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Education and Energy Consumption: A Provincial Analysis in Indonesia

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Abstract

The global and national energy consumption continues to increase every year, leading to increased carbon emissions. Households are one of Indonesia's energy consumers, where household members' educational level is considered to influence energy consumption. Due to the limited studies in Indonesia regarding the relationship between education and energy consumption, this study aims to explain the relationship between education and energy consumption among provinces in Indonesia. This study is a quantitative study under the STIRPAT framework, using three estimation methods to examine the impact of education on energy consumption among provinces in Indonesia from 2010 to 2021, namely OLS, Fixed Effect, and Fixed Effect Discroll-Kraay. The research was conducted with three different data analyses: Indonesia as a whole, Java, and non-Java regions. The study found differences in estimation results between Java and non-Java regions, providing evidence that the level of education has different associations with per capita energy consumption in these two areas. It was also found that the estimation results for Indonesia align with those in non-Java regions. The study concludes that education has a significant positive association with energy consumption in Indonesia and specifically in non-Java regions, while the association between education and energy consumption in Java is negative and significant. The policy implications suggest that the government should continue efforts to improve the quality of education and promote more efficient energy consumption education in the Java region and implement complementary policies such as compulsory education programs for non-Java regions to reduce energy consumption in Indonesia.

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INTRODUCTION

Energy is the driver of economic growth and development. Thus, it cannot be denied that energy is the primary input for economic development (Akintande et al., 2020). Other studies state that economic growth and energy consumption go hand in hand because more economic growth leads to higher energy consumption (Khan et al., 2020). Besides the manufacturing industry, growth in the service sector is also closely linked to energy usage. These sectors include tourism, banking, and finance. These sectors serve as sources of growth in several countries, leading to an increase in real income growth, which, in turn, results in higher energy consumption (Katircioglu et al., 2020).

Global energy demand and consumption have experienced significant growth over the past 20 years. This is due to the improvement in the quality of human resources resulting from an increase in educational quality and the growth of the global economy (Matthew et al., 2018). Worldwide energy consumption in 2018 grew by 2.3%, nearly double the average growth rate since 2010. Demand for all fuels increased, with the share of fossil fuels accounting for nearly 70% of the growth in energy consumption over the past two years. In addition to fuel consumption, electricity consumption also significantly contributes to the increase in global energy consumption (International Energy Agency (IEA), 2019).

The increase in energy consumption has consequences, one of which is the emission of carbon dioxide (CO2). Indonesia ranks fourth among the world's largest greenhouse gas emitters (Carbon Brief, 2019). Indonesia's carbon intensity, measured in kilograms of CO2 per kilowatt-hour, stood at 0.29 kg/kWh in 2016 (BP Statistical Review of Global Energy, 2021). This figure represents that Indonesia became the fourth largest greenhouse gas gritters. In line with the continuous increase in global energy consumption, according to data from the BP Statistical Review of Global Energy, the national energy consumption trend also continues to rise from year to year.

In Indonesia, the household sector consumes nearly one-third of the national energy, amounting to 382.94 million BOE (Barrel of Oil Equivalent), or 31% of the total national energy demand. The high energy consumption in households is attributed to the increasing number of households, from 61.39 million in 2010 to approximately 70.6 million in 2025 (Indonesia Energy Outlook 2019). By 2050, it is projected that the dominant energy source in the household sector will be electricity. The increased use of electronic appliances such as air conditioners, refrigerators, water pumps, and electric stoves drives the rising electricity consumption.

According to the Ministry of Energy and Mineral Resources (ESDM), reducing electricity consumption by 10% in the ten provinces with the highest energy consumption can save 17,411 GWh, equivalent to building 3.2 GW of new coal-fired power plants (PLTU) worth IDR43.2 trillion. With these 10% savings, approximately 2.5 million households in rural areas across six provinces in Eastern Indonesia, or roughly 10 million people, will gain access to electricity. This indicates that changing habits and increasing public awareness to consume energy-efficient and environmentally friendly products is a major challenge in reducing carbon emissions in Indonesia.

Among the 17 Sustainable Development Goals (SDGs), addressing climate change is one of the major challenges in policy directions for developed and developing countries (Zafar et al., 2020; Baumeister, 2018; Bisbis et al., 2018). Governments need to reevaluate their policy strategies regarding efforts to reduce the use of fossil fuels. Three conditioning factors that can enhance environmental awareness in mitigating issues related to fossil fuel usage are: (i) policies that promote behavioral change among individuals; (ii) decision-making institutions should have a democratic participatory process; and (iii) there should be a direct focus on community-level changes in education and related values (Zafar et al., 2020; Akerlof, 2019)

Many studies emphasize that the impact of an individual's knowledge, awareness, and energy-saving behavior on energy consumption and carbon emissions is crucial to ensure. Increasing public awareness of energy-saving behavior is important because humans significantly reduce carbon emissions by enhancing energy efficiency (Kwon, 2009). Therefore, to facilitate the transition towards sustainable development, there is a need to enhance individuals' knowledge and skills through education (IPCC, 2014).

Education is considered one of the ways that a country can promote an increased understanding of efficient energy consumption for consumers and companies simultaneously. The improvement in the quality of education in a country can lead to new technologies that can enhance the production process to become more efficient (Inglesi-Lotz & Morales, 2017). Education can reduce energy consumption in developed countries because they strive to develop better and environmentally friendly production processes. However, developing countries or relatively poorer ones use education to boost their economies to catch up with developed countries, thus increasing their energy consumption. Therefore, it can be said that education can have different impacts on energy consumption in various countries according to their level of development, where education can increase energy consumption in developing countries and help reduce energy consumption in developed countries (Inglesi-Lotz & Morales, 2017).

The relationship between education and energy consumption can be explained through three pathways: income, technology, lifestyle, and awareness. In terms of income, the increase in energy consumption is attributed to the higher income of individuals with more education (He & Reiner, 2016). Changes in an individual's energy consumption patterns can also be driven by income growth due to increased skills (Benos & Zotou, 2014). Regarding technology, education can stimulate the use of renewable energy and accelerate the transition to energy-efficient technologies (Li & Lin, 2016). Education is one of the most essential inputs in the production process that helps reduce energy consumption in the production process (Armstrong, 2011; Pablo-Romero & Sánchez-Braza, 2015).

Regarding lifestyle and awareness, Wei et al. (2007) stated that lifestyle change is one of the most effective drivers of energy conservation. Consumer lifestyle is crucial in awareness and energy consumption behavior related to an individual's education level and social environment (Li et al., 2019). The most significant lifestyle change affecting energy consumption is the shift from energy-intensive products to energy-efficient ones.

In Indonesia, the level of education, measured in part by the average years of schooling, varies among provinces. Because energy consumption is influenced by the level of education, differences in education levels among provinces in Indonesia can have varying effects among provinces. This is supported by Ram (1989), who stated that educational disparities or differences result from income inequality, affecting energy consumption patterns.

Based on previous studies, there are differents research findings from various countries that examine the relationship between education and energy consumption. Studies who assert that education has a negative impact on energy consumption include those conducted by Baiocchi et al. (2010), Bano et al. (2018), and Zafar et al. (2020). On the other hand, studies by Wang et al. (2020), Li et al. (2019), and Katircioğlu (2014) conclude that education has a positive impact on energy consumption. Interestingly, Inglesi-Lotz & Morales (2017) also present that energy consumption increases with rising education levels in developing countries, while in developed countries, energy consumption decreases with increasing education levels.

There hasn't been a specific study examining the relationship between education and energy consumption in Indonesia. Previous studies in Indonesia have generally focused on the relationship between education and/or energy consumption in the context of economic

growth. Previous study results have indicated variations in the impact of education on energy consumption. Due to the limited number of studies in Indonesia regarding the relationship between education and energy consumption, this study aims to explain the relationship between education and energy consumption among provinces in Indonesia.

Regional disparities and differences in characteristics in Indonesia are some of the parameters that need to be considered to assess the variations in the impact of education on energy consumption by region. Currently, regional disparities in Indonesia are a significant concern and are viewed with great importance, reinforced by the issuance of Presidential Regulation (Perpres) No. 63 of 2020 regarding determining underdeveloped areas for 2020-2024. Additionally, the national economic structure spatially from 2019 to 2021 remains concentrated on the island of Java (55% of the national GDP is concentrated in Java). Based on GDP by expenditure, 56% of the economy comes from household expenditures, with the highest energy intensity from households (BPS, 2020; Novianti dan Panjaitan, 2022). Furthermore, the level of education of the population (average years of schooling) in Java is higher compared to the level of education of the population outside Java (BPS, 2020).

RESEARCH METHODS

The STIRPAT framework is used for empirical analysis to assess the impact of education on energy consumption in Indonesia. This model was initially known as the IPAT framework, developed by Ehrlich & Holdren (1971) to evaluate the environmental impact of economic activities. It is important to note that the IPAT model has certain limitations. First, hypothesis testing is impossible hypothesis IPAT, as it is a mathematical identity. Second, the model assumes that all factors have the same environmental impact. Finally, this approach cannot determine the most significant environmental factors. Therefore, Dietz & Rosa (1997) developed the STIRPAT model as a derivative of the IPAT model. This allows for hypothesis testing and addresses its limitations. The STIRPAT model can be expressed as follows:

$$I_{i,t} = aP_{i,t}^{b}A_{i,t}^{c}T_{i,t}^{d}e_{i,t} \quad \text{..... (1)}$$

In equation (1), "a" represents the constant term. The variable "I" stands for the environmental impact, while "P", "A", and "T" each represent the population, prosperity, and technology, all of which determine the economic consequences on the environment. The elasticity of each factor in the environment can be described by the parameters "b", "c", and "d". Additionally, "e" symbolizes othher environmental impact variables or error terms. Finally, the subscripts "i" and "t" indicate the units of analysis and the periods under consideration.

Taking the logarithmic form on both sides of equation (1) can be viewed as an econometric model. There are several advantages to transforming it into a logarithmic form. First, the interpretation of the model coefficients becomes simpler compared to changes in independent variables affecting changes in the dependent variable. Second, transforming variables into logarithmic form can reduce multicollinearity among the variables in the model (Harefa et al., 2023). By converting equation (1) into logarithmic form, it can be represented as follows:

$$lnI_{i,t} = lna + b\left(lnP_{i,t}\right) + c\left(lnA_{i,t}\right)\, d\left(lnT_{i,t}\right) + v_{i,t} \quad \text{..... (2)}$$

This study utilizes an expanded STIRPAT model (Liu & Han, 2021; Muzayanah et al., 2022; Nosheen et al., 2020; Shahbaz et al., 2016; Wang et al., 2020) by incorporating the education variable. The empirical model for equation (2) related to this study is expressed as follows:

$$lnEC_{i,t} = \beta_0 + \beta_1\left(lnYSC_{i,t}\right) + \beta_2\left(lnGRDP_{CAP_{i,t}}\right) + \beta_3\left(lnIND_{i,t}\right) + \beta_4\left(lnUrban_{i,t}\right) + v_{i,t} \quad \text{..... (4)}$$

The variable EC represents per capita energy consumption. In this context, "i" and "t" represent provinces and time. The variable YSC

indicates the average years of schooling, a variable in the extended STIRPAT model. Furthermore, a represent GRDPCAP, t represents IND as the percentage of industrial value added to the total value added. Meanwhile, p is represented by Urban, which represents the level of urbanization as a result of population growth. Furthermore, the empirical model will be estimated based on the sample size, resulting in three empirical models: the national, Java Island, and Outside Java.

This analysis examines how education affects energy consumption in various provinces in Indonesia using three empirical models (national, Java Island, and Outside Java models). Additionally, this study employs three different estimation methods: Ordinary Least Squares (OLS), Fixed Effects (FE), and Fixed Effect-Driscoll-Kraay. To estimate accurately, the first step taken is using the OLS method. However, this method may produce biased estimates as it cannot account for heterogeneity among provinces. To address this issue, the study utilizes the Fixed Effects model. However, data indicate the presence of cross-sectional dependence, heteroskedasticity, and autocorrelation, as evidenced by the cross-sectional independence test (Pesaran, 2021), Breusch-Pagan heteroskedasticity test (Gujarati, 2022), and autocorrelation test (Wooldridge, 2003). Therefore, the results obtained through estimation in the Fixed Effect Model are inefficient.

To tackle this problem, the model utilizes Fixed Effect estimation with the Driscoll-Kraay approach. Robust Driscoll-Kraay standard errors consider heteroskedasticity and autocorrelation consistency and can handle both cross-sectional and temporal dependencies. Previous studies have demonstrated that this method is more effective for models with a relatively larger number of cross-sectional data points than periods (Hoechle, 2007; Knight, 2014).

This study utilizes data from 33 provinces in Indonesia from 2010 to 2021. Information on overall energy consumption in these provinces was collected from the State Electricity Company (PLN) and the Ministry of Energy & Mineral Resources (ESDM). Furthermore, data on variables such as average years of education, GDP per capita, urbanization rate, and the percentage of industrial value added were gathered from the Central Statistics Agency (BPS) - Indonesia (refer to Table 1).

Table 1. Operational Definition of Variables

Variable	Operational Definition	Unit	Source
Gross Domestic Product Percapita	The value of gross domestic product divided by the number of country population in certain period of time.	IDR	Central Statistics Agency (BPS)
Energy Consumption (BOE)	Total electricity and fuel consumption	Barrel of Oil Equivalent (BOE)	State Electricity Company (PLN) and the Ministry of Energy and Mineral Resources
Average Years of Schooling	Average number of years spent by the population aged 25 years and over in all types of education ever undertaken	Year	Central Statistics Agency (BPS)
Urbanization	Percentage of urban population per total population in a province	Percentage	National Social and Economic Survey (Susenas)
Proportion of Industry Value Added to Total GRDP	The proportion of industry value added to GRDP for each province	Percentage	Central Statistics Agency (BPS)

Source: Data Processed, 2023

RESULTS AND DISCUSSION

There is a significant difference between the minimum and maximum values in the per capita energy consumption variable (see Table 2). Indonesia's average per capita energy consumption also exhibits a significant difference from the minimum value.

During 2010-2021, the region with the largest total electricity and gasoline energy consumption was found on the island of Java, with a per capita energy consumption of 21,722 BOE, while the smallest per capita energy consumption was outside Java, at 0.457 BOE. This data difference indicates that per capita energy consumption in provinces on the island of Java is still higher than in provinces outside Java.

The average years of schooling represent the average duration of education for the population in Indonesia aged over 25. The average Indonesian population over 25 is 8.1 years of schooling. The DKI Jakarta province, where the population has the longest average education duration, is 11.17 years. On the other hand, Papua province, with an average of 5.59 years of schooling, has the shortest average duration of education.

The highest level of urbanization is on the island of Java, which is 100%, but it has decreased yearly. This indicates a more even distribution of development on the island of Java. Meanwhile, the lowest level of urbanization occurs outside Java, at 2.3%, consistently increasing yearly.

Table 2. Results of Descriptive Statistics of Each Variable

Variables	(1) N	(2) *Mean*	(3) *Maximum*	(4) *Minimum*	(5) *Standard Deviation*
EC (BOE)	396	1.816	21.722	0.457	1.888
YSC (Year)	396	8.115	11.170	5.590	1.029
Urban (Percentage)	396	0.467	1	0.023	0.213
IND (Percentage)	396	0.155	0.4445	0.012	0.108
$GRDP_{CAP}$ (Million Rupiah)	396	37.665	188.748	9.317	29.762

Source: Data Processed, 2023

The largest contribution of the industrial sector to the Regional Gross Domestic Product (GDP) is in the Java region, at 44.5%, and the lowest is in regions outside the island of Java, at 1.2%. There is a significant gap between the minimum and maximum values of the industrial sector's contribution to GDP, indicating that the presence of the industrial sector varies among provinces. Provinces in Java have a higher contribution of the industrial sector to GDP than provinces outside Java.

The highest per capita GDP is in the Java region, and the lowest is in regions outside the island of Java. A significant difference between the average per capita GDP and the highest per capita GDP shows a substantial disparity in per capita GDP among provinces in Indonesia. On average, DKI Jakarta has the highest per capita GDP, at 148.23 million, with the highest condition being 188.74 million. Meanwhile, the lowest is in the East Nusa Tenggara Province, at 11.33 million, with the lowest condition being 9.31 million.

Estimation Results for All Regions of Indonesia represent by table 3 results regarding the influence of education (average years of schooling) on per capita energy consumption in Indonesia. The estimation results indicate that education positively affects per capita energy consumption in Indonesia. When the average years of schooling (education) increase by 1%, per capita energy consumption will rise by 1.208%.

Table 3. Regression Results of the Whole Sample in Indonesia

Variables	(1)	(2)	(3)
	OLS	***Fixed Effect***	***Fixed Effect*** **Driscoll – Kraay**
YSC	0.665***	1.208*	1.208**
	(0.189)	(0.617)	(0.463)
$GRDP_{CAP}$	0.293***	-0.0506	-0.0506
	(0.0440)	(0.232)	(0.215)
IND	0.0618*	0.187	0.187***
	(0.0328)	(0.166)	(0.0331)
Urban	0.204***	0.0949	0.0949
	(0.0619)	(0.107)	(0.103)
constant	-1.667***	-1.444*	-1.444*
	(0.398)	(0.810)	(0.799)
Observations	396	396	396
R-squared	0.415	0.036	
Number of obs		33	
Heteroscedasticity		chi2(1) = 33.36***	
Autocorrelation		F(1,32) = 103.322***	
CSD		0.485***	
Number of groups			33
F-stat			14.82
adj R-Squared			0.0357

Source: Data Processed, 2023

These results align with studies conducted by Wang et al. (2022), Wang et al. (2020), Katircioğlu (2014 dan 2018), and Inglesi-Lotz & Morales (2017), which found that post-schooling education accumulation has a significant and positive influence on energy consumption. However, these findings are not in line with studies conducted by Bano et al. (2018), Salim et al. (2017), and Akram et al. (2019), which state that there is a significant and negative influence of education on energy consumption. The industrial sector's contribution to GRDP has a positive association with per capita energy consumption in Indonesia.

This indicates that if the industrial sector's contribution increases by 1%, it will increase per capita energy consumption by 0.187%. The predominance of energy-intensive industrial sectors in the development might further drive this. Additionally, the existing industrial sector development is not fully supported by technology that encourages more efficient energy use.

In the Java region, education negatively affects per capita energy consumption. A 1% increase in education will lead to a 1.938% decrease in per capita energy consumption (see Table 4). This result aligns with studies conducted by Salim et al. (2017) and Bano et al. (2018), which concluded that improving education quality negatively impacts energy consumption in China and Pakistan. There are differences in the impact of education on energy consumption in Indonesia as a whole compared to the Java Island region (see Table 3), where higher education in the Java region can potentially reduce energy consumption, while the opposite relationship occurs in the context of the entire Indonesian region.

Table 4. Regression Results of the Java Island Sample

Variables	(1)	(2)	(3)
	OLS	***Fixed Effect***	***Fixed Effect*** **Driscoll - Kraay**
YSC	0.0501	-1.938	-1.938*
	(0.778)	(1.538)	(1.048)
$GRDP_{CAP}$	0.469***	0.328	0.328
	(0.112)	(0.574)	(0.437)
IND	-0.0133	-0.706	-0.706
	(0.162)	(1.078)	(0.861)
Urban	0.120	-0.116	-0.116
	(0.354)	(0.335)	(0.245)
Constant	-1.202	2.456	2.456
	(1.500)	(2.371)	(2.091)
Observations	72	72	72
R-squared	0.438	0.051	
Number of obs		6	
Heteroscedasticity		chi2(1) = 6.10***	
Autocorrelation		F(1,5) = 60.405***	
CSD		0.446***	
Number of groups			6
F-stat			20.12
adj R-Squared			0.0512

Source: Data Processed, 2023

According to Bano et al. (2018), if the level of educational participation increases, carbon emissions will decrease, which means that carbon emissions can be reduced by enhancing education in the long term. Improvements in education will result in a more skilled, innovative, and productive workforce with a better understanding of energy sustainability and greater awareness of more efficient energy use.

Based on the results above, it can be said that improving the quality of education in the Java island region is more capable of reducing energy consumption significantly, but this does not apply to the entire area in Indonesia. Considering the relatively significant association between education and per capita energy consumption in Java, enhancing the quality of education and providing education on more efficient and environmentally friendly energy consumption can be intensified to produce a stronger and more significant impact.

In areas outside of Java, education has a positive and significant association with energy consumption (see Table 5). When education increases by 1%, per capita energy consumption will increase by 1.925%. Compared to the impact of education on per capita energy consumption in Indonesia as a whole (see Table 3) with a coefficient of 1.208, the estimation results indicate that education has a greater influence on increased energy consumption in regions outside of Java with a coefficient of 1.925. This suggests that the increase in education, especially in regions outside of Java, has not been able to significantly reduce energy consumption but has instead increased it, indirectly exerting a significant influence on national energy consumption.

Table 5. Regression Results of the Sample in Outer Java

VARIABLES	(1)	(2)	(3)
	OLS	***Fixed Effect***	***Fixed Effect*** **Driscoll - Kraay**
YSC	0.630***	1.925***	1.925***
	(0.206)	(0.691)	(0.418)
$GRDP_{CAP}$	0.224***	-0.223	-0.223
	(0.0531)	(0.271)	(0.141)
IND	0.104***	0.253	0.253***
	(0.0393)	(0.173)	(0.0617)
Urban	0.237***	0.137	0.137
	(0.0642)	(0.113)	(0.132)
constant	-1.213**	-2.134**	-2.134**
	(0.492)	(0.872)	(0.782)
Observations	324	324	324
R-squared	0.413	0.065	
Number of obs		27	
Heteroscedasticity		chi2(1) = 71.06***	
Autocorrelation		F(1,26) = 171.643***	
CSD		0.483***	
Number of groups			27
F-stat			9.726
adj R-Squared			0.0651

Source: Data Processed, 2023

Based on the above estimation results, it can be concluded that education alone is insufficient to reduce energy consumption (Inglesi-Lotz & Morales, 2017). According to Wang et al. (2020), an increase in the level of education in society does not necessarily lead to a shift in people's lifestyles towards low-carbon lifestyles. This indicates that the relationship between education and public knowledge and their awareness and behavior regarding energy conservation is relatively weak, especially in less developed regions. Investing in education would be more effective in promoting behavioral change and environmental awareness than simply increasing knowledge about energy conservation (Mills & Schleich, 2012).

The difference in the estimation results in Java and Outside-Java (see Table 6) demonstrates that the level of education has different associations with per capita energy consumption in these two regions. This could be due to differences in the education structure between the two regions (Hofman et al., 2004). According to Hofman et al. (2004), the influence of education on energy consumption behavior varies between regions/countries and depends on the education structure of each country. The data indicates that the quality of education in Java is higher than in Outside Java. Therefore, the differing education structures and disparities in the quality of education between provinces are challenges the government faces in efforts to conserve energy and reduce carbon emissions. The government needs to prioritize improving the education structure in Outside-Java so that the differences in education structure and education quality between Java and Outside-Java can be addressed. As a result, an increase in education will negatively affect energy consumption. This, in turn, will impact the influence of the education level on energy consumption in Indonesia as a whole.

Table 6. Regression Model Estimation Results for Indonesia, Java, and Outside Java

Variables	(1)	(2)	(3)
	Indonesia	**Java**	**Outside Java**
YSC	1.208**	-1.938*	1.925***
	(0.463)	(1.048)	(0.418)
$GRDP_{CAP}$	-0.0506	0.328	-0.223
	(0.215)	(0.437)	(0.141)
IND	0.187***	-0.706	0.253***
	(0.0331)	(0.861)	(0.0617)
Urban	0.0949	-0.116	0.137
	(0.103)	(0.245)	(0.132)
Constant	-1.444*	2.456	-2.134**
	(0.799)	(2.091)	(0.782)
F-stat	14.82	20.12	9.726
adj R-Squared	0.0357	0.0512	0.0651

Source: Data Processed, 2023

Although education has a negative association with energy consumption in Java and a positive one outside Java, the estimation results in Indonesia indicate that education has a significant and positive association with energy consumption. This suggests that the influence of education on energy consumption in Indonesia is predominantly determined by the impact of the education structure and quality in areas outside Java. Non-Javanese communities, on average, are less advanced and modern in terms of education and lifestyle, making them less able to implement energy-efficient practices. More advanced and modern societies are synonymous with efforts to reduce energy consumption and the development of better and environmentally friendly production practices. Modern and advanced communities can adapt to technology more quickly, influencing energy consumption. Moreover, the absorption and implementation of education for more efficient energy consumption is easier in more developed areas (Inglesi-Lotz & Morales, 2017).

In general, Indonesia's education level is still relatively low compared to other countries. This is evident from Indonesia's average years of schooling, which are around 8-9 years. Furthermore, when looking at the quality of education, especially in terms of basic education, the results of the Programme for International Student Assessment (PISA) survey published in 2019 ranked Indonesia 74th out of 79 observed countries. According to UNESCO data (2020), the Indonesian population's composite of educational attainment, health, and per capita income, known as the Human Development Index (HDI), indicates a declining trend. In fact, Indonesia ranks 12th out of 12 countries observed in Asia (Political and Economic Risk Consultant).

The low quality of education in Indonesia makes efforts to reduce energy consumption through the education factor less effective. Carbon emissions will continue to increase due to the low level of education. This is because a low level of education results in an unskilled workforce and can increase household energy consumption (Bano et al., 2018). Therefore, education is a crucial issue to be addressed, and efforts to improve the quality of education must be continuously pursued intensively as one way to reduce energy

consumption in Indonesia. Environmental awareness programs and energy education in schools, as well as government campaigns promoting efficient and renewable energy use, will positively impact energy consumption reduction efforts. According to Doris et al. (2009), one of Europe's most frequently used policies to regulate energy consumption is the enhancement of education, coupled with an increase in public awareness of energy conservation and environmental preservation.

CONCLUSION

This research aims to determine the influence of education on per capita energy consumption among provinces in Indonesia and to further investigate whether differences in education levels among provinces result in varying effects on energy consumption between provinces. The research conclusion is that the education level has a positive and significant association with per capita energy consumption in Indonesia as a whole and in regions outside Java. The existence of a positive relationship between education and energy consumption indicates that an increase in education has not yet become a factor capable of reducing energy consumption levels.

This study has limitations in terms of the indicators used to measure the level of education. Other indicators besides the average length of schooling can be used to assess the quality of education, such as gross enrollment rates, the number of students, or the number of universities and colleges in a region. Calculating the impact of education using variables other than the average length of schooling can provide a different perspective or analysis. This study did not perform these calculations with other variables due to data limitations. Despite the limitations of this study, several points of analysis can provide explanations regarding the impact of education on energy consumption among provinces in Indonesia.

The research results indicate that an increase in education can motivate people in Java to adopt environmentally friendly lifestyles and become more aware of their surroundings, thus reducing energy consumption, which can decrease carbon emissions. However, this does not fully apply to Indonesia, especially in areas outside of Java. This implies that education alone may not be strong enough to promote more energy-efficient usage, so supplementary instruments or policies are needed, such as compulsory education programs implemented by the government to foster public awareness of energy consumption, especially fossil fuel-based energy. Therefore, education can be considered a means to reduce energy consumption in Indonesia, which, in turn, can lead to long-term carbon emissions reduction.

The differences in the impact of education on energy consumption in Java and outside of Java demonstrate that education has varying effects on the energy consumption of a region, depending on the quality of education in that area. Therefore, the government's role in promoting development and enhancing the quality of education outside of Java is of utmost importance.

Subsequent studies that aim to examine the impact of education on energy consumption in a more specific manner can be conducted at the district or city level to generate more comprehensive results. Additionally, this study only covers a 12-year time interval due to data limitations, so future research can be conducted with a longer time interval to make the subsequent findings more comprehensive.

Education has a negative association with energy consumption in the Java region, so if the government wishes to promote more efficient energy use, education can be considered as one of the determinants of energy consumption. Regarding regional analysis results, the government should consider the importance of evaluating education in areas outside Java. If there is a desire to encourage more efficient energy use, additional policies to support education as a determinant of energy consumption are needed. One consideration could be linking the compulsory education program with an early introduction to clean and environmentally friendly energy efforts.

The government can focus on improving the quality of education and efforts to ensure education is accessible across the entire Indonesian archipelago. The government can also increase its budget for the education sector in regions outside Java and enhance the intensity and effectiveness of environmental and energy-efficient consumption campaigns on Java Island. This will raise awareness among the population regarding energy consumption that may harm the environment.

For the industrial sector or companies, the government can begin enforcing technology regulations that support more energy-efficient production processes, providing workforce training, and promoting awareness of clean energy and carbon emission reduction programs. Additionally, there is a need for law enforcement efforts against violations or the use of environmentally unfriendly production equipment.

For the public, the government can continue to provide education regarding using electronic devices and energy-efficient lifestyles. People's lifestyles and habits can change over time, so sustained and consistent efforts by the government to educate the public are expected to reduce household energy consumption. This will directly impact the overall reduction of carbon emissions. In addition to improving education quality, providing subsidies for energy-efficient goods or technologies to consumers can also be considered an alternative effort to reduce energy consumption.

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