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Original Article

# The Impact of Renewable Energy Consumption on Economic Growth in Seven ASEAN Countries

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## Abstract

Renewable energy has become a global priority to reduce fossil fuel dependence and environmental impact. Seven ASEAN countries (Indonesia, Malaysia, Thailand, Vietnam, Philippines, Singapore, Cambodia) face significant challenges in maintaining energy stability while promoting sustainable development. This study analyzes the direct effects of Renewable Energy Consumption, Electricity Consumption, and Trade on Economic Growth from 2014 to 2023 in seven ASEAN countries. Secondary data analysis using a quantitative approach was employed. The sample consisted of seven countries selected through purposive sampling. Panel data analysis was conducted using Eviews10 program. The F-statistic value of 568.6365 exceeded the F-table value of 3.13 at 95% confidence level, rejecting the null hypothesis. Collectively, Renewable Energy Consumption, Electricity Consumption, and Trade significantly influence Economic Growth. Country-specific analysis revealed that renewable energy consumption affects economic growth across all countries, electricity consumption significantly influences growth in Cambodia and Vietnam, while trade contributes to economic growth in Malaysia and Vietnam. The findings demonstrate that energy transition and regional economic integration play crucial roles in supporting long-term economic growth in the ASEAN region. Each country exhibits varying responses to different energy and trade factors, indicating the need for tailored sustainable development approaches.

**Keywords**: Economic Growth, Electricity Consumption, Renewable Energy Consumption, Trade.

## 1. Introduction

Renewable energy has become a global concern as a solution to reduce dependence on increasingly limited fossil energy sources that have negative environmental impacts. In the ASEAN region, energy needs continue to increase along with economic growth and an increasing population (Tongsopit et al., 2016). Seven ASEAN countries, namely Indonesia, Malaysia, Thailand, Vietnam, the Philippines, Singapore, and Cambodia, face major challenges in maintaining energy stability while promoting sustainable development. Despite considerable renewable energy potential, its contribution to the energy mix is still relatively low.

The transition to renewable energy has been a major driver of global economic growth in the last decade from 2014 to 2023. Massive investment in this sector not only strengthens energy resilience, but also opens job opportunities, drives technological innovation, and creates new sustainable markets (Ram et al., 2020). According to an IEA (International Energy Agency) (2022) report, the average contribution of renewable energy in ASEAN is still

below 20% of total primary energy consumption. Meanwhile, energy needs are expected to increase by up to 60% by 2040, raising concerns about the sustainability of energy supply.

The use of renewable energy is important not only from an environmental perspective, but also from an economic perspective (Adiputro & Martini, 2022; de Melo & Solleder, 2020). The availability of clean energy can increase production efficiency, open new jobs in the green technology sector, and reduce dependence on fossil energy imports. This is expected to support economic stability while strengthening regional competitiveness (Barsei et al., 2024). Indonesia actually has the potential for large amounts of renewable energy sources. Some of these can be immediately applied domestically, such as bioethanol as a substitute for gasoline, biodiesel as a substitute for diesel, solar power, wind power, and even waste/garbage can be used to generate electricity. Almost all of these energy sources have been tried on a small scale domestically (Ula & Affandi, 2019).

Electricity consumption in the seven ASEAN countries continues to increase, along with economic growth and urbanization (Lean & Smyth, 2010). Singapore, Thailand, and Malaysia dominate with high consumption, while Indonesia, Vietnam, and the Philippines are at medium levels. Cambodia, which was previously low, shows significant improvement, although it still lags behind other countries. This confirms the importance of energy infrastructure development in ASEAN to meet growing electricity needs. One of the main causes of high energy consumption in Indonesia is the growth of industry, transportation, and domestic sectors. The industrial sector, especially manufacturing and mining industries, requires large amounts of energy for daily operations. Transportation, especially in dense urban areas, uses fossil fuels as the main energy source, causing high per capita energy consumption. On the other hand, the domestic sector also plays an important role in increasing energy consumption, including for household and commercial needs.

Inter-ASEAN trade has been relatively stable during this period, although there were small fluctuations possibly influenced by global economic conditions, including the COVID-19 pandemic in 2020. Singapore occupies the highest position with consistent trade values above 2.5. This reflects Singapore's role as an international trade center in Southeast Asia with very advanced service and logistics sectors. Thailand is in second position, with trade levels around 2.4 to 2.5. This stability shows a strong economy, especially from the industrial and manufacturing export sectors. Vietnam and Malaysia occupy the upper-middle group, with values around 2.1 to 2.2. Both show quite positive trends, especially Vietnam which shows gradual increases since 2014, in line with its industrial growth.

International trade as a percentage of Gross Domestic Product (GDP) has an important relationship with the use of renewable energy and its impact on economic growth. First, renewable energy is becoming increasingly important in global trade due to increasing awareness of environmental issues and the need to reduce dependence on fossil energy resources. Countries that have abundant renewable energy resources, such as solar, wind, and hydro energy, can utilize this comparative advantage to increase their international trade in the renewable energy sector (Ilechukwu & Lahiri, 2022).

Various previous studies show that renewable energy consumption tends to contribute positively to economic growth, although results vary across countries and analytical methods (Bhuiyan et al., 2022; Yang et al., 2022). The relationship between electricity consumption and growth has also been extensively tested, with strong evidence that electricity is an important input for economic activities (Navarro et al., 2024). Meanwhile, trade openness has proven to play a significant role in driving growth in the Asian region, although its effects are not always consistent across periods (Alam & Sumon, 2020; Fadilah et al., 2020; Fahmi, 2025). However, research on ASEAN mostly still examines renewable energy partially and has

not integrated the role of renewable energy consumption, electricity consumption, and trade in one comprehensive empirical model (Tran, 2024; Kostakis et al., 2024).

From the various problems above, researchers are interested in conducting research about the impact of renewable energy consumption on economic growth in 7 ASEAN countries. Seeing the important role of energy in supporting economic activities, the utilization of renewable energy becomes a key strategy in driving sustainable economic growth. Amid continuously increasing energy needs and environmental challenges due to fossil energy use, renewable energy consumption is believed to be a long-term solution. On the other hand, efficient electricity consumption and dynamic trade activities also contribute to increasing national economic output. Therefore, this research aims to analyze the impact of renewable energy consumption, electricity consumption, and trade on economic growth, so as to provide evidence-based policy recommendations to strengthen environmentally friendly and competitive economic development.

## 2. Literature Review

### 2.1. Economic Growth

Economic growth is an increase in the ability of an economy to produce goods and services. In other words, economic growth refers more to changes that are quantitative in nature and are usually measured using gross domestic product data or per capita output income. Economic growth refers to an increase in a country's capacity to produce goods and services in a certain period (Lee & Yue, 2017).

According to Todaro & Smith (2020), economic growth is not only viewed from the size of output, but also from how the distribution and quality of that growth impacts community welfare. Economic growth is the development of activities in the economy that causes the production of goods and services in society to increase so that the quality of life of society also improves (Riani & Iryani, 2023). This increase is caused by several production factors that will always experience additions in quantity and quality.

Economic growth and energy consumption have a positive relationship, meaning that an increase in a country's economic growth will increase energy consumption. Because an increase in a country's GDP will increase that country's tendency to increase their energy consumption (Nurdin & Fuady, 2021). The richer a country is, the greater their ability to meet their energy needs. This results in increased energy consumption in rich countries (Sari & Murialti, 2025).

### 2.2. Renewable Energy Consumption

Energy consumption refers to all energy used to perform an activity, occupy buildings, or simply produce and make something. All energy consumption can be assessed by observing the amount of production and rate of energy consumption in certain production (Siregar, 2024). Energy plays an important and most crucial role in economic growth because energy is understood as the main source in a country's production and manufacturing sectors (Putri & Ibrahim, 2023). Therefore, policies and regulations related to energy are very important in understanding the relationship between economic growth and energy consumption (Rahman et al., 2021).

Renewable energy consumption theory provides a framework for understanding how renewable energy is used and how renewable energy consumption can contribute to sustainable development. According to Johann Schot and Laurens Hessels, this theory explains that the transition from fossil energy to renewable energy is not just about technology,

but also systemic changes in society, policy, and economy. They emphasize the importance of niche innovation (small-scale innovation) to drive major changes in energy systems.

The availability of sufficient energy is one of Indonesia's development capital, energy needs will increase with economic growth. There are various options to meet energy needs, but currently most of the energy used in Indonesia is still based on fossil energy. Renewable energy is abundantly available in Indonesia in the form of solar power, hydropower, geothermal, wind energy, and biomass. Indonesia's abundant renewable energy potential has only been utilized less than 2% in 2015. The consequence that will occur if Indonesia still relies on fossil energy sources as the main energy source is that Indonesia's fossil energy reserves will be depleted more quickly. Another consequence of increasing fossil energy use along with economic growth is increasing greenhouse gas emissions ($CO_2$) from burning fossil energy sources that accelerate global climate change (Rehman et al., 2019; Siddik et al., 2021; Vo et al., 2019).

Renewable energy consumption limitations refer to reduction or cutting of some renewable energy production generated, often for technical or economic reasons. This can happen when renewable energy generators produce more energy than can be absorbed by the power grid, or when renewable energy prices become negative.

## 2.3. Electricity Consumption

Electricity consumption is the amount of electrical energy used by an entity (individual, household, industry, etc.) in a certain period of time. Joskow & Torole (2000) states that electricity consumption is determined by several main factors, including electricity prices, household income, seasonal changes, and level of industrialization (Mirza & Bergland, 2015). Smil (2017) states that electricity consumption per capita reflects the level of economic development of a country. The higher the electricity consumption per person, generally the more advanced the industrial system. However, energy efficiency also plays an important role.

Electricity consumption in Indonesia has developed rapidly since early independence. Initially, electricity was only available in urban areas with very limited coverage. However, over time, the government actively launched various electrification programs to reach remote areas, so that access to electricity became more equitable. To date, more than 98% of Indonesia's territory has been electrified, and per capita electricity consumption continues to increase. This is inseparable from various efforts made by the government in providing wider electricity access and supporting increasingly complex community needs. This increase is influenced by economic growth, urbanization, and technological development (McNeil et al., 2019).

## 2.4. Trade

Trade is an economic activity that involves the process of exchanging goods or services between parties aimed at obtaining profits. Trade can occur directly or indirectly, and can take place at local, national, and international levels. Activities related to transactions of goods and/or services within the country and beyond national boundaries with the aim of transferring rights to goods or services to obtain rewards or compensation. According to Law Number 7 of 2014 concerning Trade (Ministry of Trade, 2014).

The Heckscher-Ohlin trade theory implies that openness is one of the important determining factors of high levels of emissions and economic growth, and pollution is stimulated by further production, which results from greater trade openness (Brondino, 2023). According to Adam Smith (1776), a country should export goods that can be produced more efficiently (cheaper) than other countries, and import goods that are less efficiently produced (Gerdes, 2022).

# 3. Methods

## 3.1. Research Type and Approach

This research uses quantitative methods with a correlational approach. Meanwhile, the approach taken in this research is a quantitative correlational approach. The quantitative correlational approach is research that uses statistical methods to measure and analyze relationships between two or more variables without manipulating or intervening on those variables (Creswell, 2016). The quantitative method was chosen because the research focuses on measuring the link between variables through numerical data, while the correlational approach is used to see the relationship between renewable energy consumption, electricity consumption, and trade to economic growth in seven ASEAN countries (Indonesia, Malaysia, Thailand, Vietnam, Philippines, Singapore, and Cambodia) during the period 2014-2023.

## 3.2. Population and Sample

The study population is all ASEAN member countries. The sample was selected by purposive sampling based on the availability of data during the study period, resulting in 7 countries that met the criteria.

## 3.3. Operational Definition of Variables

The operational definition in this study aims to provide clarity regarding the meaning of the concepts used, so that each research variable can be measured objectively and consistently.

a. Economic Growth

Measured by annual real Gross Domestic Product (GDP) (%):

$$EG = \frac{GDPt + GDPt - 1}{GDPt - 1} \times 100\%$$

Where:

EG = Economic Growth
GDPt = Gross Domestic Product current year
GDPt-1 = Gross Domestic Product previous year

b. Renewable Energy Consumption

Ratio of total renewable energy consumption per capita:

$$REpc = \frac{RE}{P}$$

Where:

REpc = Renewable energy consumption per capita
RE = Total renewable energy consumed
P = Population

c. Electricity Consumption

Total electrical energy used (kWh):

$$E = P \times (t/100)$$

Where:

E = Energy consumed, measured in kilowatt-hours (kwh)
P = Device power rating in watts (w)
T = Duration the device is operated, measured in hours

d. Trade

The export-import ratio is measured by the export and import price indices:

$$TOT = \frac{px}{py} \times 100$$

Where:

Px = Export Price Index
Py = Import Price Index

### 3.4. Data Collection Technique

The data used in this research is secondary data obtained from various official international institutions, including the World Bank (World Development Indicators), International Energy Agency (IEA), and UN Comtrade. The collected data includes indicators of economic growth, renewable energy consumption, electricity consumption, and international trade in seven ASEAN countries (Indonesia, Malaysia, Thailand, Vietnam, Philippines, Singapore, and Cambodia) during the 2014–2023 period. The selection of secondary data is based on the availability of valid, reliable, and consistent information, so it can provide an accurate empirical picture of the relationships between research variables.

### 3.5. Data Analysis Technique

Data analysis was conducted using the panel data regression method that combines time series dimensions (2014–2023) and cross section (seven ASEAN countries). The analysis steps were carried out through several stages. First, a model selection test was performed using the Chow Test to compare common effect and fixed effect, as well as the Hausman Test to determine whether fixed effect or random effect is most appropriate to use. Second, classical assumption tests were conducted including normality, multicollinearity, heteroscedasticity, and autocorrelation tests to ensure the validity of the regression model. Third, hypothesis testing was performed through F-test to examine simultaneous effects and t-test to examine partial effects of each independent variable on the dependent variable at a 5% significance level. All data processing was conducted with the assistance of EViews version 12 software.

## 4. Results and Discussion

### 4.1. Analysis Results

#### 4.1.1. Economic Growth Variable

**Table 1. Descriptive Statistics of Economic Growth (PE)**

| Date: 07/07/25 Time: 13:11 | |
|---|---|
| Sample: 2014 2023 | |
| | LPE |
| Mean | 3.796916 |
| Median | 3.614018 |
| Maximum | 4.946593 |
| Minimum | 3.155811 |
| Std. Dev. | 0.480755 |
| Skewness | 1.201505 |
| Kurtosis | 3.439583 |
| Jarque-Bera | 17.40577 |
| Probability | 0.000166 |
| Sum | 265.7841 |
| Sum Sq. Dev. | 15.94767 |
| Observations | 70 |

Source: Eviews12 Output, 2025

Overall, the average (mean) economic growth during the observation period is 3.80%, with a maximum value of 4.95% and minimum 3.16%, indicating variations in growth between years. The standard deviation value of 0.48 indicates that economic growth value fluctuations are relatively low around the average.

### 4.1.2. Renewable Energy Consumption Variable

**Table 2. Descriptive Statistics of Renewable Energy Consumption (KSET)**

| Date: 07/07/25 Time: 13:20 | |
|---|---|
| Sample: 2014 2023 | |
| | LKSET |
| Mean | 1.061318 |
| Median | 1.286563 |
| Maximum | 1.804139 |
| Minimum | -0.221849 |
| Std. Dev. | 0.558684 |
| Skewness | -0.764851 |
| Kurtosis | 2.786169 |
| Jarque-Bera | 6.958323 |
| Probability | 0.030833 |
| Sum | 74.29223 |
| Sum Sq. Dev. | 21.53685 |
| Observations | 70 |

Source: Eviews12 Output, 2025

Based on the results above, the average renewable energy consumption in logarithmic form during the research period is 1.06, with a maximum value of 1.80 and minimum -0.22. The standard deviation value of 0.56 shows moderate variation between observations.

### 4.1.3. Electricity Consumption Variable

**Table 3. Descriptive Statistics of Electricity Consumption Variable (KSL)**

| Date: 07/07/25 Time: 13:27 | |
|---|---|
| Sample: 2014 2023 | |
| | LKSL |
| Mean | 3.145961 |
| Median | 2.995317 |
| Maximum | 3.982271 |
| Minimum | 2.556242 |
| Std. Dev. | 0.380687 |
| Skewness | 0.469185 |
| Kurtosis | 2.044588 |
| Jarque-Bera | 5.230602 |
| Probability | 0.073146 |
| Sum | 220.2172 |
| Sum Sq. Dev. | 9.999639 |
| Observations | 70 |

Source: Eviews12 Output, 2025

The average electricity consumption in logarithmic form during the observation period is 3.15, with a maximum value of 3.98 and minimum 2.56. The standard deviation of 0.38 shows relatively moderate variation between observations.

### 4.1.4. Trade Variable

**Table 4. Descriptive Statistics of Trade (PDGN)**

| Date: 07/07/25 Time: 13:28 | |
|---|---|
| Sample: 2014 2023 | |
| | LPDGN |
| Mean | 2.062678 |
| Median | 2.095682 |
| Maximum | 2.556866 |
| Minimum | 1.518148 |
| Std. Dev. | 0.271285 |
| Skewness | -0.126646 |
| Kurtosis | 2.504342 |
| Jarque-Bera | 0.903684 |
| Probability | 0.636455 |
| Sum | 144.3875 |
| Sum Sq. Dev. | 5.078098 |
| Obse$rvations | 70 |

Source: Eviews12 Output, 2025

The average trade sector consumption in logarithmic form is 2.06, with a maximum value of 2.56 and minimum of 1.52, showing relatively moderate differences between years. The standard deviation value of 0.27 shows quite low data spread around its average.

### 4.1.5. Data Testing Results

#### a. F Statistical Test (Chow Test)

To determine whether the panel regression model used should use the common effect or fixed effect approach, the Chow Test (F-statistic test) was conducted. This test aims to see whether there are significant differences between entities (cross-section) in the model used. Below is the figure of Redundant Fixed Effects Test (Chow Test) results from Eviews output.

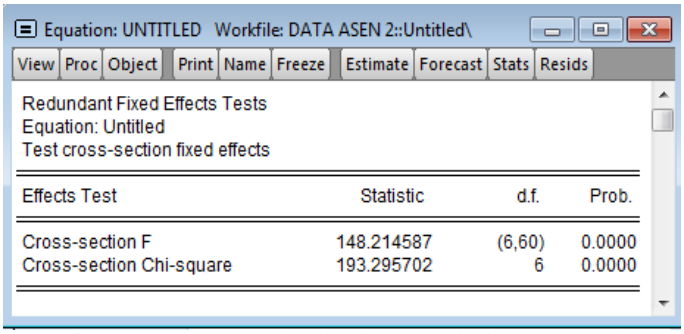



**Figure 1. F Statistical Test (Chow Test)**
Source: Eviews12 Output, 2025

From the test results figure 1 above, it shows that the F statistic value is 148.21 and the probability value (p-value) is 0.0000, which is far below the 5% significance level (0.05). Thus, $H_0$ (common effect model) is rejected, and $H_1$ (fixed effect model) is accepted.

#### b. Hausman Test

After knowing that the fixed effect model is more appropriate than the common effect (through the Chow Test), the next step is to conduct the Hausman Test. This test aims to determine whether the most suitable panel regression model is fixed effect or random effect.

The Hausman test tests whether there is a correlation between individual effects (cross-section) and independent variables in the model.

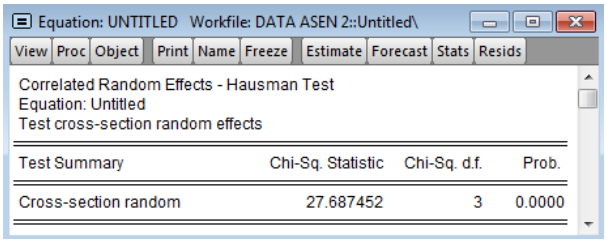



**Figure 2. Hausman Test**
Source: Eviews12 Output, 2025

The test results show a Chi-Square statistic value of 27.6875 with a probability of 0.0000. Because the probability value is also smaller than 0.05, the null hypothesis (random effect) is rejected. This means there is a correlation between individual effects and independent variables, so the fixed effect model is more appropriate than random effect.

## c. Normality Test

Residual normality test is conducted to ensure that errors in the regression model are normally distributed. The normality assumption is important to guarantee the validity of statistical tests such as t-test and F-test, although in panel data, violations of this assumption can be tolerated if the sample size is large and robust estimation methods are used.

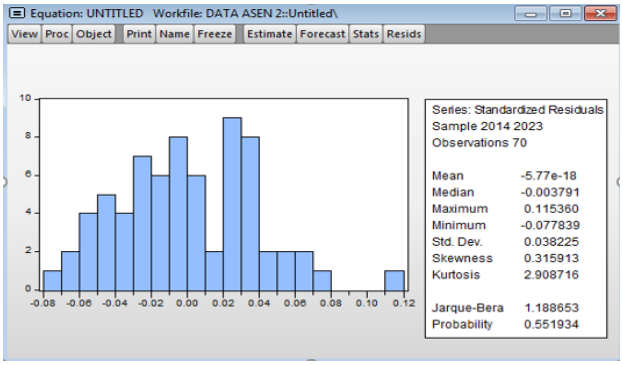



**Figure 3. Normality Test**
Source: Eviews12 Output, 2025

Based on the test results above, the Jarque-Bera value is 1.1887 with a probability of 0.5519, which is much larger than the 5% significance level (0.05). This means the null hypothesis (Ho) stating that residuals are normally distributed cannot be rejected. In other words, the model residuals are statistically normally distributed.

## d. Multicollinearity Test

In regression analysis, multicollinearity test is conducted to determine whether there is a strong linear relationship between independent variables in the model. High multicollinearity can cause instability in regression parameter estimation and make interpretation of results difficult.

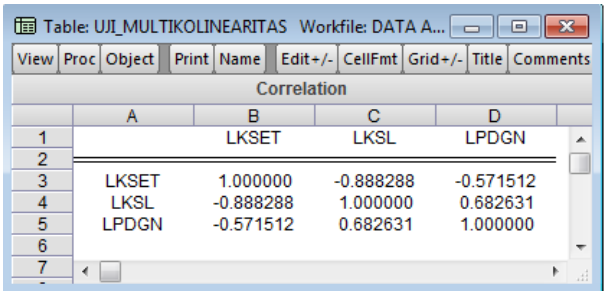


Table: UJI_MULTIKOLINEARITAS Workfile: DATA A...

View | Proc | Object | Print | Name | Edit+/- | CellFmt | Grid+/- | Title | Comments

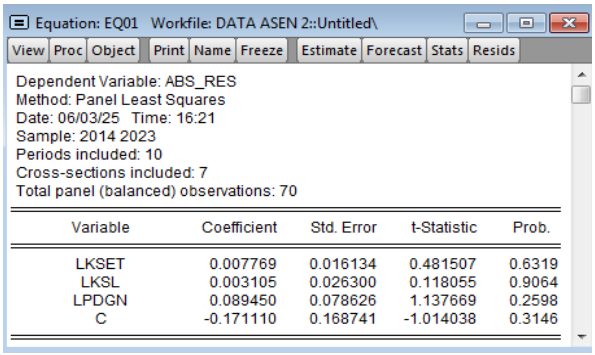
Correlation

| | A | B | C | D |
|---|---|---|---|---|
| 1 | | LKSET | LKSL | LPDGN |
| 2 | | | | |
| 3 | LKSET | 1.000000 | -0.888288 | -0.571512 |
| 4 | LKSL | -0.888288 | 1.000000 | 0.682631 |
| 5 | LPDGN | -0.571512 | 0.682631 | 1.000000 |
| 6 | | | | |
| 7 | | | | |

**Figure 4. Multicollinearity Test**
Source: Eviews12 Output, 2025

Based on the multicollinearity test results above, it can be known that the relationship between Renewable Energy Consumption (LKSET), Electricity Consumption (LKSL), and Trade (LPDGN) variables shows varying correlation levels. The highest correlation value is between Renewable Energy Consumption (LKSET) and Electricity Consumption (LKSL) variables with a value of -0.888288. Although this value shows a very strong negative relationship, it is still below the cutoff threshold of 0.90 used as a benchmark to detect multicollinearity. Thus, the relationship between Renewable Energy Consumption (LKSET) and Electricity Consumption (LKSL) does not yet meet the criteria to be categorized as multicollinearity. Meanwhile, the relationship between Renewable Energy Consumption (LKSET) and Trade (LPDGN) shows a correlation value of -0.571512, indicating a moderate negative relationship. The relationship between Electricity Consumption (LKSL) and Trade (LPDGN) shows a positive correlation of 0.682631, also in the moderate relationship category. Both relationships are clearly far below the 0.90 cutoff limit and do not raise concerns about multicollinearity in the model. Thus, based on the correlation analysis above, it can be concluded that there are no multicollinearity problems between variables in the model.

## e. Heteroscedasticity Test


Equation: EQ01 Workfile: DATA ASEN 2::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: ABS_RES
Method: Panel Least Squares
Date: 06/03/25 Time: 16:21
Sample: 2014 2023
Periods included: 10
Cross-sections included: 7
Total panel (balanced) observations: 70

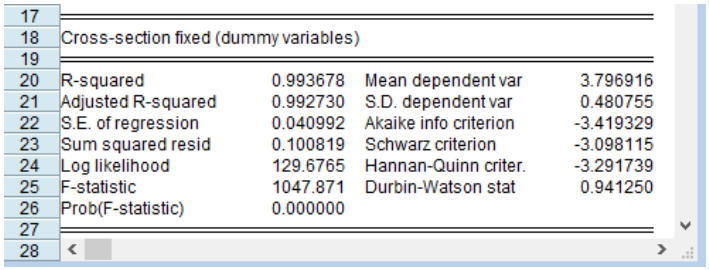
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| LKSET | 0.007769 | 0.016134 | 0.481507 | 0.6319 |
| LKSL | 0.003105 | 0.026300 | 0.118055 | 0.9064 |
| LPDGN | 0.089450 | 0.078626 | 1.137669 | 0.2598 |
| C | -0.171110 | 0.168741 | -1.014038 | 0.3146 |

**Figure 5. Heteroscedasticity Test**
Source: Eviews12 Output, 2025

From the heteroscedasticity test results above, all probability values (p-values) from each independent variable are far above the 0.05 significance level (5%). The Renewable Energy Consumption (LKSET) variable has a p-value of 0.6319, Electricity Consumption (LKSL) of 0.9064, and Trade (LPDGN) of 0.2598. This shows that none of the variables significantly affect the variation in absolute residual values, so it can be concluded that the variance is the same, in other words, there are no heteroscedasticity problems in the model.

### f. Autocorrelation Test

Autocorrelation test aims to detect whether there is a systematic relationship (correlation) between residuals (errors) in one period with residuals in the previous period in the regression model.



| | | | | |
|---|---|---|---|---|
| 17 | | | | |
| 18 | Cross-section fixed (dummy variables) | | | |
| 19 | | | | |
| 20 | R-squared | 0.993678 | Mean dependent var | 3.796916 |
| 21 | Adjusted R-squared | 0.992730 | S.D. dependent var | 0.480755 |
| 22 | S.E. of regression | 0.040992 | Akaike info criterion | -3.419329 |
| 23 | Sum squared resid | 0.100819 | Schwarz criterion | -3.098115 |
| 24 | Log likelihood | 129.6765 | Hannan-Quinn criter. | -3.291739 |
| 25 | F-statistic | 1047.871 | Durbin-Watson stat | 0.941250 |
| 26 | Prob(F-statistic) | 0.000000 | | |
| 27 | | | | |
| 28 | | | | |

**Figure 6. Autocorrelation Test**
Source: Eviews12 Output, 2025

## 4.1.6. Hypothesis Testing Results

### a. Partial Test (t-test)

#### 1) Philippines

**Table 5. Results of t-statistic Testing on Philippines Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | -1.502228 | Ho accepted | Not Significant |
| LKSL | 1.519914 | Ho accepted | Not Significant |
| LPDGN | 0.656920 | Ho accepted | Not Significant |

Source: Eviews12 Output, 2025

From the table 5 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of -1.502228, which is greater than t-table (-1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Renewable Energy Consumption (LKSET) variable does not affect the Economic Growth (LPE) variable.

b. The independent variable Electricity Consumption (LKSL) has a t-stat of 1.519914, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Electricity Consumption (LKSL) variable does not affect the Economic Growth (LPE) variable.

c. The independent variable Trade (LPDGN) has a t-stat of 0.656920, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Trade (LPDGN) variable does not affect the Economic Growth (LPE) variable.

#### 2) Indonesia

**Table 6. Results of t-statistic Testing on Indonesia Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | -0.936413 | Ho accepted | Not Significant |
| LKSL | 0.779955 | Ho accepted | Not Significant |
| LPDGN | -1.038273 | Ho accepted | Not Significant |

Source: Eviews12 Output, 2025

From the table 6 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of -0.936413, which is greater than t-table (-1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Renewable Energy Consumption (LKSET) variable does not affect the Economic Growth (LPE) variable.
b. The independent variable Electricity Consumption (LKSL) has a t-stat of 0.779955, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Electricity Consumption (LKSL) variable does not affect the Economic Growth (LPE) variable.
c. The independent variable Trade (PDGN) has a t-stat of -1.038273, which is greater than t-table (-1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Trade (PDGN) variable does not affect the Economic Growth (LPE) variable.

### 3) Cambodia

**Table 7. Results of t-statistic Testing on Cambodia Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | 0.458415 | Ho accepted | Not Significant |
| LKSL | 3.004133 | Ho rejected | Significant at α = 5% |
| LPDGN | 1.180957 | Ho accepted | Not Significant |

Source: Eviews12 Output, 2025

From the table 7 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of 0.458415, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Renewable Energy Consumption (LKSET) variable does not affect the Economic Growth (LPE) variable.
b. The independent variable Electricity Consumption (LKSL) has a t-stat of 3.004133, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected. It can be concluded that partially the Electricity Consumption (LKSL) variable affects the Economic Growth (LPE) variable.
c. The independent variable Trade (LPDGN) has a t-stat of 1.180957, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Trade (LPDGN) variable does not affect the Economic Growth (LPE) variable.

### 4) Malaysia

**Table 8. Results of t-statistic Testing on Malaysia Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | 1.714594 | Ho rejected | Significant at α = 5% |
| LKSL | 1.217130 | Ho accepted | Not Significant |
| LPDGN | 2.556483 | Ho rejected | Significant at α = 5% |

Source: Eviews12 Output, 2025

From the table 8 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of 1.714594, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected.

It can be concluded that partially the Renewable Energy Consumption (LKSET) variable affects the Economic Growth (LPE) variable.

b. The independent variable Electricity Consumption (LKSL) has a t-stat of 1.217130, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Electricity Consumption (LKSL) variable does not affect the Economic Growth (LPE) variable.

c. The independent variable Trade (LPDGN) has a t-stat of 2.556483, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected. It can be concluded that partially the Trade (LPDGN) variable affects the Economic Growth (LPE) variable.

### 5) Singapore

**Table 9. Results of t-statistic Testing on Singapore Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | 3.668778 | Ho rejected | Significant at α = 5% |
| LKSL | 0.728171 | Ho accepted | Not Significant |
| LPDGN | 0.464498 | Ho accepted | Not Significant |

Source: Eviews12 Output, 2025

From the table 9 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of 3.668778, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected. It can be concluded that partially the Renewable Energy Consumption (LKSET) variable affects the Economic Growth (LPE) variable.

b. The independent variable Electricity Consumption (LKSL) has a t-stat of 0.728171, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Electricity Consumption (LKSL) variable does not affect the Economic Growth (LPE) variable.

c. The independent variable Trade (LPDGN) has a t-stat of 0.464498, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Trade (LPDGN) variable does not affect the Economic Growth (LPE) variable.

### 6) Thailand

**Table 10. Results of t-statistic Testing on Thailand Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | 8.464940 | Ho rejected | Significant at α = 5% |
| LKSL | -0.156644 | Ho accepted | Not Significant |
| LPDGN | 0.464498 | Ho accepted | Not Significant |

Source: Eviews12 Output, 2025

From the table 10 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of 8.464940, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected. It can be concluded that partially the Renewable Energy Consumption (LKSET) variable affects the Economic Growth (LPE) variable.

b. The independent variable Electricity Consumption (LKSL) has a t-stat of -0.156644, which is greater than t-table (-1.66827, α = 0.05), so hypothesis Ho is accepted. It can

be concluded that partially the Electricity Consumption (LKSL) variable does not affect the Economic Growth (LPE) variable.

c. The independent variable Trade (LPDGN) has a t-stat of 0.464498, which is smaller than t-table (1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Trade (LPDGN) variable does not affect the Economic Growth (LPE) variable.

**7) Vietnam**

**Table 11. Results of t-statistic Testing on Vietnam Economic Growth**

| Independent Variable | t-stat | Hypothesis Ho | Conclusion |
|---|---|---|---|
| LKSET | -0.589188 | Ho accepted | Not Significant |
| LKSL | 7.177358 | Ho rejected | Significant at α = 5% |
| LPDGN | 8.234193 | Ho rejected | Significant at α = 5% |

Source: Eviews12 Output, 2025

From the table 11 above, it can be explained as follows:

a. The independent variable Renewable Energy Consumption (LKSET) has a t-stat of -0.589188, which is greater than t-table (-1.66827, α = 0.05), so hypothesis Ho is accepted. It can be concluded that partially the Renewable Energy Consumption (LKSET) variable does not affect the Economic Growth (LPE) variable.

b. The independent variable Electricity Consumption (LKSL) has a t-stat of 7.177358, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected. It can be concluded that partially the Electricity Consumption (LKSL) variable affects the Economic Growth (LPE) variable.

c. The independent variable Trade (LPDGN) has a t-stat of 8.234193, which is greater than t-table (1.66827, α = 0.05), so hypothesis Ho is rejected. It can be concluded that partially the Trade (LPDGN) variable affects the Economic Growth (LPE) variable.

### b. Joint Impact of Renewable Energy Consumption, Electricity Consumption and Trade on Economic Growth

The F-stat value from panel data regression has an F-stat of 568.6365, which is greater than the F-table value of 3.13 (F-stat 568.6365 > F table 3.13) at the 95% confidence level, so hypothesis Ho is rejected. It can be concluded that jointly, the independent variables LKSET, LKSL and LPDGN used in the model affect the dependent variable economic growth.

## 4.2. Discussion

The results of this research indicate that renewable energy consumption significantly affects economic growth in Malaysia, Singapore, and Thailand, while in the Philippines, Indonesia, Cambodia, and Vietnam the effect is not significant. This finding indicates that the positive impact of renewable energy on the economy is highly dependent on infrastructure readiness and national policies. Countries that successfully integrate renewable energy into their national energy systems can obtain benefits in the form of increased production efficiency, creation of new jobs, and strengthened industrial competitiveness. This is in line with the study by Ram et al. (2020) which emphasizes the role of energy transition in driving global economic growth through the creation of new markets and technological innovation, as well as findings by Ula & Affandi (2019) which prove the significant contribution of renewable energy to growth in Southeast Asia. However, infrastructure limitations and high investment costs make some ASEAN countries still struggle to maximize renewable energy potential (IEA, 2022).

Meanwhile, electricity consumption was found to significantly affect economic growth only in Cambodia and Vietnam. This condition illustrates that in developing countries with still growing electrification levels, increased electricity consumption can directly support productive activities, such as industrialization and service sector expansion. This result is consistent with research by Lean & Smyth (2010) which found a close relationship between electricity consumption, CO2 emissions, and economic growth in the ASEAN region. Conversely, in countries with already high electrification levels such as Singapore and Malaysia, additional electricity consumption no longer has a major impact on growth because the basic energy needs of society and industry have been relatively fulfilled. This pattern is also supported by McNeil et al. (2019) which shows that electricity consumption in Indonesia tends to approach saturation point along with the high electrification ratio, so economic growth is more determined by other factors such as energy efficiency and technological innovation.

From the trade perspective, the results of this research show that trade variables significantly affect economic growth in Malaysia and Vietnam, but not in other countries. This positive relationship can be explained through the Heckscher-Ohlin theory, where trade openness increases production and economic output through utilization of comparative advantages (Brondino, 2023). Malaysia and Vietnam successfully optimized international trade integration, particularly in the manufacturing sector, so that trade contribution to GDP is greater. Research by Ilechukwu & Lahiri (2022) also strengthens this finding by showing that the linkage between international trade and renewable energy consumption becomes an important factor in driving sustainable economic growth. Conversely, countries with stronger domestic economic orientation tend not to experience significant effects from trade on growth.

Simultaneously, this research proves that renewable energy consumption, electricity consumption, and trade together significantly affect economic growth in the ASEAN region. This result confirms the importance of integrating green energy transition policies with strengthening regional trade and energy infrastructure development. This is consistent with findings by Tongsopit et al. (2016) which emphasize that synergy between energy transition and regional integration can improve energy security while supporting sustainable development targets in ASEAN. Therefore, despite variations in results between countries, it can be concluded that renewable energy, electricity, and trade are important pillars that complement each other in driving sustainable economic growth in this region.

## 5. Conclusion

The purpose of this research is to analyze the effect of renewable energy consumption, electricity consumption, and trade on economic growth in seven ASEAN countries. The research results show that renewable energy consumption affects economic growth in some countries such as Malaysia, Singapore, and Thailand, but does not significantly affect other countries such as the Philippines, Indonesia, Cambodia, and Vietnam. Electricity consumption has a real effect only in Cambodia and Vietnam, while in other countries it does not show a meaningful relationship. Meanwhile, trade plays an important role in driving economic growth in Malaysia and Vietnam, but does not have a significant effect in other ASEAN countries. This finding confirms that the contribution of renewable energy, electricity consumption, and trade to economic growth is not uniform throughout the region.

Based on these results, it is recommended that ASEAN countries strengthen energy transition policies by adjusting to each country's domestic potential and needs. Countries that already show positive effects from renewable energy need to expand their clean energy mix, while countries with still weak effects need to build infrastructure and improve energy

consumption efficiency. In addition, international trade can be maximized as a growth driver in potential countries, while still paying attention to sustainability and competitiveness. Regional collaboration efforts, environmentally friendly technology investment, and policies that differ according to the characteristics of each country are very necessary, because this research shows that there is no single strategy that can be applied to the entire ASEAN region.

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