



## Energy Poverty and Education: Empirical Evidence from Indonesia

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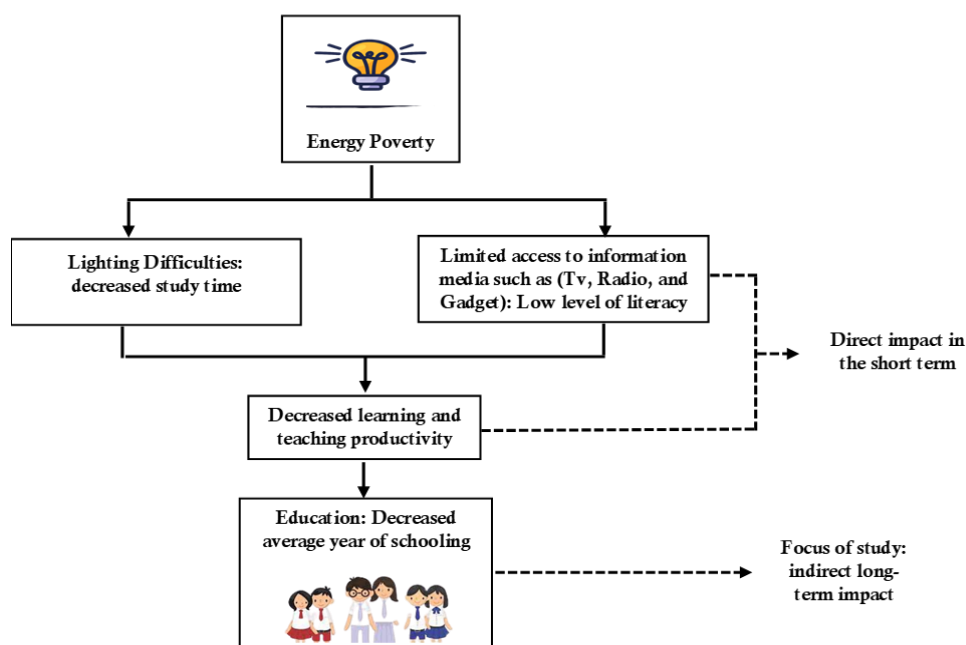
Energy poverty in Indonesia has brought negative impacts on various sectors, including education which is the fourth target in the Sustainable Development Goals. This study explores how energy poverty, which is proxied by the percentage of households consuming <32.4 kwh per month in district or cities in Indonesia in 2015 and 2017, affects education, which is proxied by average years of schooling in district or cities in Indonesia in 2019. By applying the 2SLS method, the instrument variable approach used is the geographical characteristics of an area which is the mean elevation value approach in districts or cities to accurately predict the impact of energy poverty on average years of schooling. The results show a negatively significant impact on education for both energy-poor condition. The results for the first condition (2015) shows that 0.993 year of average years of schooling will be lost due to energy poverty. Whereas in the second condition (2017), 0.164 year of average years of schooling will be lost. This research also serves as an empirical evidence that energy poverty does not directly affect the average years of schooling in districts and cities in Indonesia.

## INTRODUCTION

The phenomenon of energy poverty has been happening in almost all developing and become one of the main triggers for world development issues. International Energy Agency (IEA, 2017) states around 1.06 people around the world have no electricity access. In Africa, approximately 588 million people have no electricity access; in developing countries around Asia, there are 439 million people who experience this issue with India as the highest. Meanwhile, in ASEAN, Indonesia contributes about 5.2% of the total electricity poverty in Asia developing countries (IEA, 2017). It means that if Indonesia can alleviate its electricity poverty, significant changes in this field can happen.

Energy poverty directly inhibits someone to obtain lighting to do activities or study at night,

get information due to the lack of information media (radio/ tv/ internet), and productively join learning process both at school and outside school which later can influence his academic achievement. These phenomena are in line with a study conducted by Ouedraogo (2013), namely electricity supports the rapid development of technology and information infrastructure, such as computer, TV and the internet which truly affects community access to information and knowledge. Also, electrification can alter educational outcomes by improving school quality, covering the quantity and the quality of teachers and prolong the study time due to better lighting (World Bank, 2018). Oppositely, the household inability to get electricity can directly affect study time which in turn reduces the literacy rate (Ghali & El-Sakka, 2004



**Figure 1.** The Relationship between Education and Energy Poverty

Studies related to energy poverty are few. Some previous studies regarding this topic conclude the inability of household to get electricity (energy poverty) will directly hamper study time which in turn reduces the literacy rate. (Ghali & El-Sakka, 2004). Leung and Meisen (2005) mention that electricity is an instrument to improve human' development in the field of education and health. Sovacool and Drupady

(2012) have found energy poverty affects children productivity outside school hours, in which there is a correlation between time spent by the children to collect fuel and the reduced time in their school attendance.

Phoumin and Kimura (2019) investigated the effect of poverty on the dropout rate. They found energy poverty has a positive and significant effect on the dropout rate in Kamboja.

In addition, Sotheaoum (2019) studied the future impact of energy poverty on education determined by the average years of schooling at household level. It confirms that energy poverty negatively affects the average years of schooling at the household level in Laos.

In India, a study of energy poverty has been done by Acharya and Sadath (2019) who viewed the relationship between energy poverty by estimating the multidimensional index of energy poverty at regency level and observing its effect on the development using the components of education and income. Here, the poverty was estimated from the reachability of modern fuel access to cook, and the results the alleviation of energy poverty, in this case is the shift from fuel oil to clean energy fuel to cook can increase women's productivity to the increase in time spent to accomplish their tasks and productivity in education.

Regarding the previous studies of energy policy, especially in Indonesia, the researchers have not yet found studies that identify the effects of energy poverty, including the past limited electricity consumption on the average of the schooling length in the future. Length of schooling is an indirect impact of the energy poverty that has not yet been identified so far, but it has a significant role in a region of country as an indicator portraying the quality human resources. Thus, the researchers attempted to fill this gap and finally examined this issue in Indonesia.

In Indonesia, the newest study of energy poverty was done by Sambodo and Novandra (2019) in form of the identification of the impact of energy poverty on the household welfare. They found the energy poverty can increase the malnutrition rate of households in rural areas. Besides, discussions related to energy in Indonesia are also contained in the 2019 Annual Report of the Ministry of Energy and Mineral Resources of the Republic of Indonesia, namely there are still 1.8 million households throughout Indonesia spread over 16,056 islands that do not have electricity. (ESDM, 2019). In 2017, the electrification ratio in Indonesia (number of residential customers to total occupancy) reached

95.35%, higher than the target of 92.75% (ESDM, 2018). However, the results of a study by the Indonesian Institute of Sciences (LIPI) in terms of energy in April 2020 found that achieving a 100% electrification ratio would be trapped in quasi-data because various problems were still found, especially related to the fulfillment of electrical energy and clean energy for cooking or referred to as energy poor. Furthermore, it is also said that the poor condition of energy that afflicts a population is caused by lack of education, weak economy and living in remote areas.

The existing electrification gap portrays energy poverty in a region and causes disruption at various sectors. As the practical example, education was the focus of this study because energy is an essential component for daily basic needs and is one of requirements for many educational inputs. Improving electrical energy service will activate the necessary inputs for education, such as providing lighting for learning and narrowing digital gaps through information and communication technology for the use of modern equipment that also supports teaching and learning process. This effort indirectly affects the level of one's educational achievement. Development in education has been agreed upon by world leaders as attached in Sustainable Development Goals/ SDGs covering four targets and focusing on the equality of quality education and opening the widest possible range of lifelong learning for all.

This study noticed the influence of energy poverty indicated by the consumption of electricity less than 32.4 kwh and its impact on the average of schooling length at regency and city levels in Indonesia. Length of schooling average attainment is an indirect effect caused by energy poverty that will be felt in the future. Unfortunately, there has been no study In Indonesia discussing this matter, while the newest is from Sambodo and Novandra (2019). However, their study only examined the impact on health or malnutrition level of households. Consequently, the present study strived for enriching the previous literatures and filling research gaps in form of the lack information for continuous debate about rural economy and

electrification in regions with low income, not to mention, it adds to the literatures of human development in the field of education to more comprehend the mechanism of energy impact. The importance of energy poverty for increasing educational equity in a particular area is proxied from the average of schooling length at regency and city levels in Indonesia is a new topic that has not yet been ever investigated in Indonesia. Apart from that, this study attempted to fill the gaps of the previous studies by using 2SLS estimation from the data collected using instrumental variable (IV) applied to regency or cities in Indonesia. It is expected to give academic contributions in the matter of the findings of empirical study of energy poverty and its impact on education as well as practical contribution, namely providing inputs on the implementation of energy and education applications in order to encourage sustainable economic development.

## RESEARCH METHODS

The Average Years of Schooling (AYS) data at regency or city level as the dependent variable in this study played a role as a proxy for education obtained from the publication of Statistics Indonesia in 2019. ALS is defined as the ability of people in taking all educational levels. Meanwhile, the data of energy poverty as the independent variable took part as a proxy for the household proportion in a regency or city with the electricity consumption below 32.4 kwh per month were obtained from the National Socioeconomic Survey or Susesans in 2015 and 2017. As previously mentioned, AYS is an indirect impact that is rarely observed, but has a strong relation with energy poverty. According to the previous studies, there needs at least three to five years see the impact of energy poverty on the average of length of schooling (that was why the energy poverty data in 2015 and 2017 were used to consider the average years of schooling in 2019).

Other data involved as the control variable were the economic condition of a region projected by the GDRP (Gross Regional Domestic Product) of a regency city based on

current prices obtained from Statistics Indonesia. Then, the population characteristics data covering the poor and population were also from Statistics Indonesia. Meanwhile, the data showing support for the educational inputs described by school facilities and number of teachers were obtained from Neraca Pendidikan of the Ministry of Education and Culture (Kemdikbud), while another supporting factor, namely the background of the head of the family became the consideration in this study and were stated by the data on the proportion of head of household literacy in each regency or city obtained from the 2019 Susenas. Further data were from the data of village potential or podes in 2018 regarding regional typography, including the proportion of mountain slopes in an area became the complement in describing living conditions. Finally, the researchers used an island dummy to determine with certainty the diversity of geographical areas on the average years of schooling.

2SLS method was used because there was an omitted variable bias in the variables of energy poverty and the average years of schooling. By referring to a study by (Sotheaoum, 2019), the instrumental variable employed in this study was inspired by Dinkelman (2011) and Pagel (2019). A similar strategy IV was proposed in this study to describe the geographical conditions of an area by using the average elevation at a regency or city in Indonesia as factors that affected energy poverty. In this 2SLS regression, the first model or first-stage regression is a model to describe the impact of regional geographical condition in the average elevation on energy poverty in a regency or city. The second model or second-stage regression, the main model, is built to see the impact of energy poverty on the average years of schooling in a regency or city in Indonesia.

This study used secondary data form Statistics Indonesia, Susenas, Podes, and other sources related to education from the Ministry of Education and Culture. In addition, the unit of analysis was at regency or city level in the period of 2019 as many as 510 regencies and cities in Indonesia. To do so, the following models were formulated:

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$$AYS_i = \beta_0 + \beta_1 ePov_i + \beta_2 Gdrp_i + \beta_3 \ln\_Pop_i + \beta_4 Poor_i + \beta_5 Sfac_i + \beta_6 Teac_i + \beta_7 Hohl_i + \beta_8 Mounts_i + \beta_9 Elecr_i + \beta_{10} isInd_i + \mu_i \dots\dots (1)$$

Where  $\ln$  is logarithmic form; AYS is average years of schooling; ePov is energy poverty; Gdrp is Gross domestic regional bruto; Pop is poor population; Sfac is school facilities; Teac is number of teachers; Hohl is household head literacy; Mounts is mountain slope; Elecr is electricity ratio; isInd is dummy island and  $\mu$  error term. 2.

The variable instrument for energy poverty variable at first-stage equation is represents as follows:

$$ePov_i = \alpha_0 + \alpha_1 \text{elevation} + \varepsilon_i \dots\dots\dots (2)$$

## RESULTS AND DISCUSSION

The results of this analysis explained the characteristics of the sample from the mean, determined the extreme value of minimum and maximum values, and standard deviation of a group of research data (Gujarati, 2009). It was carried out by observing 510 samples of regencies and cities in Indonesia. In details, all variables are summarized in table 4.1.

**Table 1.** Descriptive Analysis of Variables

Variable	Description					
	Unit	Obs	Mean	Std.Dev.	Min	Max
Average years of schooling	Nominal	510	8,23	1,622	1,96	12,64
Energy Poverty in 2015 (1)	Percentage	510	24,040	21,408	0,22	100
Energy poverty in 2017 (2)	Percentage	510	13,504	11,463	0	60,24
PDRB	Billion Rp	510	21773,04	47677,71	138	452820
Population	People	510	496023,5	597007,8	13879	3800787
The poor	People	510	49,15	52,38	1.34	395.03
School facilities	Nominal	510	429,65	368,48	23	3125
Number of teachers	People	510	5025	4715	65	35736
Household heads literacy	People	510	5,861	7,960	0,011	58,513
Mountain slope	Percentage	510	15,120	19,746	0	100
Electrification ratio	Percentage	510	0,952	0.122	0	1
Average of elevation	m3	510	339,13	372,50	2,96	1099,30

Source: Data Processed, 2020

Based on table 4.1 it is known that the number of samples observed in this study were

510 covering regencies and cities in Indonesia in 2019. Their average years of schooling varied

from 1.96 to 12.64 with the mean of 8.23 in 2019. Here, the lowest schooling length occurred in Puncak Regency (Papua), while the highest was in Banda Aceh.

Energy poverty variable (1) resulted the percentage range between 0.22 percent to 100 percent with the mean of 24.04 of the percentage of poor energy households of a regency or city. The lowest energy poverty (1) occurred in South Tangerang, while the highest was in Puncak Regency in Papua. The second energy poverty (2) ranged from 0 and 60.24 percent with the highest condition situated in Asmat area. In 2017, this area had 13.50 percentage of proportion of poor energy households around its regencies and cities. This happened due to the consumption of household electricity which was less than 32.4 kwh/ month. The higher the number indicates that a particular regency or city has poorer households, while the lower means the less energy poverty in that area.

In terms of GDRP, the regencies / cities Indonesia which earned 21773.04 to 452820 billion rupiah with the lowest was Pegunungan Arfak Regency, and the highest was Central Jakarta City. Meanwhile, the population variable ranged from 13,879 to 3,800,787 people with the mean of 496.023 in 2019. It was Tambrauw Regency which became the lowest, and Tangerang Regency was the highest. In addition, the poor variable in 2019 varied from 1.34 thousand people in Tana Tidung Regency, and the highest were 395.03 thousand people in Bogor Regency. This variable had the mean of 49.15 thousand people.

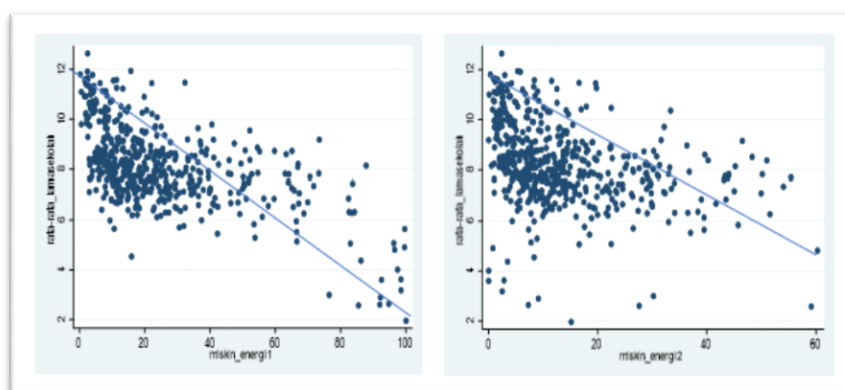
School facilities variable refer to the number of all level of schools available in every regency and city in Indonesia. It varied from 23 to 3125 with the lowest was in Kepulauan Seribu Regency, and the highest was in Bogor Regency with the total of 425.65 school facilities.

The variation of total teachers ranged from 65 to 35736 people with the mean of 5025. The lowest number of teachers was in Sumbawa Regency, and the highest was in Bogor Regency. What these data present was the total teachers spread across all regencies and cities in Indonesia from all levels of education.

Literacy of household head variable provides information on family background measured from the reading and writing skills of its head and aggregated to regency and city level. After that, there will appear the number of the household heads who are illiterate. In 2019 the mean of the literacy was 5.85 percent with the percentage of 0.010 to 58.51 percent. The highest percentage was in Lanny Jaya Regency, while the lowest were found in several locations, namely Aceh City, Yogyakarta City, Bandung City, and overall Jakarta City.

The range of variation of the variable proportion of mountain slopes in a regency or city was between 0 to 100 percent with the mean of 15.12 percent. The mountain slope variable describes the mountainous area in a regency or city. Moreover, electrification ratio variable is the percentage of the electrification ratio with National Electricity Company or PLN electricity in regencies or cities in Indonesia with a range from 0 to 1, where the value of 0 was obtained in Puncak Jaya Regency - Papua.

The elevation variable provides information related to the geographical conditions of an area by considering the average height of the land above sea level. The higher the value means the more difficult the area will be in terms of electricity availability. The average variation of elevation ranged from 2.96 meters to 1099.30 meters with the mean of 339.13 meters. The lowest was in the northern Jakarta City area and the highest was in Lanny Jaya Regency. Figure 2 shows the relationship between dependent and independent variables:



**Figure 2.** The Scatter Plot of the Average Years of Schooling and Energy Poverty  
Source: Data Processed, 2020

Figure 2 shows that the relationship between the average years of schooling in 2019 with energy poverty in 2015 and 2017 was negative and linear, meaning that the higher percentage of energy poverty lowered the average years of schooling. Thus, the assumption and linearity requirement in the model have been fulfilled, namely there exists a clear pattern of data plotting to show whether the relationship is positive or negative. In contrary, if the plotting shows no clear pattern, the linearity assumption is not met (Gujarati, 2009).

The instrument variable, the regional geographical condition in the average elevation of regency/ city, used in this study referred to a study by (Pagel, 2019). It was utilized to capture the endogeneity issue in the variable of energy poverty. Elevation variable is exogenous because it has given characteristics and directly affects energy poverty in a particular area, but does not significantly affect the average years of schooling variable. The effects of elevation on the energy poverty in 2015 and 2017 as the results of first-stage regression can be seen in the following table 2 and 3.

**Table 2.** The Results of First-Stage Regression of Elevation and Energy Poverty in 2015

Variable	Model (1) OLS	Model (2) OLS	Model (3) OLS
Elevation	0.372*** (0.026)	0.237*** (0.025)	0.317*** (0.027)
Variable control	No	Yes	Yes
Island	No	No	Yes
Constant	5.027*** (1.565)	79.584*** (12.553)	57.178*** (11.826)
N	510	510	510
R-Squared	0.2828	0.5579	0.6700
Adj R-Square	0.2814	0.5508	0.6607
F-Statistic	200.33	86.632	134.286

Notes: \* $p < 0.1$ , \*\* $p < 0.05$ , \*\*\* $p < 0.01$

Source: analysis results, 2020 (processed)

**Table 3.** The Results of First-Stage Regression from Elevation and Energy Poverty in 2017

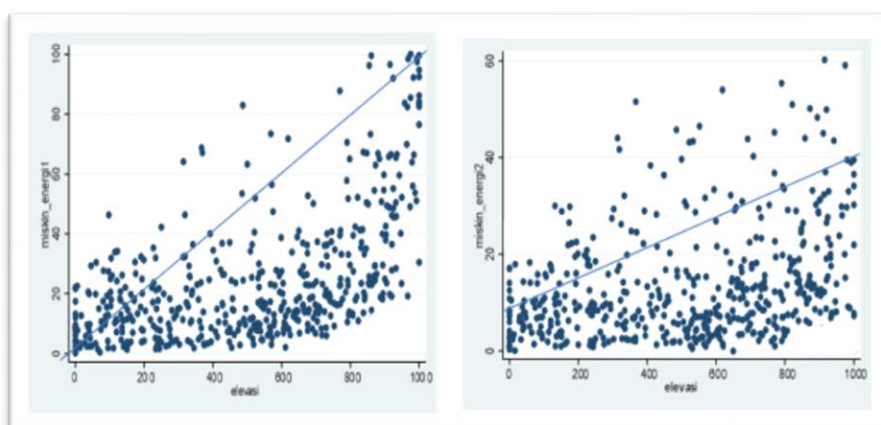
Variable	Model (1) OLS	Model (2) OLS	Model (3) OLS
Elevation	0.100*** (0.016)	0.062*** (0.018)	0.110*** (0.020)
Variable control	No	Yes	Yes
Island	No	No	Yes
Constant	8.348*** (0.953)	33.208*** (9.225)	37.548*** (8.881)
N	510	510	510
R-Squared	0.2707	0.6814	0.6826
Adj R-Square	0.2570	0.6201	0.6510
F-Statistic	39.730	18.91	28.72

Notes: \*p &lt; 0.1, \*\*p &lt; 0.05, \*\*\*p &lt; 0.01

Source: Data Processed, 2020

Based on the estimation results of the first-stage regression using OLS method in table 2, there obtained a positive and significant effect on

both conditions. It showed consistent results when other control variables in the main model were input to the first-stage regression model.

**Figure 3.** The Scatter Plot of Energy Poverty 1 and 2 with Elevation.

Source: Data Processed, 2020

Figure 3 describes the relationship between elevation and energy poverty 1 (left) and the relationship between elevation and energy poverty in 2017 (right). It is clearly seen that the higher the mean of evaluation in a region, the greater energy poverty will happen in that area.

The results of the energy poverty variable which have captured the endogeneity problem of

the elevation instrument variable in the first-stage regression were used in the main model in the second-stage regression, that is the influence of energy poverty in 2015 and 2017 in an area on achievement the average years of schooling in 2019 (in table 4 and table 5).



**Table 4.** The Results of 2SLS on the Effect of Energy Poverty in 2015 on the Average Years of Schooling in 2019

Variable	Model (1) 2SLS	Model (2) 2SLS	Model (3) 2SLS
Energy poverty 1	-0.508*** (0.005)	-0.700*** (0.008)	-0.704*** (0.007)
GRDP		0.670*** (1.433)	0.562*** (1.358)
Population		-0.337*** (0.113)	-0.172* (0.094)
Poor people		-0.005 (0.002)	-0.001 (0.002)
School facilities		0.001*** (0.004)	0.001*** (0.004)
Number of teachers		0.007*** (0.002)	0.006*** (0.002)
Household heads literacy		-0.047*** (0.012)	-0.061*** (0.010)
Slope proportion		-0.016*** (0.003)	-0.012*** (0.003)
Island dummy			-0.703 (0.164)
Sumatera			1.430*** (0.265)
Bali dan Nusa Tenggara			-1.220 (0.215)
Kalimantan			0.280 (0.195)
Sulawesi			-1.755*** (0.333)
Maluku			-1.446*** (0.308)
Papua	9.651*** (0.134)	14.345*** (1.448)	12.204*** (1.194)
Constant			
N	510	510	510
F-Statistic	200.328	86.632	134.286

Notes: \*p &lt; 0.1, \*\*p &lt; 0.05, \*\*\*p &lt; 0.01

Source: Data Processed, 2020

Based on the estimation results in table 4, model (1) was known to capture negative and significant effects of energy poverty in 2015 on the average years of schooling in 2019. In model (2) regression was added by inputting a control variable which might affect the average years of schooling. It aimed to discover the consistency of the effect of energy poverty on the average years of schooling. The results still found a negative

and significant effect of energy poverty on the average years of schooling.

In model (3), the full observation, the researchers found the consistent results of the negative and significant effects of energy poverty in 2015 on the average years of schooling in 2019, and almost all variables immediately contributed to it. Then, regression in model (3) was performed by adding a control variable from the island dummy. The consistency of the effect of

energy poverty on the average years of schooling is in line with a study by Sotheaoum (2019) which states that the past energy poverty affects the average schooling attainment. However, this study did not add a control variable of region dummy to portray any various characteristics of a country, so the present study added a variation in the research model to examine any differences in the results of analysis of the past energy poverty on the average years of schooling attainment.

GRDP variable in this study indicated positive and significant effects on the average years of schooling, that is the total GRDP of a region will increase the attainment of schooling length in that area. The GRDP per-capita was chosen as the control variable due to its ability to capture gaps between the region as the center of economic development of an area. It is similar to that of Wahyuni and Parameswari (2017) that the inequality of an area's development as measured by GRDP per capita can affect the development of the regional education sector.

Population variable resulted negative and significant effect on the schooling length attainment, meaning that the greater the number of the poor, the lower schooling length will be. Besides, the poor variable showed a negative, but insignificant effect on the average years of schooling. It implies that the greater the amount of the poor will gradually and indirectly reduce the achievement of the average years of schooling.

In association with model (3), it was found that school facilities had positive and significant effects on the average years of schooling. The

more school facilities available in an area, the higher schooling length achievement will be. It is in harmony with a study done by Sotheaoum in Laos (2019) that the total schools in an area will determine the educational achievement.

The literacy of household heads gained negative and significant effects, namely the more illiterate the heads, the lower average years of schooling will be. The same thing is stated by Sotheaoum (2019), namely the literacy of household heads has negative and significant effects on children's schooling length in Laos. Furthermore, the control related to typography, the slope proportion variable in the estimation results, obtained positive and significant effects. It meant that the condition of the area on the slopes of a mountain results in an increase in the average years of schooling. An additional variable related to the electrification ratio as a control was investigated and showed that the electrification ratio had a positive and significant effect, indicating that the greater the electrification ratio, the greater the average years of school achievement.

The island dummy variable in model (3) assessed the average years of schooling in the islands in Indonesia. It showed that the proportion of households in Sumatera Island had lower average of schooling length than Java Island, namely 0.24 followed by Bali and Nusa Tenggara Islands which had higher rate of 1.57. In the same way, those in Sulawesi Island gained higher rate than Java by 0.30. Then Kalimantan, Maluku, and Papua Island obtained lower results than Java, namely 0.39, 1.64. and 1.04 respectively.

**Table 5.** The 2SLS Results of the Effects of Energy Poverty in 2017 and Average Years of Schooling in 2019

Variable	Model (1) 2SLS	Model (2) 2SLS	Model (3) 2SLS
Energy poverty 2	-0.216*** (0.035)	-0.268*** (0.080)	-0.214*** (0.039)
GRDP		0.180 (0.413)	0.180 (0.264)
Population		-0.486 (0.302)	-0.353* (0.190)
Poor people		-0.002 (0.005)	-0.004 (0.004)
School facilities		0.001 (0.000)	0.005 (0.000)
Number of teachers		0.001* (0.000)	0.008* (0.000)
Household heads literacy		-0.086*** (0.021)	-0.109*** (0.014)
Slope proportion		-0.031** (0.012)	-0.013*** (0.006)
Island dummy Sumatera			-0.494*** (0.327)
Bali dan Nusa Tenggara			2.966*** (0.685)
Kalimantan			-1.474*** (0.433)
Sulawesi			0.457 (0.359)
Maluku			-1.493** (0.585)
Papua	11.167*** (0.487)	17.674*** (4.235)	-1.387 (0.478)
Constant			15.995*** (2.613)
N	510	510	510
F-Statistic	39.730	18.91	28.72

Notes: \*p &lt; 0.1, \*\*p &lt; 0.05, \*\*\*p &lt; 0.01

Source: Data Processed, 2020

The model (3) in the above table 5 showed consistency of the negative and significant effects of energy poverty 2 on the average years of schooling. Due to its consistency, regression was applied to this model by adding island dummy variable. The results found in this model are in line with what was found by (Sotheaoum, 2019), namely the past energy poverty affects the schooling length attainment.

When the energy poverty in 2015 was compared to that of 2017, the results of the year 2015 were worse, namely 0.993 or equal to one year school gap due to the energy poverty. Meanwhile, the condition in 2017 seemed not

significant with the value of 0.164. These became an empirical proof that the energy poverty of a region does not directly affect the school length attainment, but it needs some time to gradually show its effect as seen in this study.

The GRDP variable in this study showed positive and not significant effects on the average years of schooling, while population gained negative and significant results. In addition, the poor variable indicated negative, but not significant effect the average years of schooling, and the school facilities had positive, but not significant effects. This situation was different from the poverty 1 when the school facilities

positively and significantly affected. Further, the variable control of the number of teachers achieved positive and significant effects, the same as the one happened in 2015.

The effect household heads literacy on the average years of schooling obtained consistent results in the energy poverty 1, namely negative and significant in which the greater population of illiterate household heads in a region, the lower average years of schooling would be. Meanwhile, the slope proportion variable showed negative and significant results in both energy poverty conditions. Likewise, the variable of electrification ratio as the input for control considerations in this study had consistent results with the energy poverty condition 1, namely positive and significant. It implied that the greater the electrification ratio of an area, the greater the achievement of the average years of schooling in the region.

In terms of island dummy variable in model (3) with Java Island as the reference, it was found that the households who lived in Sumatera mainly had lower average years of schooling than Java with 0.59, while Bali and Nusa Tenggara had higher rate with 2.47. Similarly, those in Sulawesi got higher average than Java with the value of 0.39, while Kalimantan, Maluku and Papua Islands were lower than Java Island with 1.02, 1.65, and 0.41 respectively.

In general, based on the 2SLS estimation results of the effects of energy poverty in 2015 and 2017 on the average years of schooling in 2019 in model (3), the researchers obtained consistent results, namely there was negative and significant effects of energy poverty in 2015 and 2017 on the average years of schooling in 2019. This consistency is in accordance with a study by Sotheaoum (2013) which states the past energy poverty influences the future schooling length attainment. However, his study did not add the regional dummy control variable to capture the characteristics of regional variety. Moreover, this study has improved the previous studies by using two periods of energy poverty, so it enriches the novelty of researchers in this topic.

## CONCLUSION

This study was carried out to investigate the impact of the past energy poverty on the average years of schooling at the level of regency and city by involving 510 samples. It studied the energy poverty happened in two periods of time, namely 2015 and 2017 then sought for the impact on the average years of schooling in 2019. Based on the estimation results of the IV 2SLS method covering regional geographical characteristics, namely elevation variable as the variable instrument to reduce bias potential due to endogeneity, this study concludes that the past energy poverty condition in a region has negative an significant effects on the future average years of schooling. These results have been proved consistent in all three models with two different range of time produced either with a control variable or without a control variable.

The energy poverty phenomenon needs significant attention from the government. Based on the findings and conclusions, here are several recommendations that can be given to counter this issue. First, given the positive effect of geographical characteristics on the use of electricity, the government can focus more on providing energy to regions which have geographical constraints. Second, due to its negative effects on the length of schooling, the government needs to improve electrical infrastructure by making public-private partnerships that encourage the improvement of educational support facilities to realize the goals of the four SDGs which are the focus of this research and providing subsidized electricity tariff programs for schools located in areas with poor energy.

This study only portrayed the effect of energy poverty happened in 2015 and 2017 with the electricity consumption below 32.4 kwh in regencies and cities and Indonesia with the data taken from Susenas of Statistics Indonesia. Thus, the findings of this study are limited to describing the condition of energy poverty from limited electricity consumption in 2015 and 2017 to the average years of schooling in 2019 at the regency and city levels in Indonesia. For more, the effects found in this study were indirect, so the future

studies are suggested to explore the direct effects using test scores, literacy rate, and dropout rate.

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