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The Effects of Electricity Consumption on Electrification Access on Economic Growth in Papua Province, Indonesia



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ABSTRACT

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The current research aims to analyze the influence of electricity and infrastructure on regional economy. The study empirically tested the impact of the independent constructs on electrification access and economic growth in Papua, Indonesia by using mediating role of electricity consumption. Independent variables examined in this study are electrical installations and electricity capital, while the dependent variables are measured by using labor absorption. This study specifically investigates the relationship between these variables with a cross-sectional study model, conducted at Papua Province, Indonesia with data from 2012 to 2016. The results show that electricity consumption in Papua Province is significantly influenced by electrical installation, household electricity capital and industrial electricity capital. Furthermore, electricity consumption in general affects employment. The test of the mediating variable shows the role of the consumption variable in the ratio of electrification and employment. Theoretical implication posed from the findings is about the relationship between economic growth and energy infrastructure which is more likely to attract both domestic and foreign investment in a region. The novelty of this research is to reveal the role of electrification in industrialization and employment.

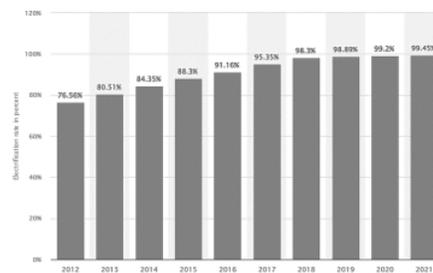
1. INTRODUCTION

Access to affordable energy has substantial impacts on the welfare and the economy of nation. There is a gap in access to energy between developed and developing countries. Since today's economy is highly dependent on energy, in turn, the economy and per capita income are also affected by energy availability. Access to cheap energy leads to industrialization and employment, especially in developing countries. In addition, the inequality in access to energy that developing countries suffer, especially electricity, poses greater challenges to the provision of education and basic needs [1]. Access to electricity also affects the ability of developing country governments to provide access to information, sanitation, health and adequate housing [2].

Today, electricity is the most basic energy need, not only for individuals and families, but also for the socio-economic development of a country [3]. Increasing welfare and meeting needs is highly dependent on access to electricity. In increasing economic development, electricity consumption is also an indicator that reflects the level of a country's social development. Kanagawa and Nakata [4] also stated that socio-economically, increasing access to modern energy in the form of electrical energy will drastically improve the quality of life.

Previous studies have confirmed the relationship between installation development and electricity capital for both industry and households in regional economic development. By analyzing the relationships between the effect of greenhouse gas emissions from electricity generation, electricity consumption, economic growth and population in Indonesia

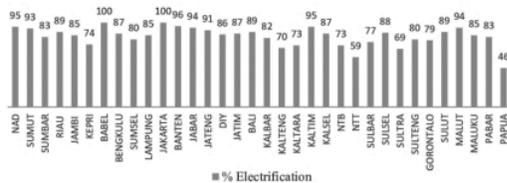
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using time series data from 1971-2011 with the restricted VAR model and VAR structural analysis, Basyiran [5] shows that electricity consumption, growth economy and population can influence changes in the intensity of greenhouse gas emissions. In addition, economic and population growth can affect the amount of electricity consumption, and population is a variable that can determine the level of economic growth [5-7]. In particular, by investigating electricity consumption in the industrial sector, Axella and Suryani [8] show that electricity is in the industrial sector, because industry has an important role in the government's economic growth. This is because the industrial sector requires electrical resources to run its business. The electrification ratio in Indonesia has increased in the last decade. Figure 1 shows the electrification ratio increasing from 76.56% in 2012 to 99.45% in 2021.



Source: [9]

Figure 1. Electrification rate in Indonesia, 2012-2020

Here, the availability of electricity is the most vital aspect besides the availability of energy, gas and oil, to attract investment and intensify industrialization [15]. Prasetyo and Firdaus [10] provide empirical evidence of the relationship between electricity sold and economic growth, where the variable electricity sold has an elasticity level of 0.33. This means that every 1 percent increase in electricity energy sold will increase economic growth by 0.33 percent. In this context, the current research aims to analyze the influence of electricity and infrastructure on regional economy. The study empirically tested the impact of the independent constructs on electrification access and economic growth in Papua, Indonesia by using mediating role of electricity consumption.



Source: [11]

Figure 2. Electrification ratio in Papua compared to other regions in Indonesia

Table 1. Human Development Index (selected regions, 2018-2021)

Provinces	2018	2019	2020	2021
North Sumatra	71.18	71.74	71.77	72.00
West Sumatra	71.73	72.39	72.38	72.65
Lampung	69.02	69.57	69.69	69.90
Bangka Belitung	70.67	71.30	71.47	71.69
Jakarta	80.47	80.76	80.77	81.11
West Java	71.30	72.03	72.09	72.45
Yogyakarta	79.53	79.99	79.97	80.22
East Java	70.77	71.50	71.71	72.14
Bali	74.77	75.38	75.50	75.69
West Nusa Tenggara	67.30	68.14	68.25	68.65
East Nusa Tenggara	64.39	65.23	65.19	65.28
South Kalimantan	70.17	70.72	70.91	71.28
East Kalimantan	75.83	76.61	76.24	76.88
North Sulawesi	72.20	72.99	72.93	73.30
South Sulawesi	70.90	71.66	71.93	72.24
West Papua	63.74	64.70	65.09	65.26
Papua	60.06	60.84	60.44	60.62

Source: [12]

The data as shown in Figure 2 shows that Papua is one of the regions with the lowest electrification rate in Indonesia. This is due to its sparse population and geographical constraints. In turn, this causes low levels of industrialization and employment in Papua along with the absence of large-scale industries or businesses. This ultimately reduces the quality of human resources as reflected by the Human Development Index by 60.62 or below the national HDI average of 72.29 in 2021 [12] (Table 1).

For the purpose of this study, independent variables examined in this study are electrical installations and electricity capital, while the dependent variables are measured by using labor absorption. The theoretical assumption of this research is the relationship between physical infrastructure and human resources as an important consideration in economic development [13]. As an infrastructure indicator, electricity capital is used in testing this study with the size of household

electrical installations and community and industrial electrical installations. All these measures are used in total to estimate electricity consumption. To examine more deeply the relationship between infrastructure and economic growth, this study uses a proxy for employment and uses electricity consumption as a mediating effect.

2. LITERATURE REVIEW AND HYPOTHESES

Several previous studies have thoroughly examined the role of electricity consumption with economic growth [14, 15]. Abosedr and Baghestani [16] and Soyta and Sari [17], examine the role of access and consumption of energy, namely electricity in economic and social growth where electricity consumption is estimated to reflect people's income and can positively trigger economic growth either through consumption of goods and services or industrialization [25]. domestic and foreign investment [18-21]. Furthermore, in a study in developing countries, Ghosh [22] found a causal relationship between energy consumption and economic growth. This means that the higher the electricity consumption, the higher the economic growth [23, 24]. Altinay and Kocogol [25] in an empirical test found a positive indication of the relationship between economic growth triggered by energy consumption. This is assumed to have an effect on human resource development through higher employment and sustainable economic growth [13].

Maqin [26] (showed as a major factor and one of the most needed resources in the industrial sector, the electricity infrastructure has an influence on economic growth. It shows that the use of electricity, especially in the industrial sector, is very important in increasing economic growth. The Central Statistics Agency report [27] also shows that when compared to the first quarter of 2013 (q-to-q), the highest growth was achieved by the electricity, gas and clean water sectors. In a study of the effect of infrastructure on regional economic growth, Winanda [28] revealed that there is a positive and significant relationship between electricity and clean water infrastructure on economic growth in Bandar Lampung, Indonesia, and electricity is the infrastructure that has the greatest influence on regional economic growth. With a time series research design from 1987-2016 regarding the effect of electricity subsidy spending on economic growth, Pasaribu [29] shows that there is an indirect effect on economic growth, and there is a significant effect of subsidy spending and electricity demand on economic growth. Furthermore, electricity consumption influence changes in economic growth economy albeit intensifying greenhouse gas emissions. In addition, Ali [6] demonstrated that economic and population growth can affect the amount of electricity consumption, and population is a variable that can determine the level of economic growth [7].

Previous studies [30, 31] have confirmed the relationship between installation development and electricity capital for both industry and households in regional economic development. By analyzing the relationship between the effect of greenhouse gas emissions from electricity generation, electricity consumption, economic growth and population in Indonesia using time series data from 1971-2011 with the restricted VAR model and VAR structural analysis.

H1: Installed electricity has a positive effect on consumption

H2: Household electricity capital has a positive effect on consumption

H3: Non-household electricity capital has a positive effect on consumption

Rizkiawan [32] reveals that there is a long-term, but not short-term, effects on the relationship of economic growth, foreign direct investment and the consumer price index affecting electricity consumption. In detail, electricity consumption has a positive effect on economic growth and has a negative effect on foreign direct investment and consumer price index. Darmayanti [33] examines the relationship between the influence of electricity consumption, economic growth, gas emissions and the population in Indonesia using time series data from 1971-2014. By using the Granger Causality method with the VAR/VECM model and the Johansen cointegration test, Darmayanti [33], however, shows that there is no causal relationship between electricity consumption and economic growth, a direct relationship between electricity consumption and population and a unidirectional relationship between population and economic growth. Gargita [34] showed that in Indonesia and the Philippines, the results show that the consumption of electrical energy has an effect on GDP. The results showed that consumption of electrical energy has an effect on GDP. In Thailand, GDP affects the consumption of electrical energy. In particular, in the relationship between consumption, electrification ratio, Susila and Pribadi [35] concluded that electricity consumption and electrification ratio in Indonesia has a strong relationship with HDI indicators. Furthermore, with regard to employment, Triatmanati et al. [36] show that the increase in Gross Domestic Product that comes from the contribution of electricity investment has an impact on the availability of employment and absorption of labor in Indonesia.

H4: Consumption has a positive effect on labor

H5: Consumption has a positive effect on the electrification ratio

H6: Consumption mediates the effect of electrical installations, household electricity capital, and non-household electricity capital on labor absorption, and the electrification ratio

3. METHODOLOGY

This study conceptualizes a positive relationship between economic growth driven by infrastructure capital, in this case, access, installation and energy consumption. The research was designed quantitatively by empirically investigating the relationship between these variables with a cross-sectional study model, with data from 2012 to 2016 (Figure 3). In addition, government support is seen as one of the most important things in providing electricity infrastructure, especially with regard to the electricity monopoly in Indonesia, which affects the installation of electrical installations for household, business and industrial users. The availability of electricity in turn will attract greater consumption by both households and industry. This will increase the absorption of labor and the electrification ratio as two forms of economic growth. In this study, the independent variable is divided into 3 constructs, namely electrical installation, household electricity capital, and industrial electricity capital. The mediating variable is electricity consumption, while the dependent variable is labor absorption and the electrification ratio as a proxy for economic growth.

This study was conducted with samples at the district and

city level with 13 districts and cities in Papua Province as samples (Merauke, Boven Digoel Jayawijaya, Sarmi, Keroom, Nabire Mimika, Kepulauan Yapen, Biak Numfor, Supiori and Waropen). The data taken includes installed electrical installations, household capital, industrial capital as measured in rupiah, which shows the amount of infrastructure that is issued to expand the availability of electricity. The mediating variable is electricity consumption, which is measured in kilo watt-hours (KWH). For the variable of economic growth, which is proxied by labor absorption and electrification ratio, it is measured sequentially by the number of populations entering the labor force and currently working, the percentage of areas that have access to electricity. The sources of data in this study come from the Commerce Department of PT. PLN Persero Trading Section and Finance Section PT PLN Persero Papua & West Papua Region, Papua Province Central Statistics Agency. The analytical tool in this study is regression with SPSS to analyze direct relationships, and with a test model to analyze indirect relationships.

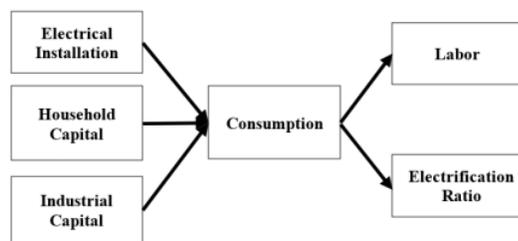


Figure 3. Empirical research model

4. RESULTS

The first hypothesis states that electricity capital has a positive effect on consumption (H1a) and consumption mediates the effect of electricity capital on employment or the absorption of labor (H1b) and the electrification ratio (H1c). Based on the results of the SPSS calculation, t-value is 0.091, while the p-value is $0.929 > 0.05$, meaning that there is no significant influence between the electricity capital variable on consumption. Based on the results of the Sobel Test Calculator, the z-value of the effect of electricity capital on labor mediated by consumption is 2.416 with a significance of 0.015 below 5% ($0.015 < 0.05$), meaning that electrical consumption is able to strengthen the significant influence of electricity capital on the absorption of labor. Statistical output also revealed z-value of the influence of electricity capital on the electrification ratio by using mediating role of consumption with the value of 68,497,286 and p-value of $0.000 < 0.05$, meaning that consumption is more likely able to strengthen the positive impact of electricity capital on the electrification ratio. The statistical output indicates that there is no influence between electricity capital and consumption so that H1a is rejected. However, consumption can mediate the effect of electricity capital on labor and the electrification ratio so that H1b and H1c are accepted (Table 2).

The second hypothesis states that household electricity capital has a positive effect on consumption (H2a) and consumption mediates the effect of household electricity capital on labor (H2b) and electrification ratio (H2c). Based on the results of SPSS calculations, t-value is 3.063, while the

2 p-value is 0.014 < 0.05, meaning that there is a significant influence between the household electricity capital variable on consumption. Based on the results of the Sobel test calculator, the z-value of the effect of household electricity capital on labor mediated by consumption is 1.894 with a significance of 0.058 > 0.05. It has a meaning that consumption is less likely able to strengthen the effect of household electricity capital on labor. Moreover, the z-value of the effect of household electricity capital on the electrification ratio mediated by consumption is 3.052 with a significance of 0.002 < 0.05, meaning that consumption can mediate the effect of household electricity capital on the electrification ratio, indicating that household electricity capital significantly affect electrical consumption that H2a is accepted. However, consumption is not of a mediating role in the relationship between household electricity capital and the absorption of labor or employment. Thus, H2b is rejected. However, consumption is more likely able to have a mediating effect in the relationship between household electricity capital and the electrification ratio, so that H2c is accepted.

The third hypothesis states that non-household electricity capital has a positive effect on consumption (H3a) and consumption mediates the effect of non-household electricity capital on labor (H3b) and the electrification ratio (H3c). Based on the SPSS calculation, the value is t 3.725, while the p-value is 0.005 < 0.05, meaning that there is a significant influence between the non-household electricity capital variable on consumption. Based on the results of the Sobel Test Calculator, the z-value of the effect of non-household electricity capital on labor mediated by consumption is 2.035 with a significance of 0.041 < 0.05, meaning that consumption can mediate the effect of non-household electricity capital on power work. Meanwhile, the z-value of the effect of non-household electricity capital on the electrification ratio mediated by consumption is 3.777 with a significance of 0.000 < 0.005, meaning that consumption can mediate the effect of non-household electricity capital on the electrification ratio. These results indicate that non-household electricity capital

has a significant positive effect on consumption, meaning that H3a is accepted. Furthermore, consumption can also mediate the effect of non-household electricity capital on labor and the electrification ratio. Thus H3b and H3c are accepted.

The fourth hypothesis states that consumption has a positive effect on employment of the absorption of labor (H4). Based on SPSS calculations, the t-value is 2.427, while the p-value is 0.034 < 0.05, meaning that there is a significant influence between consumption variables on labor. These results indicate that consumption has a significant positive effect on labor so that H4 is accepted.

The fifth hypothesis states that consumption has a positive effect on the electrification ratio (H5). Based on SPSS calculations, the value is t 1.828, while the p-value is 0.095 > 0.05, meaning that there is no significant influence between consumption variable on the electrification ratio. These results indicate that there is no influence between consumption and electrification ratio so that H5 is rejected.

The results of the research through statistical outputs get a significant and positive value in the effect of electricity consumption on employment. However, statistical results also show that there is no significant effect between consumption and electrification ratio. This indicates that in expanding access to electricity in Papua, the growth in electricity consumption has not been taken as an important consideration for the government to increase the electricity ratio. In testing the effect of consumption on employment, the results show a positive effect. This means that the greater electricity consumption, the greater the absorption of labor (table 3). The results of the mediation test found that there was no mediating effect of electricity consumption in the relationship between household electricity capital and labor. This means that electricity consumption is less able to bridge the supply of labor. The results also show that electricity consumption is better able to strengthen the relationship between household electricity capital to the electrification ratio and industrial and industrial electricity capital to labor, as well as household and industrial electricity capital to the electrification ratio [37].

Table 2. Test direct relationship

Independent variables	Dependent variables	T-stat.	T-table	Significance	Information
Electrical Installation	Consumption	0.091	2.36462	0.929	accepted
Household Electricity Capital	Consumption	3.063	2.36462	0.014	accepted
Industrial Electricity Capital	Consumption	3.725	2.36462	0.005	accepted
Consumption	Labor	2.427	2.36462	0.034	accepted
Consumption	Electrification Ratio	1.828	2.36462	0.095	rejected

Table 3. Mediating effects of electricity consumption

Independent variables	Mediation variables	Dependent variables	Sobel test statistic	Two tailed probability	Information
Electrical Installation	→ Consumption	→ Labor	2.416	0.015	accepted
Household Electricity Capital	→ Consumption	→ Labor	1.894	0.058	rejected
Industrial Electricity Capital	→ Consumption	→ Labor	2.035	0.041	accepted
Electrification Capital	→ Consumption	→ Electrification Ratio	68.497,286	0.000	accepted
Household Electricity Capital	→ Consumption	→ Electrification Ratio	3.052	0.002	accepted
Industrial Electricity Capital	→ Consumption	→ Electrification Ratio	3.777	0.000	accepted

28 The results of this study are in line with previous research. The results denote the importance of public access to affordable energy as it has substantial impacts on the welfare and the economy of nation. As today's economy is highly dependent on energy, the economy and per capita income are also affected by energy availability. Bridge et al. [1] stated that

access to cheap energy leads to industrialization and employment, and reducing inequality in access to energy can further enhance greater fulfillment to education and public basic needs. Birol [2] showed that access to electricity also affects the ability of developing country governments to provide access to information, sanitation, health and adequate

housing. Previous research also affirmed that hydropower energy consumption is related with Gross Domestic Product in some countries examined [38]. Furthermore, Winanda [28] revealed that there is a positive and significant relationship between electricity and clean water infrastructure on economic growth in Bandar Lampung, Indonesia, and electricity is the infrastructure that has the greatest influence on regional economic growth. With a time series research design from 1987 - 2016 regarding the effect of electricity subsidy spending on economic growth, Pasaribu [29] shows that there is an indirect effect on economic growth, and there is a significant effect of subsidy spending and electricity demand on economic growth. Soyatas and Sari [17] found the effect of access and consumption of energy, namely electricity in economic and social growth where electricity consumption is estimated to reflect people's income and can positively trigger economic growth either through consumption of goods and services or industrialization and domestic and foreign investment [18-21]. In addition, in a study in developing countries, Ghosh [22] found a causal relationship between energy consumption and economic growth. This means that the higher the electricity consumption, the higher the economic growth [23]. Altınay and Karagöl [25] in an empirical test found a positive indication of the relationship between economic growth triggered by energy consumption.

5. CONCLUSIONS

The results of the study show that show that empirically, household and industrial electricity capital all have a significant positive effect on consumption. The results of the research through statistical outputs get a significant and positive value in the effect of electricity consumption on employment. In testing the effect of consumption on employment, the results show a positive effect. This means that the greater the electricity consumption, the greater the absorption of labor. The results of the mediation test found that there was no mediating effect of electricity consumption in the relationship between household electricity capital and labor. This means that electricity consumption is less able to bridge the supply of labor. The results also show that electricity consumption is better able to strengthen the relationship between household electricity capital to the electrification ratio and industrial and industrial electricity capital to labor, as well as household and industrial electricity capital to the electrification ratio.

The results show that electricity consumption in Papua Province is significantly influenced by electrical installation, household electricity capital and industrial electricity capital. Furthermore, electricity consumption in general affects employment. The test of the mediating variable shows the role of the consumption variable in the ratio of electrification and employment. The findings had a theoretical implication about the relationship between energy infrastructure and regional economic growth which is more likely to attract both domestic and foreign investment in a region.

The originality of this research is to examine whether electrification can spur industrialization and employment, by testing Papua's area with the lowest electrification ratio in Indonesia. However, this study has some limitations. This study does not analyze in depth in a longitudinal way regarding the relationship between electrification and industrialization. This study only examines the period 2012-

2016. Further research is expected to update the analysis by adding a longer period of time in examining the role of electrification in employment and industrialization. Furthermore, further research is expected to be able to elaborate empirically on the relationship of household capital to the formation of electrification for the industrial sector.

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