Aswadi, Khairul; Jamal, Abdul; Syahnur, Sofyan et al.

Article

Renewable and non-renewable energy consumption in Indonesia : does it matter for economic growth?

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Aswadi, Khairul/Jamal, Abdul et. al. (2023). Renewable and non-renewable energy consumption in Indonesia : does it matter for economic growth?. In: International Journal of Energy Economics and Policy 13 (2), S. 107 - 116.
https://econjournals.com/index.php/ijeep/article/download/13900/7190/32593.
doi:10.32479/ijeep.13900.

This Version is available at:
http://hdl.handle.net/11159/593919

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2023, 13(2), 107-116.

Renewable and Non-renewable Energy Consumption in Indonesia: Does it Matter for Economic Growth?

Khairul Aswadi[1,2], Abd. Jamal[1]*, Sofyan Syahnur[1], Muhammad Nasir[1]

[1]Faculty of Economics and Bussines, Universitas Syiah Kuala, Banda Aceh, Indonesia, [2]Faculty of Economics and Bussines, Universitas Islam Kebangsaan Indonesia, Bireuen, Indonesia. *Email: abdjamal@unsyiah.ac.id

Received: 01 November 2022 **Accepted:** 10 February 2023 **DOI:** https://doi.org/10.32479/ijeep.13900

ABSTRACT

During the last decade, the energy sector has become important in shaping a country's economy. This study aims to analyze renewable and non-renewable energy's impact on Indonesia's economic growth. This study uses a quantitative method, using the Johansen cointegration test and FMOLS and DOLS cointegrating regression. The data period used in this study is from 1990 to 2019. The results of the study show that renewable energy consumption has a negative effect on Indonesia's economic growth. This is because renewable energy production is still limited, but the level of consumption continues to increase. Consumption of non-renewable energy has a positive effect on Indonesia's economic growth. The consumption of fossil energy causes this is still very high in Indonesia. Dependence on fossil energy is still high amid renewable energy production, which the government is continuously promoting. In general, energy consumption positively affects Indonesia's economic growth. When the two are combined, they positively contribute to the national economy.

Keywords: Cointegrating Regression, Economic Growth, Non-renewable Energy Consumption, Renewable Energy Consumption
JEL Classifications: O13; O40; Q20; Q30; Q43

1. INTRODUCTION

The energy demand has increased rapidly around the world. Despite the evolving global context of absorbing energy consumption for a clean environment, the increase in energy demand is expected to grow even more in 2040 (U.S. Energy Information Administration (IEA), 2017). Fossil fuels supply about 80% of the world's energy needs. Population and GDP growth rates mainly drove the increase in world energy demand. Economic growth in the Asian region, which contributes to world economic growth, greatly influences the share of world energy. Based on IEA projections for the 2006-2030 period, most of the world's energy demand comes from non-OECD countries (IEA, 2021).

Sustainable economic growth is economic development that seeks to meet human needs but in a way that preserves natural resources and the environment for future generations. High economic growth has increased energy demand, carbon emissions, and global warming (Ozturk and Al-Mulali, 2015; Manta et al., 2020; Tong et al., 2020). Global warming has forced policymakers to take action. Measures to reduce energy demand can affect economic growth. Warnings about renewable and non-renewable energy greatly affect global economic performance (Guo et al., 2022; Sha, 2022), especially for developing countries that urgently need energy (Shahbaz et al., 2020). If there are bottlenecks or shortages in energy supply, it can lead to cost increases that can pressure the economy and disrupt prospects for sustainable development.

Achieving environmental sustainability while minimizing the effects of climate change has become a global endeavor (Baydoun and Aga, 2021). The process of producing fossil fuels that originate from petroleum, natural gas and coal, is very dangerous for the environment which is considered to increase CO_2 emissions and damage the environment (Nawaz et al., 2020; Hubacek et al., 2021; Li et al., 2022). One of the main methods to deal with environmental damage is to use renewable energy consumption, which comes from solar, wind, hydropower, and biomass energy. Unlike non-renewable energy, most renewable energy produces little or almost zero greenhouse gas emissions (Liu et al., 2021).

The importance of developing renewable energy to achieve net-zero emissions by 2050 has gradually emerged, marked by the presence of the Kyoto Protocol on environmental policy and the 26th Conference of Parties (COP26) for the United Nations Framework Convention on Climate Change (UNFCCC) held in November 2021 in Glasgow, United Kingdom. Several countries reached a common consensus in which all signatories aim to accelerate the energy transition and control climate change and global warming (Dogan et al., 2020). This is a big step in line with the Sustainable Development Goals/SDGs. The Kyoto Protocol has had a significant positive impact on the energy transition. The Kyoto Protocol is based on principles and policies emphasizing economically developed and industrialized countries to improve environmental quality and reduce greenhouse gases by promoting renewable energy resources (Dogan et al., 2022).

Indonesia has abundant renewable energy resources of more than 3,000 GW, mainly solar, wind, hydropower, bioenergy, marine, and geothermal energy. The energy transition is critical in the current global climate situation, considering that Indonesia's primary energy mix is still dominated by fossil energy, which accounts for around 90% of national energy production (IRENA, 2022). As stated in the National Energy General Plan (RUEN) program, Indonesia has a target of using renewable energy for the primary energy mix of 23% in 2025 and 31% in 2050 (GoI, 2017). Indonesia aspires to reduce 29-41% of national carbon emissions in 2030 and achieve net zero emissions in 2060 (Chandrarin et al., 2022). Thus, renewable energy is the right choice for sustainable economic growth, reducing the effects of climate change, and creating energy security in Indonesia.

2. LITERATURE REVIEW

2.1. Renewable Energy Consumption and Economic Growth

A study by Kraft and Kraft (1978) explores the relationship between energy consumption and economic growth, often manifested in four hypotheses: The first hypothesis, referred to as the growth hypothesis, states that there is a unidirectional causal effect of energy consumption on economic growth. It states that energy is an important input in production. Thus, energy consumption or policy changes will affect economic growth significantly. The second is the conservation hypothesis, which states that economic growth has a unidirectional causal effect on energy consumption. The third hypothesis is the feedback hypothesis which states that there is a two-way causal relationship between energy consumption and economic growth. Finally, the neutrality hypothesis states that there is no causality between energy consumption and economic growth in both directions.

In recent decades there has been significant attention to developing renewable energy for sustainable economic growth (Table 1). Results from studies testing this hypothesis have been mixed. One of the main reasons for the differences in the empirical findings of these studies is the differences in the econometric methodologies used by the researchers. Using the NARDL model from 1990 to 2016, Luqman et al. (2019) investigated the asymmetric impact of renewable and nuclear energy on Pakistan's economic growth. The results of the study reveal that there is asymmetric cointegration between the variables. Positive and negative shocks to renewable and nuclear energy variables positively impact Pakistan's economic growth. Next, Bouyghrissi et al. (2020) analyzed the relationship between renewable and non-renewable energy consumption, CO_2 emissions, and economic growth in Morocco from 1990 to 2014 using the ARDL model approach and the Granger causality test. Empirical results support that renewable energy in Morocco has a positive effect on the economic dimension of sustainable development and found causality from renewable energy consumption on economic growth. Likewise, Slusarczyk et al. (2022) investigated the mutual correlation between renewable energy sources and economic growth for the two European Union economies. A comparative analysis was conducted for the low-income Polish and high-income Swedish economies. They use the regression model to answer research questions examining the correlation between renewable energy sources and economic growth. This study analyzes data from 1991 to 2022. The results show a positive correlation (statistical significance) between the variables Gross Domestic Product and Gross National Income for Sweden (84.6% and 83.7%, respectively) and Poland (respectively 79.9% and 79.2%, respectively, which affect the use of renewable energy sources.

Furthermore, Dasanayaka et al. (2022) analyzed the effect of renewable energy on the economic growth of Sri Lanka, an island country in South Asia. They use a structural equation modeling approach. The results of the study show that there is no significant direct effect of renewable energy consumption on Sri Lanka's GDP. Sri Lanka has aligned the country's economic strategy with global trends and aims to become a 100% sustainable energy-dependent country by 2050.

Ocal and Aslan (2013) examined the causal relationship between renewable energy consumption and economic growth in Turkey. The study results support the conservation hypothesis. The empirical test results of the ARDL approach show that renewable energy consumption negatively impacts economic growth, and the Toda-Yamamoto causality test shows unidirectional causality from economic growth to renewable energy consumption. Likewise, Lee and Jung (2018) examined the causal relationship between renewable energy consumption and economic growth in South Korea, using the ARDL cointegration technique and the VECM causality test for the period 1990-2012. The results support the conservation hypothesis for South Korea. The ARDL limit test results show that renewable energy consumption negatively affects economic growth, and the VECM causality test results show a unidirectional relationship between economic growth and renewable energy consumption. They implied that economic growth is a direct driver of using renewable energy

Table 1: Summary of literature review

Author	Country	Period	Methodology	Results
Tiwari (2011)	India	1960-2009	SVAR	REC ↔ GDP
Jafari et al. (2012)	Indonesia	1971-2007	toda-yamamoto	NREC ≠ GDP
Ocal and Aslan (2013)	Turkey	1990-2010	ARDL	GDP → REC
Lin and Moubarak (2014)	China	1977-2011	ARDL VECM granger causality	REC ↔ GDP
Shahbaz et al. (2015)	Pakistan	1972Q1-2011Q4	ARDL VECM granger causality	REC ↔ GDP
Boontome et al. (2017)	Thailand	1971-2013	Causality model	REC ≠ GDP NREC ≠ GDP
Brini et al. (2017)	Tunisia	1980-2011	ARDL	REC (-) → GDP
Mbarek et al. (2017)	Tunisia	1990-2015	VECM granger causality	REC → GDP NREC → GDP
Rafindadi and Ozturk (2017)	Germany	1971Q1-2013QIV	ARDL VECM granger causality	REC ↔ GDP
Shakouri and Yazdi (2017)	South Africa	1971-2015	ARDL VECM granger causality	REC ↔ GDP NREC ↔ GDP
Yazdi and Shakouri (2017)	Iran	1979-2014	ARDL VECM granger causality	REC ↔ GDP NREC ↔ GDP
Lee and Jung (2018)	South Korea	1990-2012	ARDL VECM granger causality	GDP → REC
Tugcu and Topcu (2018)	G7 Countries	1980-2014	NARDL Asymmetric Causality	REC → GDP NREC → GDP
Wang et al. (2018)	Pakistan	1990-2014	2SLS model VECM granger causality	REC ≠ GDP
Can and Korkmaz (2019)	Bulgaria	1990-2016	ARDL toda-yamamoto	REC ≠ GDP
Luqman et al. (2019)	Pakistan	1990-2016	NARDL asymmetric causality	REC → GDP
Pegkas (2019)	Greece	1990-2016	ARDL	REC → GDP NREC → GDP
Tuna and Tuna (2019)	ASEAN-5 Countries	1980-2015	Hatemi-j (2012) Test	REC ↔ GDP
Bouyghrissi et al. (2020)	Morocco	1990-2014	ARDL granger causality	REC → GDP NREC ≠ GDP
Fan and Hao (2020)	China	2000-2015	VECM granger causality	GDP → REC
Razmi et al. (2020)	Iran	1990-2014	ARDL	REC ≠ GDP
Baz et al. (2021)	Pakistan	1980-2017	NARDL asymmetric causality	REC ↔ GDP NREC ≠ GDP
Cevik et al. (2021)	United states	1973-2019	Granger causality	REC ≠ GDP NREC ↔ GDP
Elfaki et al. (2021)	Indonesia	1984-2018	ARDL, FMOLS, DOLS, CCR	NREC → GDP
Namahoro et al. (2021)	Rwanda	1990-2015	NARDL asymmetric causality	GDP → REC
Salari et al. (2021)	United states	2000-2016	GMM	REC (-) → GDP NREC → GDP
Zhe et al. (2021)	Turkey	1990-2015	VAR	REC (-) → GDP
Benlaria and Hamid Hamad, 2022)	Saudi Arabia	1990-2019	NARDL	REC (-) → GDP
Dasanayaka et al. (2022)	Sri Lanka	1990-2018	SEM models	REC → GDP
Gyimah et al. (2022)	Ghana	1990-2015	Granger causality	REC ↔ GDP
He and Huang (2022)	China	1990-2020	Granger causality	REC ↔ GDP
Slusarczyk et al. (2022)	Polish and Swedish	1991-2022	Regression model	REC → GDP
Minh and Van (2023)	Vietnam	1995-2019	ARDL ECM granger causality	GDP → REC

→ unidirectional, ↔ bidirectional, ≠ neutral

in South Korea. Next, Namahoro et al. (2021) examined the asymmetric relationship between renewable energy consumption and economic growth using the NARDL model and causality tests from 1990 to 2015 in Rwanda. The results of the study show evidence that renewable energy consumption affects economic growth in Rwanda.

Furthermore, Zhe et al. (2021) evaluated the positive impact of using renewable energy on economic growth in Turkey from 1990 to 2015 using VAR analysis. The findings show that the use of renewable energy does not have a strong influence on economic growth. Likewise, Benlaria and Hamid Hamad (2022) studied the asymmetrical relationship between renewable energy consumption and economic growth combining capital and labor for the case of Saudi Arabia during the 1990-2019 period. The NARDL cointegration model is used to test the asymmetric cointegration between variables. The results of the study show that there is an asymmetrical relationship between the variables. Policies to promote economic growth are essential for boosting the renewable energy sector in Saudi Arabia. Then the latest study by Minh and Van (2023) examines the relationship between real GDP and the use of renewable energy in Vietnam for the 1995-2019 period. They use the ARDL model to evaluate the relationship between renewable energy consumption, capital, labor, and economic growth in the long run and determine causality using the Granger causality test. This study establishes a conservative effect indicating a unidirectional relationship between renewable energy use and economic growth, and the relationship lasts in the long run.

However, several other studies on the relationship between renewable energy consumption and economic growth have found evidence to support the feedback hypothesis. Lin and Moubarak (2014) investigated the relationship between renewable energy consumption and economic growth in China for the period 1977-2011. They used the ARDL approach for cointegration and the Granger causality test to determine the direction of causality between variables. The results of the study show that there is a long-term two-way causality relationship between renewable energy consumption and economic growth. These findings imply that economic growth in China is beneficial for developing the renewable energy sector, which in turn helps drive economic growth. Next, Shahbaz et al. (2015) examined the relationship between renewable energy consumption and economic growth by including capital and labor as determinants of the potential production function in the case of Pakistan and using the ARDL model for cointegration and causality analysis using Granger's VECM causality. This study uses quarterly data for the period 1972Q1-2011Q4. The study results show that all the variables in the study are cointegrated, indicating a long-term relationship between variables.

Furthermore, renewable energy, capital, and labor consumption drive economic growth. The causality analysis shows a feedback effect between Pakistan's economic growth and renewable energy consumption. Similarly, Rafindadi and Ozturk (2017) examines the impact of renewable energy consumption on economic growth in Germany using quarterly data from 1971Q1 to 2013QIV. The results of various modeling techniques, including the ARDL boundary test, the cointegration test, and the Granger VECM causality test, show that renewable energy consumption drives economic growth in Germany. Causality analysis, on the other hand, reveals a feedback effect between renewable energy consumption and economic growth in Germany.

Furthermore, Gyimah et al. (2022) investigated renewable energy's direct and indirect impacts on Ghana's economic growth using the Granger causality and mediation models in their analysis based on data from 1990 to 2015. The variables used for this study were renewable energy, gross domestic product, foreign investment direct investment, gross capital formation, and trade. The results show a feedback effect between Ghana's economic growth and renewable energy consumption. Renewable energy has a significant total impact on economic growth. Therefore, the increase in the total consumption of renewable energy has a positive effect on Ghana's economic growth.

Similarly, He and Huang (2022) reviewed the direct and indirect economic impacts of renewable energy consumption in China from 1990 to 2020. Using the Granger causality test to conduct empirical analysis, the results demonstrated a two-way causality between renewable energy consumption and economic growth. Then, the mediation model is used for further analysis. The study results show that renewable energy consumption positively influences China's economic growth. Meanwhile, renewable energy consumption can indirectly affect China's economic growth by forming gross capital, labor force, trade openness, research and development spending, and foreign direct investment.

Other literature finds support for the neutrality hypothesis. For example, Can and Korkmaz (2019) analyzed the relationship between renewable energy consumption and Bulgarian economic growth from 1990 to 2016, using the Toda-Yamamoto analysis and the ARDL test. Three different results were obtained from this study. One of them shows that renewable energy consumption and the output of renewable electricity cause economic growth. Another result of this study is that economic growth and renewable electricity output are the causes of renewable energy consumption. The final result is that economic growth and renewable energy consumption are not the cause of renewable electricity output, and there is no long-term relationship between the variables. Next, Razmi et al. (2020) investigated the relationship between renewable energy consumption with stock market value and economic growth in Iran. They were using the ARDL Model for data from 1990 to 2014. The results show that the stock market value affects renewable energy in the long term, while renewable energy consumption does not affect economic growth in the short and long term.

Encouraging renewable energy development is important for achieving sustainable economic growth (Qi et al., 2022; Filimonova et al., 2022). Academics agree that economic growth to achieve sustainable development goals replaces the use of non-renewable energy resources with renewable energy that is environmentally friendly and can reduce the impact of climate change and CO_2 emissions of all countries in the world (Shahbaz et al., 2020; Kasperowicz et al., 2020; Saidi and Omri, 2020; Khan et al., 2021; Oryani et al., 2021; Qudrat-ullah and Miracle, 2022). Therefore, sustainable economic growth serves as a stimulus to steer countries toward using renewable energy since renewable energy technologies are often more expensive than fossil fuels. A higher GDP can cover regulatory costs for developing renewable energy (Dogan et al., 2022). So the development of renewable energy is a crucial component in the transformation towards a low-carbon economy (Chen et al., 2022; Abhan et al., 2022; Mujtaba et al., 2022). The efficiency and productivity of renewable energy are beneficial for replacing fossil fuels with renewable energy. In this case, increasing R&D investment in the renewable energy sector and increasing the productivity and profitability of renewable energy investments will generate long-term benefits (Cevik et al., 2021).

2.2. Non-Renewable Energy Consumption and Economic Growth

Most studies state that the use of non-renewable energy has driven high economic growth in both developed and developing countries (Mbarek et al., 2017; Shakouri and Yazdi, 2017; Yazdi and Shakouri, 2017; Tugcu and Topcu, 2018; Pegkas, 2019; Cevik et al., 2021; Salari et al., 2021). Nevertheless, the Transition from fossil fuels to renewable energy has received significant attention given the increasing concern about climate change due to the increasing consumption of oil, coal, natural gas, and other fossil fuels (Akadiri et al., 2021; Liu et al., 2021). Consumption of renewable and non-renewable energy drives economic growth in Non-OECD countries, indicating that developing countries play an important role in the transition process to renewable energy (Ivanovski et al., 2020).

There is mixed evidence on the relationship between non-renewable energy consumption and economic growth (Table 1). Empirically, the study of Pegkas (2019) investigates the relationship between renewable and non-renewable energy consumption and economic growth in Greece, using data from 1990 to 2016. The results show a significant long-term positive effect of both renewable and non-renewable energy consumption on economic growth. In the short term, the results are one-way. The overall findings imply that renewable and non-renewable energy consumption significantly stimulates economic growth in Greece. Next, the study of Cevik et al. (2021) examined the relationship between renewable and non-renewable energy consumption and economic growth in the United States. Granger causality test results for non-renewable energy consumption and economic growth show two-way causality in both regimes. The United States fulfills its energy demand from non-renewable sources. Thus, renewable energy consumption in the United States does not appear to affect economic growth.

Furthermore, Boontome et al. (2017) investigated the causal relationship between non-renewable and renewable energy consumption, CO_2 emissions, and economic growth in Thailand during 1971-2013, using cointegration and causality models. The study results confirm the existence of cointegration among the variables. The causality relationship was found in a direction starting from non-renewable energy consumption to CO_2 emissions. These results indicate that the consumption of non-renewable energy can increase CO_2 emissions in Thailand.

Several other studies have shown that fossil energy consumption is the key to economic growth. Mbarek et al. (2017) investigated the dynamic relationship between economic growth, renewable energy consumption, energy consumption, and CO_2 emissions in Tunisia from 1990 to 2015. The results of the Granger causality test and the VECM model show a two-way causal relationship between energy use and CO_2 emissions. Economic growth affects CO_2 emissions in the short and long term. In contrast, a unidirectional relationship runs from energy use to economic growth in the short term. Considering the possibility of asymmetry between variables, Tugcu and Topcu (2018) tested the long-term and short-term relationship between total, renewable, and non-renewable energy consumption and economic growth in G7 countries during 1980-2014 using the NARDL model and an asymmetric causality approach. The findings show that the production function determines the cointegration between variables.

On the other hand, the results of asymmetric and symmetrical relationships and causality analysis were very volatile across the energy production and proxy functions. However, when energy consumption is measured by total energy use, the results support the asymmetric relationship between energy consumption and economic growth in the long run. Next, Salari et al. (2021) investigated the relationship between economic growth and energy consumption at the United States state level from 2000 to 2016 using the GMM estimator. The four hypotheses tested: growth, conservative, feedback, and neutral differentiate between the consumption of renewable and non-renewable energy. Overall, the results show that total and non-renewable energy consumption support the feedback hypothesis. The results for renewable, industrial, and residential energy consumption show more support for the growth hypothesis. These results have policy implications in optimizing decisions and investments to increase economic growth efficiently while reducing state energy consumption in the United States.

However, other studies have different conclusions. For example, in Pakistan, Baz et al. (2021) examine the relationship between fossil fuels, renewable energy, and economic growth using time series data from 1980 to 2017. Using the NARDL model and asymmetric causality approach, this study determines the asymmetric impact of one variable on another. The results confirm the asymmetric and non-linear cointegration between the variables. The asymmetric causality test shows positive and negative shocks to fossil fuels and economic growth have a neutral effect. Likewise, Jafari et al. (2012) examined the long-run Granger causality relationship between economic growth, carbon dioxide emissions, and energy consumption from 1971 to 2007 in Indonesia, controlling for capital stock and urban population. Using the Toda-Yamamoto procedure, it was found that there is no relationship between these variables except for a causality effect that runs from urban population to energy consumption. This disconnection suggests that Indonesia's energy conservation strategy may not have the desired effect on reducing emissions and that Indonesia should not give up economic growth. However, the results may not be sufficient to warrant Indonesia's specific policy choices and strategies for limiting carbon emissions in fighting global climate change.

3. DATA AND METHODOLOGY

3.1. Data

This study uses secondary data from the World Development Indicator (WDI), the United States Energy Information Administration (EIA), and the Harvard Atlas. A summary description of the data is shown in Table 2.

3.2. Model Specification

Following the literature in previous studies, we adapted the conventional neo-classical Cobb-Douglas production function by including renewable and non-renewable energy consumption variables (Luqman et al., 2019; Pegkas, 2019; Shahbaz et al., 2015; Tugcu and Topcu, 2018). Adding these variables to the production function can provide better insight into understanding the relationship between energy consumption and economic growth and also ease eliminating the potential omitted variable bias problem. The basic study modeling formula is written as follows:

$$\ln GDP_t = f(\ln GFCF_t, \ln LF_t, \text{Energy Consumption}_t)$$

Where ln*GDP* is the natural logarithm of real GDP, ln*GFCF* is the natural logarithm of gross fixed capital formation, ln*LF* is the natural logarithm of the labor force and energy consumption (ln*REC* and ln*NREC* are the natural logarithms of consumption of renewable and non-renewable energy).

Based on the basic model in Equation (1), the model for this study is rewritten in Equations (2) and (3) as follows:

Model 1: $\ln GDP_t = \beta_0 + \beta_1 \ln GFCF_t + \beta_2 \ln LF_t + \beta_3 \ln REC_t + \varepsilon_t$

Where β_0 is the constant β_1, β_2, and β_3 is the coefficient of the estimated variable, ln*GDP*, ln*GFCF*, ln*LF*, and ln*REC* are the

Table 2: Description of variables

Variable	Description	Period	Source
ln*GDP*	Natural logarithm of gross domestic product (constant 2015 US$)	1990-2019	WDI, World Bank
ln*GFCF*	Natural logarithm of gross fixed capital Formation (constant 2015 US$)	1990-2019	WDI, World Bank
ln*LF*	Natural logarithm of labor force, 15-64	1990-2019	WDI, World Bank
ln*REC*	Natural logarithm of renewable energy consumption (BOE)	1990-2019	EIA, U.S.
ln*NREC*	Natural logarithm of non-renewable energy consumption (BOE)	1990-2019	EIA, U.S.

Table 3: Descriptive statistics

Test	ln*GDP*	ln*GFCF*	ln*LF*	ln*NREC*	ln*REC*
Mean	0.046777	0.048927	0.019884	0.042246	0.059013
Median	0.050449	0.062904	0.019849	0.042066	0.043621
Maximum	0.078996	0.154756	0.048124	0.109926	0.450927
Minimum	−0.140720	−0.400599	−0.004509	−0.060321	−0.299243
SD	0.038387	0.107092	0.011415	0.039798	0.161389
Jarque-Bera	4.830.579	1.575.097	0.423700	2.888.636	1.189.870
Probability	0.000000	0.000000	0.809086	0.235907	0.551599
Observations	29	29	29	29	29

Table 4: Unit root tests

Variables	No constant and trend		Constant	
	Level	First difference	Level	First difference
ln*GDP*	2.654132 (0.9967)	−2.439446* (0.0172)	−1.215753 (0.6474)	−3.811749** (0.0088)
ln*GFCF*	1.757096 (0.9775)	−0.948212 (0.2930)	−3.038353* (0.0492)	−4.292878** (0.0031)
ln*LF*	8.037235 (1.0000)	−0.834459 (0.3424)	−0.112772 (0.9372)	−3.829386** (0.0088)
ln*REC*	1.680168 (0.9738)	−6.236629** (0.0000)	−0.461392 (0.8826)	−7.305851** (0.0000)
ln*NREC*	4.571731 (1.0000)	−2.328910* (0.0223)	−0.655097 (0.8398)	−5.893322** (0.0001)

**P<1%, and *P<5%. The number of lag is based on the AIC. The maximum number of lag is 5

Table 5: Johansen cointegration test-renewable energy consumption

Unrestricted cointegration rank test (trace value)					
Hypothesis		Eigenvalue	Trace	Critical Value	Probability
H_0	H_1		Statistic	(0.10)	
r≤0	r>1	0.747362	5.871.661	4.785.613	0.0035
r≤1	r>2	0.373864	2.294.588	2.979.707	0.2487
r≤2	r>3	0.226913	1.077.301	1.549.471	0.2258
r≤3	r>4	0.145281	4.081.550	3.841.466	0.0433
Unrestricted cointegration rank test (maximum eigenvalue)					
Hypothesis		Eigenvalue	Max-eigen	Critical value	Probability
H_0	H_1		Statistic	(0.10)	
r≤0	r>1	0.747362	3.577.072	2.758.434	0.0036
r≤1	r>2	0.373864	1.217.288	2.113.162	0.5307
r≤2	r>3	0.226913	6.691.458	1.426.460	0.5262
r≤3	r>4	0.145281	4.081.550	3.841.466	0.0433

Table 6: Result of johansen cointegration test-non-renewable energy consumption

Unrestricted cointegration rank test (trace value)					
Hypothesis		Eigenvalue	Trace	Critical value	Probability
H_0	H_1		Statistic	(0.05)	
r≤0	r>1	0.949346	1.038.160	4.785.613	0.0000
r≤1	r>2	0.406873	2.626.486	2.979.707	0.1210
r≤2	r>3	0.277064	1.268.385	1.549.471	0.1269
r≤3	r>4	0.150754	4.248.559	3.841.466	0.0393
Unrestricted cointegration rank test (maximum eigenvalue)					
Hypothesis		Eigenvalue	Max-eigen	Critical value	Probability
H_0	H_1		Statistic	−0.05	
r≤0	r>1	0.949346	7755115	2758434	0.0000
r≤1	r>2	0.406873	1358101	2113162	0.4003
r≤2	r>3	0.277064	8435291	1426460	0.3362
r≤3	r>4	0.150754	4248559	3841466	0.0393

natural logarithms of real GDP, gross fixed capital formation, labor force, and renewable energy consumption.

Model 2: $\ln GDP_t = \beta_0 + \beta_1 \ln GFCF_t + \beta_2 \ln LF_t + \beta_3 \ln NREC_t + \varepsilon_t$

Where β_0 is the constant β_1, β_2, and β_3 is the coefficient of the estimated variable, ln*GDP*, ln*GFCF*, ln*LF*, and ln*NREC* are the natural logarithms of real GDP, gross fixed capital formation, labor force, and non-renewable energy consumption.

3.3. Econometric Methodology

Investigating the impact of renewable and non-renewable energy consumption on the Indonesian economy is carried out through the following stages: The first stage, pre-estimation testing, is carried out, namely testing the unit-roots of the observed data to ensure that the data is stationary. This test was carried out through the Augmented Dickey-Fuller (ADF) method. The second stage is conducting cointegration testing of the data series to be observed. This test was conducted to investigate the long-term relationship between the dependent variable and the independent variable. This test uses Johansen's cointegration test method. In the third stage, to ensure the strength of the research results in testing long-term relationships, cointegration regression with the Fully Modified Ordinary Least Squares (FMOLS) and Dynamic Ordinary Least Squares (DOLS) approaches was applied (Elfaki et al., 2021; Mardhani et al., 2021).

Table 7: FMOLS and DOLS estimates-model 1

Variable	FMOLS				DOLS			
	Coefficient	Std. error	t-statistic	P-value	Coefficient	Std. error	t-statistic	P-value
ln*GFCF*	0.319801	0.022564	1.417.298	0.0000	0.311522	0.025669	1.213.609	0.0000
ln*LF*	0.087266	0.208857	0.417828	0.6798	0.086958	0.237656	0.365900	0.7175
ln*REC*	−0.030630	0.015442	−1.983.599	0.0589	−0.033971	0.017571	−1.933.427	0.0646

ln*GDP* is the dependent variable

Table 8: FMOLS and DOLS estimates-model 2

Variables	FMOLS				DOLS			
	Coefficient	Std. error	t-statistic	P-value	Coefficient	Std. error	t-statistic	P-value
ln*GFCF*	0.303294	0.026824	1.130.689	0.0000	0.295066	0.027338	1.079.338	0.0000
ln*LF*	−0.271314	0.245267	−1.106.200	0.2796	−0.266768	0.249968	−1.067.210	0.2961
ln*NREC*	0.216210	0.079427	2.722.124	0.0119	0.216395	0.076133	2.842.328	0.0088

ln*GDP* is the dependent variable

4. RESULTS AND DISCUSSION

4.1. Descriptive Statistics

This section begins by explaining the descriptive statistics of the variables used in this study which are shown in Table 3. The highest value of this variable is ln*REC,* and the smallest is ln*LF*. The ln*REC* variable has the highest data gap value, followed by the ln*GFCF* variable. From the probability value, ln*GDP* and ln*GFCF* have a probability below 1%.

4.2. Unit Root Test

Based on the research model presented in the previous section, the first step that must be taken is to test the stationarity of the data. This test uses the Augmented Dickey-Fuller (ADF) method. The stationarity test results in Table 4 show that at the level and constant, only the lnGFCF variable is stationary at a level below 5%. At the first difference level, all variables are stationary below 1%.

4.3. Cointegration Test

The next step is to carry out a cointegration test to ensure that there has been a long-term balance or not in the time series model based on the Johansen method. Cointegration test results for renewable and non-renewable energy are shown in Tables 5 and 6.

The cointegration test results in Table 5 show that the trace statistical value and maximum eigenvalue at $r = 0$, $r \leq 1$, and $r \leq 2$ are more significant than the critical value with a significance level of 1%, 5%, and 10%. This means the null hypothesis, which states that there is no cointegration, is rejected. Otherwise, the alternative hypothesis that there is cointegration cannot be rejected. Based on the econometric analysis above, it can be seen that among the five variables in this study, it is stated that there is a long-term relationship and balance between variables. So that it can be continued to carry out cointegration regression tests with the FMOLS and DOLS approaches.

4.4. FMOLS and DOLS Results

This section presents the long-term estimation results of the effects of renewable energy consumption, non-renewable energy consumption, gross fixed capital formation, and the labor force on economic growth (Model 1). Long-term estimation results for renewable and non-renewable energy variables are presented in Tables 7 and 8, respectively.

Estimates from FMOLS and DOLS yielded similar results confirming the robustness of the results of this study. This study's findings indicate that two variables significantly affect economic growth, namely the ln*GFCF* and ln*REC* variables. The negative sign on the ln*REC* variable coefficient value indicates that renewable energy consumption in Indonesia is still low. The findings of this study establish that renewable energy has a negative and significant impact on Indonesia's economic growth.

The above research results are in line with the findings of a study by Brini et al. (2017) for Tunisia, Salari et al. (2021) for the United States, Zhe et al. (2021) for Turkey, and Benlaria and Hamid Hamad (2022) for Saudi Arabia. Findings in both developed and developing countries show a negative effect on economic growth. This is caused by renewable energy consumption, which is still in developing countries. Conversely, there are also research findings showing that renewable energy consumption has a positive effect on economic growth, such as Ocal and Aslan (2013) and Alper and Oguz (2016) for Turkey, Mbarek et al. (2017) for Tunisia, Tugcu and Topcu (2018) for the G7 Countries, Luqman et al. (2019) for Pakistan, Pegkas (2019) for Greece, Bouyghrissi et al. (2020) for Morocco, Dasanayaka et al. (2022) for Sri Lanka, Slusarczyk et al. (2022) for Polish and Swedish.

The results of the cointegration regression test with the FMOLS and DOLS approaches show that of all the independent variables, two variables have a significant effect on economic growth, namely the GFCF and ln*NREC* variables. On the other hand, the ln*LF* variable has no significant effect on economic growth. This shows that Indonesia still has a high dependency on fossil energy consumption. The results of this study are in line with the findings of a study by Mbarek et al. (2017) for Tunisia, Tugcu and Topcu (2018) for the G7 Countries, Pegkas (2019) for Greece, Elfaki et al. (2021) for Indonesia, Salari et al. (2021) for the United States.

5. CONCLUSION AND POLICY IMPLICATIONS

The world's attention to sustainable development has accelerated renewable energy consumption in recent decades. High and volatile energy prices and the geopolitical debate around the use of fossil fuels will accelerate the development and accessibility of markets for renewable energy. In addition, a transition towards renewable energy is also needed to achieve a better sustainable energy mix that can support a sustainable energy supply and long-term sustainable economic growth in Indonesia. Therefore, this article examines the impact of renewable and non-renewable energy consumption on economic growth in Indonesia. It used the FMOLS and DOLS estimation techniques to look at the long-term dynamic relationship between renewable and non-renewable energy consumption and real GDP by including capital and labor force as important factors of the production function in Indonesia during the 1990-2019 period. The labor force coefficient is negative and insignificant, indicating that an increase in the labor force reduces economic growth in Indonesia. This implies that economic growth in Indonesia is more capital-oriented than labor-oriented. Indonesia is the fourth most populous country in the world and has a surplus labor force. So, the labor force is not a determining factor for economic growth in Indonesia.

Meanwhile, capital and non-renewable energy consumption are determinants of Indonesia's sustainable economic growth. The renewable energy coefficient is negative but significant. These results show that renewable energy in Indonesia is not the main determinant of production compared to fossil energy which controls 90% of national energy consumption. This shows that Indonesia must increase and encourage the development of the renewable energy sector to become one of the main contributors to economic growth and take advantage of its positive impact on economic growth and a sustainable environment.

The energy sector has an important role in improving the performance of the Indonesian economy, so the government needs to make strategic policies in the energy sector so that energy consumption has a positive impact on the economy. Policies that need to be taken by the government to improve economic performance through the energy sector by ensuring a shift from fossil energy to renewable energy to reduce dependence on non-renewable fossil energy and price stability, which are not conducive when a crisis occurs. Finally, future analysis with a larger sample size could help us determine a more appropriate renewable energy policy for Indonesia.

REFERENCES

Abhan, O.J., Hongxing, Y., Nuta, A.C., Dankyi, A.B., Ofori, C., Cobbinah, J. (2022), Renewable energy, economic growth, and CO_2 emissions contained Co-movement in African oil-producing countries : A wavelet based analysis. Energy Strategy Reviews, 44, 100977.

Akadiri, S.S., Alola, A.A., Usman, O. (2021), Energy mix outlook and the EKC hypothesis in BRICS countries: A perspective of economic freedom vs. Economic growth. Environmental Science and Pollution Research, 28, 8922-8926.

Alper, A., Oguz, O. (2016), The role of renewable energy consumption in economic growth : Evidence from asymmetric causality. Renewable and Sustainable Energy Reviews, 60, 953-959.

Baydoun, H., Aga, M. (2021), The effect of energy consumption and economic growth on environmental sustainability in the GCC countries: Does financial development matter? Energies, 14, 5897.

Baz, K., Cheng, J., Xu, D., Abbas, K., Ali, I., Ali, H. (2021), Asymmetric impact of fossil fuel and renewable energy consumption on economic growth: A non-linear technique. Energy, 226, 120357.

Benlaria, H., Hamid Hamad, A.A.J. (2022), The economic impact of renewable energy on sustainable development in Saudi Arabia. International Journal of Energy Economics and Policy, 12(5), 311-318.

Boontome, P., Therdyothin, A., Chontanawat, J. (2017), Investigating the causal relationship between non-renewable and renewable energy consumption, CO2 emissions and economic growth in Thailand. Energy Procedia, 138, 925-930.

Bouyghrissi, S., Berjaoui, A., Khanniba, M. (2020), The nexus between renewable energy consumption and economic growth in Morocco. Environmental Science and Pollution Research, 28, 5693-5703.

Brini, R., Amara, M., Jemmali, H. (2017), Renewable energy consumption, International trade, oil price and economic growth inter-linkages: The case of Tunisia. Renewable and Sustainable Energy Reviews, 76, 620-627.

Can, H., Korkmaz, Ö. (2019), The relationship between renewable energy consumption and economic growth the case of Bulgaria. International Journal of Energy Sector Managemen, 11, 1-12.

Cevik, E.I., Yıldırım, D.Ç., Dibooglu, S. (2021), Renewable and non-renewable energy consumption and economic growth in the US: A Markov-Switching VAR analysis. Energy and Environment, 32(3), 519-541.

Chandrarin, G., Sohag, K., Cahyaningsih, D.S., Yuniawan, D. (2022), Will economic sophistication contribute to Indonesia's emission target? A decomposed analysis. Technological Forecasting and Social Change, 181, 121758.

Chen, C., Pinar, M., Stengos, T. (2022), Renewable energy and CO2 emissions: New evidence with the panel threshold model. Renewable Energy, 194, 117-128.

Dasanayaka, C.H., Perera, Y.S., Abeykoon, C. (2022), Investigating the effects of renewable energy utilization towards the economic growth of Sri Lanka: A structural equation modelling approach. Cleaner Engineering and Technology, 6, 100377.

Dogan, B., Lorente, D.B., Nasir, M.A. (2020), European commitment to COP21 and the role of energy consumption, FDI, trade and economic complexity in sustaining economic growth. Journal of Environmental Management, 273, 111146.

Dogan, E., Chishti, M.Z., Alavijeh, N.K., Tzeremes, P. (2022), The roles of technology and Kyoto Protocol in energy transition towards COP26 targets: Evidence from the novel GMM-PVAR approach for G-7 countries. Technological Forecasting and Social Change, 181, 121756.

Elfaki, K.E., Handoyo, R.D., Ibrahim, K.H. (2021), The impact of industrialization, trade openness, financial development, and energy consumption on economic growth in Indonesia. Economies, 9, 174.

Fan, W., Hao, Y. (2020), An empirical research on the relationship amongst renewable energy consumption, economic growth and foreign direct investment in China. Renewable Energy, 146, 598-609.

Filimonova, I.V, Komarova, A.V, Kuzenkova, V.M., Provornaya, I.V., Kozhevin, V.D. (2022), Emissions of CO 2 in Europe and the Asia-pacific region: Panel data model. Energy Reports, 8, 894-901.

GoI. (2017), National Energy General Plan (RUEN). Indonesia: Government of Indonesia.

Guo, Y., Ma, F., Li, H., Lai, X. (2022), Oil price volatility predictability based on global economic conditions. International Review of Financial Analysis, 82, 102195.

Gyimah, J., Yao, X., Tachega, M.A., Sam Hayford, I., Opoku-Mensah, E. (2022), Renewable energy consumption and economic growth: New evidence from Ghana. Energy, 248, 123559.

He, Y., Huang, P. (2022), Exploring the forms of the economic effects of renewable energy consumption: Evidence from China. Sustainability, 14, 8212.

Hubacek, K., Chen, X., Feng, K., Wiedmann, T., Shan, Y. (2021), Evidence of decoupling consumption-based CO2 emissions from economic growth. Advances in Applied Energy, 4, 100074.

IEA. (2017), World Energy Outlook 2017. Vol. 8. France: International Energy Agency, OECD. p1-569.

IEA. (2021), Global Energy Review : CO2 Emissions in 2021 Global Emissions Rebound Sharply to Highest Ever Level. International Energy Agency. p1-14. Available from: https://www.iea.org

IRENA. (2022), Indonesia Energy Transition Outlook. Abu Dhabi: International Renewable Energy Agency.

Ivanovski, K., Hailemariam, A., Smyth, R. (2020), The effect of renewable and non-renewable energy consumption on economic growth: Non-parametric evidence. Journal of Cleaner Production, 286, 124956.

Jafari, Y., Othman, J., Nor, A.H.S.M. (2012), Energy consumption, economic growth and environmental pollutants in Indonesia. Journal of Policy Modeling, 34, 879-889.

Kasperowicz, R., Bilan, Y., Štreimikienė, D. (2020), The renewable energy and economic growth nexus in European countries. Sustainable Development, 28, 2060.

Khan, I., Hou, F., Zakari, A., Tawiah, V.K. (2021), The dynamic links among energy transitions, energy consumption, and sustainable economic growth: A novel framework for IEA countries. Energy, 222, 119935.

Kraft, J., Kraft, A. (1978), On the relationship between energy and GNP. The Journal of Energy and Development, 3(2), 401-403.

Lee, S.H., Jung, Y. (2018), Causal dynamics between renewable energy consumption and economic growth in South Korea: Empirical analysis and policy implications. Energy and Environment, 29(7), 1298-1315.

Li, P., Akhter, M.J., Aljarba, A., Akeel, H., Khoj, H. (2022), G-20 economies and their environmental commitments: Fresh analysis based on energy consumption and economic growth. Frontiers in Environmental Science, 2022, 1-11.

Lin, B., Moubarak, M. (2014), Renewable energy consumption-economic growth nexus for China. Renewable and Sustainable Energy Reviews, 40, 111-117.

Liu, H., Liang, S., Cui, Q. (2021), The nexus between economic complexity and energy consumption under the context of sustainable environment: Evidence from the LMC countries. International Journal of Environmental Research and Public Health, 18, 124.

Liu, Y., Lin, B., Xu, B. (2021), Modeling the impact of energy abundance on economic growth and CO2 emissions by quantile regression: Evidence from China. Energy, 227, 120416.

Luqman, M., Ahmad, N., Bakhsh, K. (2019), Nuclear energy, renewable energy and economic growth in Pakistan: Evidence from non-linear autoregressive distributed lag model. Renewable Energy, 139, 1299-1309.

Manta, A.G., Florea, N.M., Badarcea, R.M., Popescu, J., Cîrciumaru, D., Doran, M.D. (2020), The nexus between carbon emissions, energy use, economic growth and financial development: Evidence from central and eastern European countries. Sustainability, 12, 7747.

Mardhani, M., Majid, M.S.A., Jamal, A., Muhammad, S. (2021), Does international tourism promote economic growth? Some evidence from Indonesia. Geojournal of Tourism and Geosites, 37(3), 775-782.

Mbarek, M.B., Saidi, K., Rahman, M.M. (2017), Renewable and non-renewable energy consumption, environmental degradation and economic growth in Tunisia. Quality and Quantity, 52, 1105-1119.

Minh, T.B., Van, H.B. (2023), Evaluating the relationship between renewable energy consumption and economic growth in Vietnam, 1995-2019. Energy Reports, 9, 609-617.

Mujtaba, A., Jena, P.K., Bekun, F.V., Sahu, P.K. (2022), Symmetric and asymmetric impact of economic growth, capital formation, renewable and non-renewable energy consumption on environment in OECD countries. Renewable and Sustainable Energy Reviews, 160, 112300.

Namahoro, J.P., Wu, Q., Xiao, H., Zhou, N. (2021), The asymmetric nexus of renewable energy consumption and economic growth: New evidence from Rwanda. Renewable Energy, 174, 336-346.

Nawaz, M.A., Hussain, M.S., Kamran, H.W., Ehsanullah, S., Maheen, R., Shair, F. (2020), Trilemma association of energy consumption, carbon emission, and economic growth of BRICS and OECD regions: Quantile regression estimation. Environmental Science and Pollution Research, 23, 16014-16028.

Ocal, O., Aslan, A. (2013), Renewable energy consumption-economic growth nexus in Turkey. Renewable and Sustainable Energy Reviews, 28, 494-499.

Oryani, B., Koo, Y., Rezania, S., Shafiee, A. (2021), Investigating the asymmetric impact of energy consumption on reshaping future energy policy and economic growth in Iran using extended Cobb-Douglas production function. Energy, 216, 119187.

Ozturk, I., Al-Mulali, U. (2015), Investigating the validity of the environmental Kuznets curve hypothesis in Cambodia. Ecological Indicators, 57, 324-330.

Pegkas, P. (2019), The impact of renewable and non-renewable energy consumption on economic growth: The case of Greece. International Journal of Sustainable Energy, 39, 380-395.

Qudrat-ullah, H., Nevo, C.M. (2021), The impact of renewable energy consumption and environmental sustainability on economic growth in Africa. Energy Reports, 7, 3877-3886.

Rafindadi, A.A., Ozturk, I. (2017), Impacts of renewable energy consumption on the German economic growth: Evidence from combined cointegration test. Renewable and Sustainable Energy Reviews, 75, 1130-1141.

Razmi, S.F., Bajgiran, B.R., Behname, M., Salari, T.E., Razmi, S.M.J. (2020), The relationship of renewable energy consumption to stock market development and economic growth in Iran. Renewable Energy, 145, 2019-2024.

Saidi, K., Omri, A. (2020), The impact of renewable energy on carbon emissions and economic growth in 15 major renewable energy-consuming countries. Environmental Research, 186, 109567.

Salari, M., Kelly, I., Doytch, N., Javid, R.J. (2021), Economic growth and renewable and non-renewable energy consumption: Evidence from the U.S. States. Renewable Energy, 178, 50-65.

Sha, Z. (2022), Total natural resources, oil prices, and sustainable economic performance: Evidence from global data. Resources Policy, 79, 103046.

Shahbaz, M., Loganathan, N., Zeshan, M., Zaman, K. (2015), Does renewable energy consumption add in economic growth? An application of auto-regressive distributed lag model in Pakistan. Renewable and Sustainable Energy Reviews, 44, 576-585.

Shahbaz, M., Raghutla, C., Chittedi, K.R., Jiao, Z., Vo, X.V. (2020), The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index. Energy, 207, 1-58.

Shahbaz, M., Sinha, A., Kontoleon, A. (2020), Decomposing scale and technique effects of economic growth on energy consumption: Fresh evidence from developing economies. International Journal of Finance and Economics, 27, 1-12.

Shakouri, B., Yazdi, S.K. (2017), Causality between renewable energy, energy consumption, and economic growth. Energy Sources Part B Economics Planning and Policy, 2017, 838-845.

Slusarczyk, B., Zeglen, P., Kluczek, A., Nizioł, A., Górka, M. (2022), The impact of renewable energy sources on the economic growth of Poland and Sweden considering COVID-19 times. Energies, 15, 332.

Tiwari, A.K. (2011), A structural VAR analysis of renewable energy consumption, real GDP and CO2 emissions: Evidence from India. Economics Bulletin, 31(2), 1793-1806.

Tong, T., Ortiz, J., Xu, C., Li, F. (2020), Economic growth, energy consumption, and carbon dioxide emissions in the E7 countries: A bootstrap ARDL bound test. Energy Sustainability and Society, 10(20), 1-17.

Tugcu, C.T., Topcu, M. (2018), Total, renewable and non-renewable energy consumption and economic growth: Revisiting the issue with an asymmetric point of view. Energy, 152, 64-74.

Tuna, G., Tuna, V.E. (2019), The asymmetric causal relationship between renewable and NON-RENEWABLE energy consumption and economic growth in the ASEAN-5 countries. Resources Policy, 62, 114-124.

Wang, Z., Zhang, B., Wang, B. (2018), Renewable energy consumption, economic growth and human development index in Pakistan: Evidence form simultaneous equation model. Journal of Cleaner Production, 184, 1081-1090.

Yazdi, S.K., Shakouri, B. (2017), Renewable energy, non-renewable energy consumption, and economic growth. Energy Sources Part B Economics Planning and Policy, 2017, 1-8.

Zhe, L., Yüksel, S., Dinçer, H., Mukhtarov, S., Azizov, M. (2021), the positive influences of renewable energy consumption on financial development and economic growth. SAGE Open, 11, 1-10.