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The impact of electricity investment on inter-regional economic development in Indonesia: An Inter-Regional Input-Output (IRIO) approach

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ABSTRACT

Electricity is a development priority for low and middle income countries, including Indonesia, especially in the households living in suburban and rural areas. By 2020, Indonesia's electrification ratio has reached 96.71%. However, there were 433 villages that did not have electricity, most of which were located in eastern Indonesia (Papua, West Papua, East Nusa Tenggara, and Maluku). Investment in the electricity sector will drive regional economic growth. This research attempts to figure out the impact of investment in electricity on economy. This study used Indonesian inter-regional Input-Output data. The method used in this study was the Interregional Input-Output (IRIO) model. The analysis shows that electricity impacted not only the territory being built but also other regions in Indonesia. Electricity industry investment in Indonesia have been able to provide a multiplier effect on the economy as many as 3.11. Java region gets the greatest benefit from electricity development in Indonesia. This was rationally acceptable due to the fact that most of the industry was located in this region. This causes a development gap between Java and outside Java. It is necessary to accelerate reallocate several national strategic industries on various islands in Indonesia based on the advantages of each region and to strive for areas that are still "dark" to have electricity.

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INTRODUCTION

The trend of electricity consumption in Indonesia has progressively increased in recent years. According to the Central Bureau of Statistics, per capita consumption of electricity grew gradually from 0.91 MWH in 2015 to 1.08 MWH in 2019 (BPS, 2021). Nowadays, electricity is considered as one of the energy sources that is utilized in generating economic activities of the Indonesian people. Economic activities related to production of goods and services are mostly powered by electricity as their energy sources. Therefore, the utilization of electricity is still considered having significant contributions to the improvement of economic development (Chakravorty et al., 2016; Khandker et al., 2014; Van de Walle et al., 2017). Moreover, it is an undeniable fact that the increase of electricity consumption is also supported by the investment in the electricity sector. In addition, the increasing trend of electricity utilization has also encouraged various researches on the identification of the impact of electricity utilization and investment on economic development. Electricity is able to provide a multiplier effect to other sectors, such as manufacturing (Rud, 2012), agriculture (Kline & Moretti, 2014), real estate (Lipscomb et al., 2013), and industry (Hadi et al., 2021). Additionally, electricity also has a positive effect to the increase of the Human Development Index (Maqin & Sidharta, 2017). However, the Government of Indonesia should also develop the renewable energy in reducing greenhouse gas emissions and the use of petroleum fuels (Erdiwansyah et al., 2021).

In terms of investment, many studies revealed that investment is expected to increase economies (Cavallo & Daude, 2011; Cullison, 1993; Levine & Renelt, 1992; Milbourne et al., 2003). The investment can be implemented in the forms of infrastructure developments and supporting facilities, from which it can generate economic activities. Therefore, investment can also be a main drive in recovering economy both in short term and in long term development. Moreover, other empirical researches also highlighted that investment on infrastructure has direct effects on community prosperity, especially income improvement (Lee et al., 2020; Prastiwi et al., 2017), labor supply increase (Grogan & Sadanand, 2013), better respiratory health (Barron & Torero, 2017), higher schooling attainment for children (Khandker et al., 2014).

In the context of investment on electricity, some previous empirical studies in various countries revealed the importance of electricity investment. For instance, electricity investment played a significant role in maintaining business cycle in Chile (Agurto et al., 2021). Other studies showed that, in the macroeconomic perspective, electrification is able to trigger economic development in regions (Bhattacharyya, 2012; Cook, 2011; Mulder & Tembe, 2008). In addition, studies conducted by Khandker et al. (2014) and Lee et al. (2020) confirmed that, in the microeconomic level, electrification advantages also has positive impacts on economic activities. Saidi et al. (2017), using dynamic panel data analysis for 67 sampled countries, found that information communication technology (ICT) and economic growth have a significant effect on electricity consumption in both high-income, middle-income, and low-income countries. Furthermore, using a different perspective regarding the different relationship between use, investment in the electricity sector and economic growth, one research attempted to identify whether there was an economic loss during the time of power outage due to flooding in the United Kingdom (Koks et al., 2019). This study found that the flood resulting in a blackout caused a decline in the UK economy. The results showed that up to a 300% increase in total economic losses due to power outages was included in the risk assessment, compared to analysis that just included the economic impacts of business interruption due to flooded business premises (Koks et al., 2019). Another similar study found that there was a significant economic loss when there was a power outage due to a disaster (Kajitani et al., 2013). These findings become a foundation in identifying further impacts of electricity investment on economy.

At present, electricity is one of the major projects in development in Indonesia. This can be seen from the electrification ratio target set by the government, which is 100% by 2024. In 2020, the electrification ratio in Indonesia reached 96.71%, where in Java it reached 98.91% and outside Java it reached 93.49% (PLN, 2020). To achieve the target of electrification ratio, the Indonesian government power sector developed an investment plan of USD48.74 billion for generators (fossil and new renewable energy), transmissions, and substations during 2020-2024 (Direktorat Jenderal Ketenagalistrikan KESDM, 2020).

Investment on electricity in Indonesia is also important to be further identified due to the fact that Indonesia is an archipelago country with various cultures. Various research on the impact of electricity on the economy have been carried out in Indonesia (Handayani et al., 2017; Munasinghe, 1988; Sambodo, 2015; Sambodo & Novandra, 2019). However, the impact of electricity investment in this country may vary among regions or provinces and there is still little research on this topic. Thus, this research attempts to figure out the impact of investment in electricity on economy, especially on interregional and intraregional outputs, in several regions in Indonesia.

RESEARCH METHOD

This study used data of the 2016 Indonesian interregional Input-Output table with the domestic transactions at producer's price by six island groups and 52 industries. The unit of measurement in Input-Output table was calculated in million rupiah. The six island groups included Sumatera, Java, Bali and Nusa

Tenggara, Kalimantan, Sulawesi, Maluku and Papua, while the 52 industries can be seen in Appendix.

Technical Analysis

This research utilized Interregional Input-Output (IRIO) Model. The model was first introduced by Walter Isard in 1951, and thus was also known as "Isard Model". This model was then developed by Miller and Blair (2009) with the basic structure as presented in Table 1.

Table 1. Basic Structure of IRIO Models

Selling Sector		Purchasing Sector				
		Regional r			Regional s	
		1	2	3	1	2
Regional r	1	z_{11}^{rr}	z_{12}^{rr}	z_{13}^{rr}	z_{11}^{rs}	z_{12}^{rs}
	2	z_{21}^{rr}	z_{22}^{rr}	z_{23}^{rr}	z_{21}^{rs}	z_{22}^{rs}
	3	z_{31}^{rr}	z_{32}^{rr}	z_{33}^{rr}	z_{31}^{rs}	z_{32}^{rs}
Regional s	1	z_{11}^{sr}	z_{12}^{sr}	z_{13}^{sr}	z_{11}^{ss}	z_{12}^{ss}
	2	z_{21}^{sr}	z_{22}^{sr}	z_{23}^{sr}	z_{21}^{ss}	z_{22}^{ss}

Note: There are two regions, r and s, let there be three purchasing sectors (1, 2, 3) in region r and two (1, 2) in region s. Notation z_{ij}^{rr} and z_{ij}^{ss} are intraregional flows, while z_{ij}^{sr} and z_{ij}^{rs} are interregional flows (Miller & Blair, 2009)

If the data in Table 1 is transformed into matrix model, it can be written as followed:

$$Z = \begin{bmatrix} Z^{rr} & Z^{rs} \\ Z^{sr} & Z^{ss} \end{bmatrix}$$

The notation of Z^{rr} and Z^{ss} are called as intraregional linkages, while Z^{rs} and Z^{sr} are called interregional linkages. if X is total output and Y is final demand, the basic structure of IRIO can be formulated into equations as followed:

Regional r:

$$X_1^r = z_{11}^{rr} + z_{12}^{rr} + z_{13}^{rr} + z_{11}^{rs} + z_{12}^{rs} + Y_1^r \quad (1)$$
$$X_2^r = z_{21}^{rr} + z_{22}^{rr} + z_{23}^{rr} + z_{11}^{rs} + z_{22}^{rs} + Y_2^r \quad (2)$$
$$X_3^r = z_{31}^{rr} + z_{32}^{rr} + z_{33}^{rr} + z_{31}^{rs} + z_{32}^{rs} + Y_3^r \quad (3)$$

Regional s:

$$X_1^s = z_{11}^{sr} + z_{12}^{sr} + z_{13}^{sr} + z_{11}^{ss} + z_{12}^{ss} + Y_1^s \quad (4)$$
$$X_2^s = z_{21}^{sr} + z_{22}^{sr} + z_{23}^{sr} + z_{11}^{ss} + z_{22}^{ss} + Y_2^s \quad (5)$$

From the above equations, it can be simplified for the regional input coefficients for regional r that is writen as follows.

$$a_{ij}^{rr} = \frac{z_{ij}^{rr}}{X_j^r} \quad (6)$$

Whereas, the regional input coefficients for regional s can be written as follows.

$$a_{ij}^{ss} = \frac{z_{ij}^{ss}}{X_j^s} \quad (7)$$

Regarding interregional trade coefficients from regional r to regional s, it can be formulated as follows.

$$a_{ij}^{rs} = \frac{z_{ij}^{rs}}{X_j^s} \quad (8)$$

Whereas, interregional trade coefficients from regional s to regional r can be written as follows.

$$a_{ij}^{sr} = \frac{z_{ij}^{sr}}{X_j^r} \quad (9)$$

If equations of regional input and trade coefficients are substituted into equations (1) until (5), it can result in equations as follows.

Regional r:

$$X_1^r = a_{11}^{rr}X_1^r + a_{12}^{rr}X_2^r + a_{13}^{rr}X_3^r + a_{11}^{rs}X_1^s + a_{12}^{rs}X_2^s + Y_1^r \quad (10)$$
$$X_2^r = a_{21}^{rr}X_1^r + a_{22}^{rr}X_2^r + a_{23}^{rr}X_3^r + a_{11}^{rs}X_1^s + a_{22}^{rs}X_2^s + Y_2^r \quad (11)$$
$$X_3^r = a_{31}^{rr}X_1^r + a_{32}^{rr}X_2^r + a_{33}^{rr}X_3^r + a_{31}^{rs}X_1^s + a_{32}^{rs}X_2^s + Y_3^r \quad (12)$$

Regional s:

$$X_1^s = a_{11}^{sr}X_1^r + a_{12}^{sr}X_2^r + a_{13}^{sr}X_3^r + a_{11}^{ss}X_1^s + a_{12}^{ss}X_2^s + Y_1^s \quad (13)$$
$$X_2^s = a_{21}^{sr}X_1^r + a_{22}^{sr}X_2^r + a_{23}^{sr}X_3^r + a_{11}^{ss}X_1^s + a_{22}^{ss}X_2^s + Y_2^s \quad (14)$$

if equations (10) until (14) is formed into matrix model, it can be written as follows,

$$\begin{vmatrix} a_{11}^{rr} & a_{12}^{rr} & a_{13}^{rr} & a_{11}^{rs} & a_{12}^{rs} \\ a_{21}^{rr} & a_{22}^{rr} & a_{23}^{rr} & a_{21}^{rs} & a_{22}^{rs} \\ a_{31}^{rr} & a_{32}^{rr} & a_{33}^{rr} & a_{31}^{rs} & a_{32}^{rs} \\ a_{11}^{sr} & a_{12}^{sr} & a_{13}^{sr} & a_{11}^{ss} & a_{12}^{ss} \\ a_{21}^{sr} & a_{22}^{sr} & a_{23}^{sr} & a_{21}^{ss} & a_{22}^{ss} \end{vmatrix} \begin{vmatrix} X_1^r \\ X_2^r \\ X_3^r \\ X_1^s \\ X_2^s \end{vmatrix} + \begin{vmatrix} Y_1^r \\ Y_2^r \\ Y_3^r \\ Y_1^s \\ Y_2^s \end{vmatrix} = \begin{Vmatrix} X_1^r \\ X_2^r \\ X_3^r \\ X_1^s \\ X_2^s \end{Vmatrix} \quad (15)$$

or can be simply writen as follows,

$$AX + Y = X \quad (16)$$

or

$$X = (I - A)^{-1}Y \quad (17)$$

where I is Identity matrix, Y is Final demand, X is Total output, $(I - A)$ is Leontief matrix, $(I - A)^{-1}$ is Inverse Leontief matrix.

Injection in Input-Output Model

Equation (17) can be used to find out the impact of the 35.000 MW electricity supply program on economy. Injection in the model is defined by final demand (Y), representing the value of investment that is planned to be absorbed in electricity industry. This research utilizes the 2020-2024 electricity industry investment plan released by the Ministry of Energy and Mineral Resources of Indonesia (KESDM) (Table 2), as the injection in the Input-Output model. There are three types of electricity investment: generators, transmissions, and substations. Investment in power plants is divided into two categories, based on the fuel used, i.e. fossil and new renewable energy. Power plant investment is the largest investment component of electricity investment which reached 7.70% during the period.

Table 2. Electricity Industry Investment Plan, 2020-2024

Region	2020	2021	2022	2023	2024
	.... US$ billion				
Sumatera	2.20	2.18	2.90	3.39	2.46
Java	5.81	6.22	5.38	4.60	4.55
Bali & Nusa Tenggara	0.42	0.37	0.44	0.14	0.17
Kalimantan	1.98	0.81	0.52	0.36	0.33
Sulawesi	0.71	0.26	0.75	0.48	0.66
Maluku & Papua	0.24	0.30	0.08	0.01	0.03
Total	11.35	10.14	10.07	8.98	8.20

RESULT AND DISCUSSION

Electricity Development in Indonesia

The theory of neoclassical growth (Solow, 1956; Swan, 1956) stated that investment has effects on community prosperity. One of these investments is electricity. Since Indonesian New Order regime, investment in all economic sectors has been intensified, including in electricity industry. Data from the Central Bureau of Statistics indicates that the consumption of public electricity shows an increase from year to year. The installed capacity of power plants has also increased from year to year. Nevertheless, the development of the electricity sector in Indonesia has differences among regions considering the conditions in Indonesia which have many differences both in terms of topography and regional contours. In addition, several regions in Indonesia also experience power outages more often than other regions.

Several studies empirically show that the investment in the electricity sector can affect economic performance. The use of electricity for economic activities leads to the improvement in economic productivity and growth. However, there are also other researches concluding that actually economic growth affects the increase of electricity consumption. For example, some researchers found that the variable that significantly affects electricity consumption is the consumption of electronic goods (Saidi et al., 2017; Van de Walle et al., 2017; Winkler et al., 2011). Public demand for electronic goods encourages the use of electricity because generally electronic goods are powered by electricity.

The increase in the installed capacity of power plants is accompanied by an increase in the electricity consumption of the Indonesian people. Table 3 shows the electricity consumption of Indonesian people, in which during the 2016 – 2020 period increased by 3.08% per year. This is in line with the increase in installed capacity of power plants in the same period by an average of 3.93% per year (Table 4). Electricity consumption in Indonesia is also used for economic activities, from which the use of electricity should be able to increase the economy as a whole. By region, people living in Java Island consume more electricity than those outside Java. During the 2016 – 2020 period, the average electricity consumption in Java was 71.05% of Indonesia's total electricity consumption. In terms of electricity consumption growth, electricity consumption in Java decreased by 0.75% per year.

Table 3. Energy Sold by Type of Customers, 2016-2020

Customer Group	2016	2017	2018	2019	2020
	.... GWh				
Java					
Residential	59,481.08	59,665.19	61,593.86	64,963.35	70,330.61
Industrial	60,475.37	63,553.99	67,105.54	67,229.65	61,205.75
Business	26,493.13	27,791.12	29,218.40	31,135.04	28,205.75
Public[1]	8,655.87	8,980.83	9,567.92	10,263.91	9,952.32
Total	155,105.45	159,991.13	167,485.72	173,591.95	169,694.43
Outside Java					
Household	34,153.55	34,792.19	36,238.42	38,770.09	41,825.24
Industry	7,669.95	8,868.38	9,840.96	10,649.00	11,034.11
Business	13,581.25	13,903.67	14,809.00	15,766.21	14,395.00
Public[1]	5,494.12	5,578.35	6,243.77	6,740.92	6,633.97
Total	60,898.87	63,142.59	67,132.15	71,926.22	73,888.32

[1]public customer including social, government office building, and public street lighting.

Table 4. Power Balance by Region in Indonesia, 2016-2020

Customer Group	2016	2017	2018	2019	2020
	…………	…………	MW	…………	…………
Java					
Installed Capacity	36,712.15	36,517.23	37,721.60	40,174.66	40,685.01
Rated Capacity	34,373.06	33,673.21	34,977.43	41,204.80	33,609.01
Peak Load	33,208.14	25,680.47	27,097.58	26,657.90	24,420.29
Outside Java					
Installed Capacity	17,420.13	19,208.73	19,823.87	21,632.99	22,433.27
Rated Capacity	13,577.40	15,718.18	16,286.63	17,211.77	18,512.64
Peak Load	12,115.08	13,116.68	11,672.35	14,932.80	15,545.95

Table 5. Linkage of Interregional Trade in Indonesia

Destination	Origin					
	Sumatera	Java	Bali and Nusa Tenggara	Kalimantan	Sulawesi	Maluku and Papua
	…………	…………	%	…………	…………	…………
Sumatera	85.02	4.31	2.38	1.36	2.18	5.72
Java	13.24	90.11	10.38	15.88	12.60	20.51
Bali & Nusa Tenggara	0.44	1.32	83.59	1.46	2.15	0.41
Kalimantan	0.78	2.01	1.87	76.96	3.38	1.02
Sulawesi	0.32	1.55	1.10	3.49	78.22	1.19
Maluku & Papua	0.20	0.71	0.69	0.85	1.46	71.15
Total	100.00	100.00	100.00	100.00	100.00	100.00

Although electricity consumption in Java has decreased, the contribution to Indonesia's GDP is still the highest at 58.59% per year in the same period. Based on the above conditions, it is expected that economic growth outside Java will increase in line with the increase of electricity consumption. Empirically, some researchers found that electricity consumption in the US has a positive impact on economic growth (Wu et al., 2021). Wu et al. (2021) also concluded that expanding access to electricity is able to increase economic growth in rural area in India. Other empirical research showed that, from the macroeconomic perspective, electrification is able to encourage the economic development of a region (Bhattacharyya, 2012; Cook, 2011; Mulder & Tembe, 2008).

Reserve margin is the amount of generation reserves owned by the system based on the total installed generating capacity in a system with a large peak load of the system. Based on the data in Table 5, it can be seen that in 2020 the reserve margin in the Java region was higher than that in the area outside Java. The reserve margin value for the last 5 years (2016 – 2020) shows that the reliability of power plants outside Java decreased, but in Java it increased. The reserve margin value can also show the magnitude of the electricity surplus. In 2020, the amount of electricity surplus in the Java region was 66.60% of the total installed capacity, while outside Java was 44.30%. When compared to the previous year, the electricity surplus in Java increased by 31.36% and outside Java decreased by 1.26%. The increase in the surplus in the Java region was due to a decrease in electricity consumption by the industrial, business and public sectors, by 8.96%, 9.41%, and 3.04%, respectively. The surplus of electricity both in Java and outside Java is expected to be utilized by the industrial and business sectors in increasing production capacity. In addition, there is a need for regulations from the government related to restrictions on the granting of business permits to provide electricity and the use of independent electricity (captive power).

Interregional Trade in Indonesia

Input-Output data for the year of 2016 describes the linkage of interregional trade in Indonesia. The results indicate that Indonesian trade remains to be dominated by the trade in own regions, and only a few of those regions perform interregional trade. Java Island was the highest benefit receiver of interregional trade and intraregional trade. On the other hand, Maluku and Papua were the regions that received the lowest benefit of both interregional and intraregional trade.

Data from Input-Output table also shows contribution of each region in terms of foreign trade.

The analysis results indicate that more than 50% of Indonesia's foreign trade is generated from Java region, followed by Sumatera and Kalimantan, with 24.59% and 15.85%, respectively (Figure 1). This is in line with the distribution of industrial area in Indonesia, where 61.16% of industrial areas are located on the island of Java, 29.75% on the island of Sumatra, and 5.79% on the island of Kalimantan.

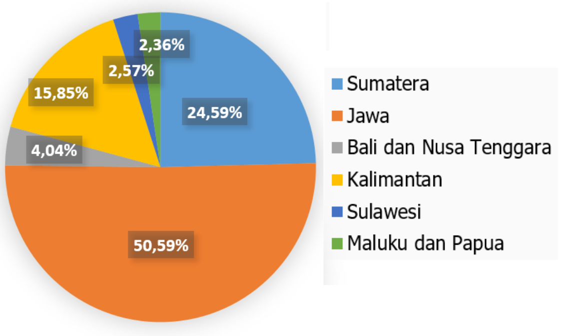

Figure 1. Regional shares by Indonesia's total export

Indonesia's 2020 export structure based on islands can be divided into two categories based on the largest contribution, i.e. the island group with the largest contribution from the manufacturing sector and the island group with the largest contribution from the mining sector. The first group consists of Java, Sumatra, and Sulawesi, while the second group consists of Bali and Nusa Tenggara, Kalimantan, and Maluku and Papua. Total export to Java Island reaches US$76,523.9 million, of which the manufacturing industry dominates up to 95.56%, followed by the agricultural sector at 2.36%, and oil and gas at 2.03%. Sumatra has a total export value of US$44,697.4 million, the manufacturing industry contributes 86.71%, oil and gas 6.55% and agriculture 3.96%. Sulawesi has a total export value of US$12,666.6 million, the manufacturing industry contributes 90.86%, oil and gas 6.66% and agriculture 2.44%. The islands of Bali and Nusa Tenggara have a total export value of US$1,143.8 million, mining industry 51.74%, manufacturing industry 40.74% and agriculture 7.45%. Kalimantan has a total export value of US$23,262.1 million, the mining industry contributes 68.73%, the manufacturing industry 25.86% and oil and gas 4.94%. The islands of Maluku and Papua have a total export value of US$4,898.0 million, the mining industry contributes 38.31%, oil and gas 36.25% and the manufacturing industry 24.73%.

Table 6. Leading Industries based on Shares of Foreign Export and Regional Output, and Total Backward and Forward Linkages

Region	Indicator	Leading Industry[1]		
		1	2	3
Sumatera	Share of Foreign Export	I-13	I-08	I-23
	Share of Regional Output	I-13	I-31	I-33
	Backward Linkages > 1	-	-	-
	Forward Linkages >1	I-33	I-13	I-12
Java	Share of Foreign Export	I-15	I-33	I-19
	Share of Regional Output	I-31	I-33	I-13
	Backward Linkages > 1	-	-	-
	Forward Linkages >1	I-19	I-33	I-48
Bali & Nusa Tenggara	Share of Foreign Export	I-40	I-10	I-41
	Share of Regional Output	I-31	I-33	I-40
	Backward Linkages > 1	-	-	-
	Forward Linkages >1	I-33	I-28	-
Kalimantan	Share of Foreign Export	I-09	I-12	I-13
	Share of Regional Output	I-09	I-31	I-13
	Backward Linkages > 1	-	-	-
	Forward Linkages >1	I-12	I-19	I-10
Sulawesi	Share of Foreign Export	I-22	I-13	I-12
	Share of Regional Output	I-31	I-13	I-33
	Backward Linkages > 1	-	-	-
	Forward Linkages >1	I-33	I-13	-
Maluku & Papua	Share of Foreign Export	I-10	I-12	I-33
	Share of Regional Output	I-31	I-49	I-10
	Backward Linkages > 1	-	-	-
	Forward Linkages >1	I-33	-	-

[1]see Appendix

The leading industries of each region can be valued from three indicators, namely share of export, share of output, and backward linkage index and forward linkage index (Table 6). According to the analysis of export share, each region has various specifications based on the first leading industry. Moreover, the classification of leading industries based on share of output indicates that almost all regions (Java, Bali and Nusa Tenggara, Sulawesi, and Maluku and Papua) have a similar leading industry, which is construction. In addition, construction also becomes the second leading industry in Sumatera and Kalimantan. Infrastructure development programs accelerated by the national government in the whole regions in Indonesia also become a logical reason of the improvement of construction sector, in addition to the development carried out by the private sectors.

Furthermore, backward and forward linkages were also analyzed in order to find out the relationship of one sector to other sectors upstream and downstream. The backward linkage relates to the linkage of one sector to the supply of raw materials for that sector (input providers), while forward linkage indicates the linkage of one sector to the sector that sells products produced from that sector. If the value of backward linkage and forward linkage value is more than one, then the sector can be indicated to be a leading sector. The findings suggested that that there was no leading industry in a region. This means that there was no single industry where input fulfillment and input sales were concentrated in one area. No backward linkages value was worth more than one, meaning that the fulfillment of raw materials for an industry did not only come from one region but from others.

Impact of 35,000 MW Electricity Program on Regional Output

The Leontif's inverse matrix is a matrix that describes the output multiplier of each industry. This value can also be interpreted as the response of industry to the changes in exogenous variables (final demand). Changes in exogenous variables can occur in various scenarios, including: a) one industry in one region; b) one industry in several regions; c) one industry in the entire region; d) more than one industry in one area; e) more than one industry in several regions; f) more than one industry in the entire region. Each industry will provide a response that can be seen in two ways: a) the response of the industry within the region itself; and b) industrial response outside the region. The total value of the industry response is referred to as the total impact on output owing to changes in exogenous variables.

Table 7. Impact of Electricity Investment on Total Output

Region	2020	2021	2022	2023	2024
	……………….	US$ billion	…………….		
Sumatera	7.32	7.26	8.90	9.85	7.49
Java	16.57	17.13	15.45	13.37	12.90
Bali & Nusa Tenggara	1.03	0.91	1.07	0.35	0.44
Kalimantan	7.61	4.31	3.42	2.58	2.51
Sulawesi	1.78	0.77	1.85	1.23	1.63
Maluku & Papua	0.96	1.11	0.65	0.51	0.46
Total	35.28	31.50	31.35	27.90	25.43

The results presented in Table 7 shows the total impact of the estimated injection of the electricity industry on the economy within the region itself and between regions. The analysis highlights that the Java region receives the greatest benefits from investment in the electricity industry. This is rationally acceptable due to the fact that most of the industry was located in this region. Electricity industry investment in this region was able to provide an average multiplier effect on the economy of 2.84. This value was smaller than the national average of 3.11. The smallest multiplier value was obtained by Bali and Nusa Tenggara (2.48) and the highest was obtained by Maluku and Papua (15.20). The total output value in Table 7 still contains the value of spillover effect (Table 8) and feedback effect (Table 9).

Table 8. Value of Spillover Effect of Electricity Investment by Region

Region	2020	2021	2022	2023	2024
	……………	US$ billion	…………….		
From Sumatera to					
Java	0.99	0.98	1.31	1.53	1.11
Bali & Nusa Tenggara	0.01	0.01	0.01	0.01	0.01
Kalimantan	0.11	0.11	0.15	0.18	0.13
Sulawesi	0.03	0.03	0.04	0.04	0.03
Maluku & Papua	0.23	0.23	0.31	0.36	0.26
Total	1.37	1.36	1.82	2.12	1.54
From Java to					
Sumatera	1.48	1.60	1.38	1.17	1.15
Bali & Nusa Tenggara	0.02	0.02	0.02	0.01	0.01
Kalimantan	1.49	1.60	1.38	1.18	1.16
Sulawesi	0.13	0.14	0.12	0.10	0.10
Maluku & Papua	0.16	0.17	0.15	0.12	0.12
Total	3.27	3.52	3.04	2.58	2.55
From Bali & Nusa Tenggara to					
Sumatera	0.06	0.05	0.06	0.02	0.03
Java	0.26	0.20	0.26	0.08	0.11
Kalimantan	0.19	0.15	0.20	0.06	0.08
Sulawesi	0.01	0.01	0.01	0.00	0.00
Maluku & Papua	0.01	0.00	0.01	0.00	0.00
Total	0.53	0.40	0.53	0.17	0.23
From Kalimantan to					
Sumatera	0.16	0.06	0.04	0.03	0.03
Java	0.47	0.19	0.12	0.09	0.08
Bali & Nusa Tenggara	0.01	0.00	0.00	0.00	0.00
Sulawesi	0.03	0.01	0.01	0.00	0.00
Maluku & Papua	0.01	0.00	0.00	0.00	0.00
Total	0.68	0.28	0.18	0.12	0.11
From Sulawesi to					
Sumatera	0.03	0.01	0.03	0.02	0.03
Java	0.26	0.10	0.28	0.18	0.25
Bali & Nusa Tenggara	0.00	0.00	0.00	0.00	0.00
Kalimantan	0.21	0.08	0.23	0.14	0.20
Maluku & Papua	0.00	0.00	0.00	0.00	0.00
Total	0.52	0.19	0.55	0.35	0.48
From Maluku & Papua to					
Sumatera	0.01	0.01	0.00	0.00	0.00
Java	0.07	0.09	0.02	0.00	0.01
Bali & Nusa Tenggara	0.00	0.00	0.00	0.00	0.00
Kalimantan	0.08	0.10	0.03	0.00	0.01
Sulawesi	0.00	0.00	0.00	0.00	0.00
Total	0.16	0.21	0.05	0.01	0.02

The value of the spillover effect is the output value received by a region due to investment in another region. On average, electricity investment in the Sumatera region is able to contribute to the region approximately US$1.64 billion per year, of which Java becomes the region that benefits the most. Electricity investment in the Java region is able to provide an average additional output in other regions of US$2.99 billion per year, of which Kalimantan region receives the largest impact. Electricity investment in Bali and Nusa Tenggara, Kalimantan, Sulawesi, as well as Maluku and Papua contributes to the economy as much as US$0.37 billion per year, US$0.27 billion per year, US$0.42 billion per year, US$0, 09 billion per year, respectively. Java is the region that receives the greatest impact from electricity investment in Bali and Nusa Tenggara, Kalimantan and Sulawesi. Meanwhile, Kalimantan region receives the biggest impact from electricity investment in Maluku and Papua region.

Table 9. Value of Feedback Effect of Electricity Investment by Region

Region	2020	2021	2022	2023	2024
	…………………	US$ billion	……………….		
Sumatera	80.13	79.50	106.00	123.57	89.74
Java	318.55	343.50	296.07	251.91	248.55
Bali & Nusa Tenggara	0.73	0.56	0.74	0.24	0.32
Kalimantan	16.98	6.93	4.42	3.12	2.85
Sulawesi	2.70	1.00	2.86	1.84	2.53
Maluku & Papua	0.32	0.40	0.11	0.02	0.04
Total	419.42	431.89	410.19	380.69	344.02

The value of the feedback effect is the amount of value received by a region due to investment from that region which has had an impact on other regions and then has a back impact on the region of origin. The results show that Java region has the largest feedback effect value compared to other regions. The average feedback effect received by Java region is about US$291.71 million per year or 73.44% of the total feedback from electricity investment in Indonesia. Maluku and Papua region receive the smallest feedback effect, which is US$0.18 million per year. It can affect the economic growth as Sitorus and Yuliana (2018) found that there is inequality between the economic growth of province in Java and outside of Java.

Research Implication

Based on the findings, there are some policy implications that should be implemented. First, electricity has an important role in development, so it is necessary to strive for areas that are still "dark" to have electricity. Some results of previous studies show that the development of the electricity industry can increase the economic growth of a region (Kumari & Sharma, 2018; Tiwari et al., 2021). The presence of electricity in areas that are still "dark" can reduce disparities among regions in Indonesia. IRIO's 2016 table shows that the electricity industry is an industry that provides the main output multiplier in the economy of every province in Indonesia. This applies in particular to the 433 villages that do not have electricity, most of which are located in eastern Indonesia (Papua, West Papua, East Nusa Tenggara, and Maluku). The government can encourage the use of new and renewable energy in providing electricity in the region. Renewable energy as a power plant provides good benefits for environmental sustainability and reduces energy subsidies.

Secondly, to reduce the development gap between Java and outside Java, it is necessary to accelerate and reallocate several national strategic industries on various islands in Indonesia based on the advantages of each region. Some results of previous studies show that the development of the electricity industry is able to encourage the development of other industries (Hadi et al., 2021; Rosenberg, 1998). This reallocation will lead to more benefits from the 35,000 MW development being enjoyed by the electricity-producing regions. The value of the spillover effect of electricity investment going to the Java region will be smaller. Examples are the construction of Bintuni Industrial Zone in West Papua Province based on the gas processing industry (petrochemicals, fertilizers, etc.) and Ketapang Industrial Zone in West Kalimantan Province focused on the alumina industry. With the future plans regarding equality of distribution of electricity supply throughout all regions in Indonesia, local governments are also encouraged to create new business centers in order to take advantages of the abundance of electrical energy, and to contribute to economic improvement. Currently, Indonesia is experiencing an excess of electricity supply both in Java and outside Java. The industry is expected to be able to take advantage of the excess electrical energy that exists today to increase production. In addition, industry is expected not to provide independent electrical energy (captive power).

CONCLUSION AND SUGGESTION

The consumption of electricity in Indonesia increases in recent years, especially in powering economic activities. In 2021, Indonesia's electrification ratio would reach 99.4%, having a 0.2% increase from the previous year. However, the distribution of electricity has not been spread evenly, impacting the inter-regional trade in Indonesia. The results of this study indicate that Java region receive the highest benefit of electricity investment due to the fact that majority of economic industries are located there. Moreover, electricity investment in Java region contributes to interregional trade, with the largest spillover effect to other regions. The average spillover of Java region was approximately US$2.99 billion per year. In addition, Java region became the largest receiver in terms of the value of feedback effect, with a value of US$291.71 million per year, while Maluku and Papua region was the region with the smallest feedback effect at US$0.18 million per year. Thus, the government must redistribute economic centers in the island of Java to other regions in Indonesia. Some policy implications include supplying electricity to areas that have not been electrified with new and renewable energy. Moreover, it is necessary to accelerate and reallocate national strategic industries to areas outside Java so that electricity development there can be well absorbed. The government should encourage local authorities to plan a new business center in order to take advantage of the abundance of electrical energy that will come.

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Appendix. Classification 52 industry at Input-Output Table, 2016

Code	Name of Industry	Code	Name of Industry
I-01	Food Corps Agriculture	I-27	Other Processing Industries, Machinery and Equipment Repair and Installation Services
I-02	Farming Horticulture Crips Annuals, Annual Horticulture and etc	I-28	Electricity
I-03	Annual and Annual Plantations	I-29	Gas Procurement and Ice Production
I-04	Farming	I-30	Water Supply, Waste Management, Waste and Recycling
I-05	Agricultural and Hunting Services	I-31	Construction
I-06	Forestry and Logging	I-32	Car, Motorcycle and Repair Trade
I-07	Fishery	I-33	Wholesale and Retail Trade, Not Cars and Motorcycles
I-08	Oil, Gas and Geothermal Mining	I-34	Rail Transport
I-09	Coal and Lignite Mining	I-35	Land Transport
I-10	Metal Ore Mining	I-36	Sea Freight
I-11	Mining and Other Quarry	I-37	River Lake and Crossing Transportation
I-12	Coal Industry and Oil and Gas Refinery	I-38	Air Freight
I-13	Industry of Food and Beverage	I-39	Warehousing and Supporting Services for Transport, Post and Couriers
I-14	Industry of Tobacco Processing	I-40	Accommodation Provision
I-15	Industry of Textile and Apparel	I-41	Food and Drink Provision
I-16	Industry of Leather, Leather Goods and Footwear	I-42	Private Information and Communication Services
I-17	Industry of wood, goods made of wood and cork and woven goods from bamboo, rattan and the like	I-43	Financial Intermediary Services Other Than Central Bank
I-18	Industry of Paper and Paper Goods, Printing and Recording Media Reproduction	I-44	Insurance and Pension Fund
I-19	Industry of Chemical, Pharmaceutical and Traditional Medicine	I-45	Other Financial Services
I-20	Industry of Rubber, Goods from Rubber and Plastic	I-46	Financial Support Services
I-21	Industry of Non-Metal Mineral	I-47	Real Estate
I-22	Industry of Base Metal	I-48	Company Services
I-23	Industry of Metal, Computer, Electronic, Optical and Electrical Equipment	I-49	Government Administration, Defense and Mandatory Social Security
I-24	Industry of Machinery and YTDL Equipment	I-50	Private Education Services
I-25	Transportation Industry	I-51	Health Services and Private Social Activities
I-26	Furniture Industry	I-52	Other Private Services