021; Serlites, 2001). Conservation hypothesis suggests that the contribution of energy to economic growth refers to a certain point, once it reaches that point, increasing energy consumption will not increase economic growth significantly (Bonsu & Wang, 2022). Other theories such as the neutrality hypothesis state that energy consumption indirectly affects economic growth in terms of the absence of relationship between energy consumption and economic growth (Menegaki & Tugcu, 2016).

Previous literature on OECD and E7 countries as the study object, revealed that renewable and non-renewable energy has a positive impact on economic growth but is consistent as the main cause of CO emissions and environmental pollution (Gozgor, Lau, & Lu, 2018; Tong, Ortiz, Xu, & Li, 2020). Research conducted in Asia, Europe, America, and Africa demonstrates the relationship between energy consumption, economic growth, and environmental sustainability (Cicea et al., 2021). Results on the G7 and N-11 countries show two separate conditions. There are conditions where renewable energy does not hinder economic development, on the other hand, in several other countries it hinders economic growth and needs policies to support energy, infrastructure, and economic conditions (Bhuiyan et al., 2022). Research in GCC countries shows that renewable energy encourages economic growth even though they must focus on developing renewable energy technology and energy mix fields (AlKhars, Miah, Qudrat-Ullah, & Kayal, 2020). Research conducted in 20 developed and developing countries shows that increasing renewable energy production in developing countries can increase economic growth better than non-renewable energy fields (Singh, Nyuur, & Richmond, 2019).

From existing theory and literature, the effect of energy consumption has a long-term economic impact on growth. However, in current conditions, variations in the impact of energy use on economic growth may vary for each different object of study. Moreover, in Indonesia, the transition condition towards the concept of environmentally friendly sustainable development enables the identification of the impact of long-term and short-term energy development, both renewable and non-renewable.

RESEARCH METHOD

This type of study is quantitative research. Quantitative research is based on the philosophy of positivism which prioritizes real observations and empirical conditions, is objective and mathematical, and emphasizes proof or hypothesis testing (Jannah et al., 2023). This research was conducted in

Indonesia and employs secondary data. Data source refers to Handbook of Energy & Economic Statistics of Indonesia 2022 (ESDM, 2022); Handbook of Energy & Economic Statistics of Indonesia 2007 (ESDM, 2007); Indonesia's GDP According to Business Fields Series 2010 (Billion Rupiah) (BPS, 2022). The data used is time series data for 23 years from 2000-2022. The dependent variable is economic growth, while the independent variables are renewable and non-renewable energy such as traditional biomass, natural gas, oil fuel, and electricity.

Economic growth is defined as the growth or increase in the value and amount of production of a country, calculated in a certain period. In this study, economic growth refers to the value of constant Gross Domestic Product (GDP) in 2010 in billion rupiahs. Traditional biomass is explained as renewable energy in the form of waste from commodities resulting from factory processing, gardens, or processed rice fields. Natural gas is classified as non-renewable energy in the form of a mixture of ethane, butane, methane, and propane gasses that are produced by nature. Oil fuel is non-renewable energy that comes from fossil sources in nature. Electricity is derived energy that originates from sources such as coal (non-renewable), wind, solar, water, and geothermal energy. Traditional biomass, natural gas, oil fuel, and electricity refer to the final energy consumption value in thousand barrels of oil equivalent (BOE).

This research applies error correction model (ECM) data analysis techniques. It enables the researchers to correct short-term analytical imbalances, and possible bias regressions, and establish long-term relationships. The requirements for this model are fulfilled if the data is stationary at the same difference and meets the cointegration equation (Vanegas & Ridderstaat, 2016). Data processing uses e-views 12. Stages in this analysis include data stationarity tests, cointegration tests, classical assumption tests, and ECM model estimation. The following is the equation model formulated in this research.

Long-term equation model:

$$GDP_t = \alpha + \beta_1 Bio_t + \beta_2 Gas_t + \beta_3 Fuel_t + \beta_4 Elc_t + \mu_t$$

Short-term equation model:

$$\Delta GDP_t = \alpha + \beta_1 \Delta Bio_{t-i} + \beta_2 \Delta Gas_{t-i} + \beta_3 \Delta Fuel_{t-i} + \beta_4 \Delta Elc_{t-i} + \theta ECT_{t-1} + \mu_t$$

In which:

GDP= Economic Growth

Bio = Traditional Biomass

Gas = Natural Gas

$Fuel$ = Oil Fuel

Ect = Electricity

Δ = Variable change from the previous period

α = constant

$\beta_1,\beta_2,\beta_3,\beta_4$ = coefficient in measuring long-term influence; measuring the impact of changes in the short term

θ = error correction term coefficient for the previous period

ECT_{t-1} = error correction term for the

previous period

μ_t = error term

RESEARCH RESULTS AND DISCUSSION

Research result

The research uses data analysis techniques with error correction models, by previously carrying out the stationary tests, cointegration tests and classical assumption tests. First, the stationary test employs the Augmented Dickey-Fuller method that meets the condition in ECM analysis, in which all variables tested must not be stationary at a level. The stationary criterion for the Augmented Dickey-Fuller method is that the p-value is smaller than 0.05. The stationary test results in Table 1 explain that the p-value of each variable is smaller than 0.05 in the first difference. Hence, all variables meet stationarity at the first difference.

Table 1. Stationary Test Results

Variable	Order of Integration	Prob. (ADF Test)	Description
GDP	I (1)	0.0091	Stationer
Bio	I (1)	0.0031	Stationer
Gas	I (1)	0.0002	Stationer
Fuel	I (1)	0.0001	Stationer
Elc	I (1)	0.0096	Stationer

Source: E-Views 12, processed data

The next stage is to identify the cointegration relationship using ECT (error correction term) generated from the cointegration model. Then, a unit root test using Augmented Dicky-Fuller is run. The calculation results suggest that ECT is stationary at this level. This condition explains that there is cointegration, in which each variable in the model has a long-term relationship. So that error correction occurs, and each variable is cointegrated.

Table 2. Cointegration Test Results

Variable	Order of Integration	Prob. (ADF Test)	Description
ECT	I (0)	0.0138	Stationer

Source: E-Views 12, processed data

The third stage is to carry out classical assumption tests such as normality tests, autocorrelation, heteroscedasticity, and multicollinearity. The classical assumption test is useful for ensuring the accuracy and efficiency of the estimated model. This condition applies both in the long and short term. The following are the results of the classic assumption test for the long term:

Table 3. Long-Term Classical Assumption Test

Normality	
Prob. Jarque-Bera	0.1364
Autocorrelation	
Prob. Chi-Square	0.6679
Heteroscedasticity	
Prob. Chi-Square	0.2412
Multicollinearity	
Variable	**Centered Vif**
Bio	4.4209
Gas	2.3108
Fuel	4.2846
Elc	7.0588

Source: E-Views 12, processed data

In Table 3, the normality test results show the value of prob. Jarque-Bera at 0.1364 is greater than 0.05. It means that the model residuals in the long term are normally distributed. Autocorrelation test results show prob. Chi-Square 0.6679 is greater than 0.05. It indicates the absence of an autocorrelation problem. The heteroscedasticity test results show the prob value. Chi-Square 0.2412 is

greater than 0.05, which means that the homoscedasticity assumption has been fulfilled. This condition aims to avoid biased regression estimates. The results of the multicollinearity test on the long-term model indicate that the centered VIF value of each independent variable shows a value, which is smaller than 10. It proves a low correlation between each independent variable and each other.

Table 4. Classic Short-Term Assumption Test

Normality	
Prob. Jarque-Bera	0.1857
Autocorrelation	
Prob. Chi-Square	0.7252
Heteroscedasticity	
Prob. Chi-Square	0.4217
Multicollinearity	
Variable	**Centered Vif**
Bio	1.1427
Gas	1.2218
Fuel	3.3128
Elc	2.9988

Source: E-Views 12, processed data

In table 4, the normality test results show the prob value. Jarque-Bera at 0.1857 is greater than 0.05. It means that the model residuals are normally distributed. Autocorrelation test results show prob. Chi-Square 0.7252 is greater than 0.05. This indicates the absence of an autocorrelation problem. The heteroscedasticity test results show the prob value. Chi-Square at 0.4217 is greater than 0.05. It suggests that the homoscedasticity assumption has been met and the regression estimates are not considered biased. The results of the multicollinearity test on the short-term model shows that the centered VIF value for each independent variable shows a value smaller than 10. It proves that each independent variable is not highly correlated with each other.

Table 5. Long-Term ECM Estimation

Variable	**Coef.**	**Std. Error**	**t-Stat.**	**Prob.**
Bio	-1.7663	724.3548	-0.0024	0.9981
Gas	4197.57	3038.17	1.3816	0.1840
Fuel	-4963.54	1390.73	-3.5690	0.0022
Elc	63263.90	2115.47	29.9053	0.0000
C	2358346	423753.7	5.5653	0.0000
		R-Squared		0.9967
		Adjusted R-Squared		0.9959
		F-statistic		1364.15
		Prob(F-statistic)		0.0000

Based on the analysis results using ECM, the estimated equation for long-term model is as follows:

$$GDP_t = 2358346 - 1{,}76Bio_t + 4197{,}57Gas_t - 4963{,}54Fuel_t + 63263{,}90Elc_t + \mu_t$$

Based on the form of this equation, if biomass, natural gas, oil fuel and electricity energy consumption is equal to 0, then the basic value of economic growth is 2358.346 trillion rupiah. The coefficient value for the biomass variable at 1.76, indicating that the increasing of traditional biomass energy consumption by 1000 BOE will reduce economic growth by -1.76 billion rupiah. The coefficient value of the natural gas variable is 4197.57, illustrating that an increase in natural gas energy consumption by 1000 BOE will increase economic growth by 4197.57 billion rupiah. The coefficient value of the oil fuel variable is -4963.54, indicating that an increase in oil fuel energy consumption by 1000 BOE will reduce economic growth by 4963.54 billion rupiah. Later, the coefficient value of the electricity variable is 63263.90,

indicating that an increase in electricity energy consumption by 1000 BOE will increase economic growth by 63263.90 billion rupiah.

Based on the value of prob. t-statistics, each variable shows that the probability of the traditional biomass variable that counted at 0.99 and natural gas at 0.99 is greater than the probability of 0.05. It shows that traditional biomass and natural gas energy consumption has no partial effect on economic growth. Meanwhile, the probability of the oil fuel and electricity variables at 0.00 is smaller than 0.05, which explains that oil fuel and electricity have a partial effect on economic growth. The R-squared value of 0.9967 reveals that the independent variables in the model can explain the existence of 99.67 percent of the dependent variable variation, the remaining is influenced by other variables outside this research study. Simultaneously, the consumption of biomass energy, natural gas, oil fuel, and electricity influences economic growth, based on the F-statistic value of 1364.15 with prob. F-statistic of 0.00, which is smaller than 0.05.

Table 6. Short-Term ECM Estimation

Variable	Coef.	Std. Error	t-Stat.	Prob.
Bio	-866.31	512.84	-1.6892	0.1106
Gas	-144.18	1982.44	-0.0727	0.9429
Fuel	-1180.13	1262.91	-0.9344	0.3640
Elc	30468.27	8765.99	3.4757	0.0031
ETC(-1)	-0.6814	0.2172	-3.1366	0.0064
C	169452.3	52112.60	3.2516	0.0050
		R-Squared		0.6764
		Adjusted R-Squared		0.5753
		F-statistic		6.6893
		Prob(F-statistic)		0.0015

Based on the analysis results using ECM, the estimated equation for short-term model is as follows:

$$\Delta GDP_t = 169452{,}3 - 866{,}31\Delta Bio_{t-i} - 144{,}18\Delta Gas_{t-i} - 1180{,}13\Delta Fuel_{t-i} + 30468{,}27\Delta Elc_{t-i} - 0{,}68ECT_{t-1} + \mu_t$$

Based on the form of this equation, if biomass, natural gas, oil fuel and electricity energy consumption is equal to 0, the basic value of economic growth is 169.452 trillion rupiah. In the short term, the coefficient value on the biomass variable at -866.31, indicating that increasing traditional biomass energy consumption by 1000 BOE will reduce economic growth by -866.31 billion rupiah. The coefficient value of the natural gas variable at -144.18, indicating that an increase in natural gas energy consumption by 1000 BOE will reduce economic growth by 144.18 billion rupiah. Later, the coefficient value of the oil fuel variable at -1180.13, indicating that an increase in oil fuel energy consumption by 1000 BOE will reduce economic growth by 1180.13 billion rupiah. The coefficient value of the electricity variable at 30,468.27, indicating that an increase in electricity energy consumption by 1,000 BOE will increase economic growth by 30,468.27 billion rupiah.

Based on the value of prob. t-statistics for each variable, it is shown that the probability of the traditional biomass, natural gas, and oil fuel variables is greater than the probability of 0.05, which indicates that energy consumption in these three variables

has no partial effect on economic growth, in the short term. Meanwhile, the probability of electricity being 0.00 is smaller than 0.05. It explains that electricity has a partial effect on economic growth in the short term. The R-squared value of 0.6764 shows that the independent variables in the model can explain the existing 67.64 percent variation in the dependent variable, the remaining is influenced by other variables outside this research study. Simultaneously, consumption of biomass, natural gas, oil fuel and electricity energy has an impact on economic growth in the short term, based on an F-statistic value of 6.68 with prob. F-statistic of 0.00, which is smaller than 0.05.

In addition, in short-term conditions, the ECT coefficient value is counted at -0.68. The ECT coefficient explains how quickly the imbalance in the previous period can be corrected in the current year towards long-term balance. An ECT value of -0.68 indicates a relatively rapid adjustment to balance. The absolute value explains that 68% of the imbalance that occurred as a result of any changes in economic growth in the previous period will be corrected in the current period towards long-term balance.

Discussion

Over the last 23 years, Indonesia's economic growth has continued to show improvement. The large GDP of Indonesia has made Indonesia one of the countries with the largest GDP in the world.

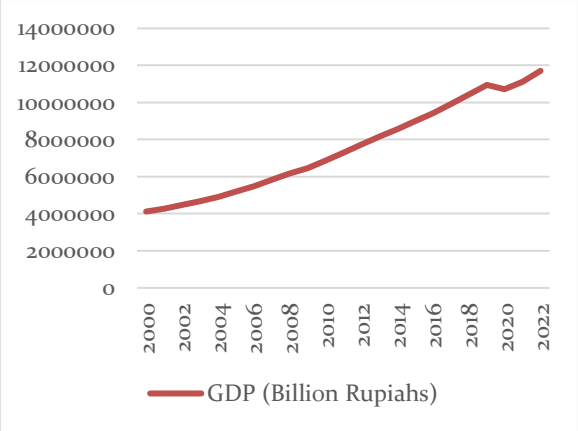

Figure 1. Indonesia's GDP 2000-2022 (constans 2010) in billions of rupiah

This condition in inseparatable from the large economic activity that continues to occur. This growth is also correlated to the mobility that occurs in Indonesia. All economic activities, including energy consumption, are highly related to various industrial activities and mobility.

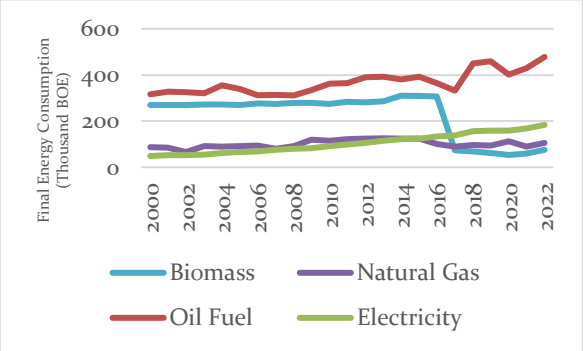

Figure 2. Energy Consumption 2000-2022 in Indonesia

Large energy consumption certainly has an impact on high economic output. The increase in energy consumption has continued over the last 23 years. Also, it is related to the increasing population and greater energy needs. The increase occurred mainly in non-renewable energy such as natural gas, oil fuel, and electricity. Meanwhile, renewable energy such as biomass shows a drastic decline which started to occur

in 2017 until recently. The current condition reveals that bio energy is not always renewable energy which has a good impact on nature. The government's efforts to carry out energy transformation towards environmentally friendly and sustainable renewable energy, that is in line with the concept of "green economy", are not always on target.

Biomass renewable energy, which is a form of bioenergy, provides analysis results which reveal that in fact biomass has insignificant effect on economic growth in both the long and short term in Indonesia. Based on the latest facts related to biomass in Indonesia, its development has the potential to trigger deforestation (Yulianus, 2024). Biomass originating from plantation and industrial waste is insufficient to generate energy and support economic growth. Specifically, the government is creating energy plantation forests to create biomass energy by planting several trees such as eucalyptus, acacia and sengon. However, this has apparently triggered deforestation with a projection of around 4.65 million hectares of plantation forest if it continues to be cultivated as a renewable energy source. It would be inappropriate if renewable energy does not utilize remaining resources, instead causing more forest destruction. The limited waste for biomass production leads to its less impact on economic growth, until now. The government's efforts to introduce this energy will actually trigger natural damage. The concept of renewable energy should refer to energy that can be produced without disturbing future existence of natural resources, should not have a negative impact on the environment, should be cheaper than fossil energy, and should be efficient in converting resources into energy (IRENA, 2017). The decline in biomass consumption from 2017 to 2022 shows that the energy transition has led to other forms of alternative energy sources that are considered more responsible and sustainable.

Renewable energy sources do not always have an effect on economic growth, which is in line with the neutrality hypothesis that indicates no relationship between energy consumption on economic growth (Menegaki & Tugcu, 2016). Several countries that became the object of research by Bhuiyan et al. (2022) concluded that the use of renewable energy will actually hamper economic growth so it requires appropriate and responsible energy policy support. There are quite a lot of other renewable energy options available in Indonesia and it is important to explore this potential. Other renewable energy potentials still require special tests for their implementation.

Meanwhile, several non-renewable energies that have been tested in this research show different results. In the natural gas variable, energy consumption began to stagnate in 2015 and experienced a trend of decreasing consumption (figure 2). The results

of data analysis in the long term and short term show that natural gas energy consumption has an insignificant effect on economic growth in Indonesia. This statement supports the neutrality hypothesis which states the absence of a relationship between energy consumption and economic growth (Menegaki & Tugcu, 2016). Aligned with other literature which states that natural gas gives no impact on increasing economic growth, on the contrary, a decrease in economic growth (Bulkani, Sonedi, & Putra, 2021). Natural gas is an alternative energy transition from almost run-out fossil energy to renewable energy. Natural gas produces cleaner energy with more availability than fossil energy. Exploration of natural gas in Indonesia has not yet reached its maximum point (Hartono, Purwanto, Nurkholis, & Rum, 2017). There are quite a lot of natural gas points that have not been explored by the government. It is related to inadequate infrastructure and supporting technology for natural gas energy production. The industrial, electricity and fertilizer sectors dominate the use of natural gas in Indonesia (Sutrisno, 2022).

In fact, Indonesia is still waiting for investors to develop this energy. The sufficient availability in nature is imbalanced with the evenly distribution to various regions, in order to expand energy consumption. Infrastructure such as gas pipes need to be improved and involve investment in the process. Moreover, natural gas consumption is considered to have no impact on Indonesia's economic growth because of the limited market for this kind of energy. Apart from that, foreign countries that need gas for consumption are also still considering the flow of gas from Indonesia. This is due to prices that are less competitive compared to prices offered by Russia, the US, Qatar, and Australia (Cindy, 2021). Besides, natural gas is made by demand. No demand from customers, both domestically or abroad will lead to significant losses if the energy is produced or stored. Storing this energy in large amounts is dangerous and uneconomical.

Another way for future implementation, so natural gas can be utilized optimally and have an impact on economic growth, is by increasing domestic consumption. Switching from (imported) LPG gas to natural gas is a good consideration to make. The government needs to be serious about building adequate infrastructure for this purpose, and channeling sufficient funds for cleaner natural gas energy (Martha, 2022). As previously implemented by Europe in its effort, to unleash its dependence on fossil energy by focusing on developing natural gas energy by building mass gas pipelines to meet domestic consumption. This effort could be an alternative and reduce Indonesia's dependence on fossil energy and LPG imports. If this effort can be adopted, it is certain that at that point, the condition of Indonesia's infrastructure in natural gas management will

be more mature. This condition can encourage more competitive and economical natural gas prices in international trade and support global demand for natural gas exports from Indonesia. Hence, the development of such energy can increase economic growth. In the meantime, a lot of improvement needs to be done both from the government and private parties to improve infrastructure such as terminals and gas pipelines, cost efficiency, availability, competitive prices, and sustainable energy reserves.

The results of research on other non-renewable energy, namely oil fuel, demonstrate that in the long term, oil fuel has a significant effect on reducing economic growth, with an estimate that every 1000 BOE of oil fuel consumption will cause a decrease in economic growth of 4963.54 billion rupiah. Meanwhile, oil fuel energy consumption in the short term shows an insignificant effect. Oil fuel energy consumption has become increasingly massive since the 1900s. The driving factors for this energy use are population growth, energy requirements for production in the industrial sector, and increasing demand for oil-fueled transportation. Economic growth increased rapidly in those years. As time goes by, the world realizes that the crisis of fossil fuels such as oil fuel has begun. The supply of reserves on earth is running low. The effects that have occurred over decades have caused quite a lot of carbon emissions and environmental damage. The latest fact is that the world has been working towards a low carbon emission target to protect the environment by minimizing the use of oil fuel, including in Indonesia.

The current use of oil fuel has reached a certain point, where increasing the use of oil fuel will actually reduce economic growth according to the conservation hypothesis (Bonsu & Wang, 2022). This condition is in line with other literature that reveals a relationship between energy consumption, economic growth, and sustainable development (Cicea et al., 2021). This condition is in line with other literature that discloses a relationship between energy consumption, economic growth, and sustainable development (Hidayat, 2022). In addition to pollution, Co_2 emissions, and other environmental damage caused by oil fuel, will increase government spending on this matter. Thus, contributing to a decline in economic growth. Efforts that should be made are to seriously prepare for the energy transition by prioritizing the concept of a "green economy". Countries that do not innovate and invest money in developing technology that supports renewable energy, will cause deeper losses due to lost opportunities in the economic sector.

Another energy in Indonesia that has been analyzed is electricity energy consumption. The results of the analysis illustrate that both in the long and short term,

energy consumption has a positive and significant effect on economic growth in Indonesia. Energy consumption of 1000 BOE will increase Indonesia's economic growth by 63263.90 billion rupiahs, in the long term, and increase Indonesia's economic growth by 30468.27 billion rupiahs in the short term. It is aligned with Solow's theory, stating that the use of energy as a production factor and capital has a positive effect on economic growth (Boediono, 2012; Buhaerah, 2018; Cicea et al., 2021; Serlites, 2001). Other research explained that energy use, indeed, increases economic growth but at the same time contributes to the increase of Co2 emissions and environmental pollution (Gozgor et al., 2018; Tong et al., 2020). Electricity energy consumption in Indonesia has continued to increase over the last 23 years (figure 2). When it is compared to other energy, electricity has enormous potential to grow the economy. Economic growth will be faster with this energy (Kolin, Sedlar, & Kurevija, 2021). Currently, progress and developments have caused society to be very dependent on electricity. This is due to every available technology requiring electricity. Although the consumption is not as large as oil fuel, the future potential for technology, the economic sector, industry, and AI development is very dependent on this energy. The fact, this energy greatly influences Indonesia's economic growth since every part of life requires far more electricity than is available. The industrial sector uses quite a lot of electricity in the production process, the service and banking sectors also need electricity, especially communication and information technology. All of these sectors provide higher economic returns compared to the amount of electricity used.

However, Indonesia's electricity supply is still very poor at 110 watts per capita, compared to countries such as China with 1100 watts per capita, and Singapore with 2500 watts per capita, Indonesia is way far from its actual needs (Sihite, 2017). Outside Java, electricity supply is still not properly accommodated, especially in 3T (underdeveloped, frontier, outermost) areas. Under these conditions, the economic growth cannot yet reach its maximum establishment.

Primarily, electricity consumption plays a big role in the industrial sector to produce greater production, encourage innovation for more competitive products, and open business opportunities. Electricity can also support the industrial sector if the price is affordable and not intermittent since it will support greater industrial expansion and open up job opportunities. This energy can support the banking, finance, retail, service, and tourism sectors for more comfortable operational activities to meet addressed needs. All of this potential should be able to encourage economic growth to reach maximum levels if electricity meets energy consumption needs in Indonesia.

With the current electricity shortage, the government needs to focus on developing electricity energy in Indonesia. Development should prioritize the concept of a "green economy" to encourage sustainable economic growth in accordance with the government's target, namely the use of renewable energy by 23% by 2025. Currently, electricity is still sourced from two sources of energy, namely non-renewable energy, which is coal, and renewable energy such as steam, wind and solar. Creating electricity energy from coal will indeed make electricity prices cheaper, making it easier for the industrial sector to produce competitive goods/services, but the sustainability of coal must be put under consideration, in terms of its availability. Meanwhile, the production of electricity energy through renewable energy such as steam, wind, and solar cannot be relied on to meet the needs of all Indonesian people. Indonesia's resource potential is enormous to form renewable energy that can produce electricity. The government must be serious about forming a comprehensive ecosystem for renewable energy, in terms of investment, technology, management, maintenance, and accessibility. If all of the above things can be fulfilled, electricity energy will meet the needs of Indonesian people and directly impact economic growth to be higher than currently.

This research shows that traditional biomass as renewable energy has no effect on increasing economic growth in the long and short term. It is highly related to the development of biomass in Indonesia which has the potential to trigger deforestation since it is necessary to provide energy plantation forests to provide this energy. There is insufficient biomass waste available to be converted into renewable energy. Efforts to transform renewable energy in Indonesia are still at an early development stage that still requires a lot of improvements.

Non-renewable energy such as natural gas have an insignificant influence on Indonesia's economic growth in the long or short term. There is quite a lot of natural gas available in nature, but it fails to impact to economic growth due to the lack of infrastructure and investment in natural gas management. Demand for energy consumption is still low, while production costs are high, and prices are not yet competitive in the international market. Meanwhile, oil fuel energy consumption has a negative and significant effect on increasing economic growth in the long term. This is due to the dwindling availability of fossil energy, fluctuating prices on the international market, the state's burden on energy subsidies, and environmental pollution which exacerbates government spending in dealing with environmental issues.

CONCLUSION AND SUGGESTION

Meanwhile, electricity in the long and short term has a positive and significant effect on economic growth in Indonesia. However, electricity is still generated from several energy sources, namely coal (non-renewable) and other renewable energy. So maximizing the use of electricity to increase economic growth still has an impact on environmental pollution. In fact, the potential created by utilizing electricity energy is very large, especially if we prioritize the use of renewable energy to produce this energy.

Based on this research, renewable energy is still not reliable for driving economic growth at this time. Dependence on non-renewable energy is still quite large and still has the potential to increase economic growth according to government targets. Although, in the future costs must be incurred to overcome environmental damage.

The government needs to be serious in the efforts to encourage energy transformation of sustainable economic growth which is aligned with the concept of a "green economy". The government needs to be serious about investing in the development of non-renewable energy infrastructure, providing areas, good management, and accessibility for future use. The initial stage will trigger large costs, but if renewable energy has been well conceptualized and implemented, then concerns about the unavailability of non-renewable energy will end.

The implications of this research can provide an impact on the direction of government policy to focus on electricity energy sourced from natural (renewable) energy due to its effects on economic growth and contribution to sustainable development. Limitations in this research include limitations in the scope of research and interpretation of findings which have not specifically focused on discussing each geographic region in Indonesia.

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