Determinants of electricity demand in the industrial and commercial sector in Indonesia

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Abstract

This research aims to analyze the development of electricity needs in the two main sectors served by PT PLN (Persero), namely the industrial and commercial sectors. Next, an analysis was carried out of the factors thought to influence electricity demand in the industrial and commercial sectors, namely the variables Average Electricity Tariff for the Industrial Sector, GDP for the industrial sector and Domestic Investment in the industrial sector on Electricity Demand in the Industrial Sector. Then the influence of the variable average electricity tariff for the commercial sector, GRDP in the commercial sector and domestic investment in the commercial sector on the demand for electricity in the commercial sector. The analytical method used is descriptive and quantitative analysis with panel data regression analysis tools using 34 provinces during 2017-2021. The results of the analysis show that there has been development in a positive direction towards electricity demand in the industrial and commercial sectors, however developments in 2020 show negative growth which has resulted in an excess supply of electricity. Then the results of panel data regression analysis in the industrial and commercial sectors show that there is a positive and significant influence from the GRDP and domestic investment variables, while the electricity tariff variable has no significant effect at the 95% degree.

Keywords: *average price electricity, GRDP, domestic investment, industrial sector, commercial sector*

INTRODUCTION

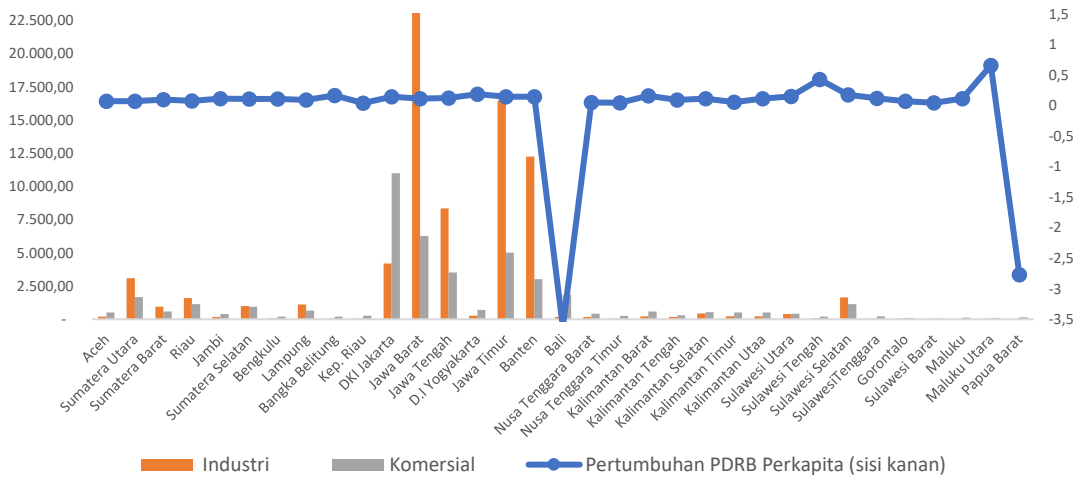
A country's economic development cannot be separated from energy needs. Energy needs and economic development are closely related. Energy ownership will contribute to a country's ability to prosper economically. Developments in the economic structure of various sectors, such as the shift from the agricultural sector to the industrial and service sectors, are driving high economic growth and energy needs. This shift is caused by a shift in the traditional economy towards industrialization. Furthermore, in line with technological developments, changes and progress over time, electricity has become one of the main energy sources that supports people's lives, so its quality, availability and sustainability must continue to be maintained (ESDM, K, 2016). Apart from that, electrical energy is the main energy source for the industrial sector and a determining factor in the competitiveness of domestic industry.

The electricity statistics report illustrates that the industrial and commercial sectors (business customers in PT. PLN (Persero) are sectors that are intensive in using electricity after the household sector. These two sectors contribute to consuming almost half of the total electricity supply for each sector served by PT .PLN (Persero). The industrial sector is an effort to produce finished goods from raw materials or raw materials through a manufacturing production process in large quantities so that these goods can be obtained

at the minimum possible cost but with the best possible quality (Sandi, 2010). The commercial sector is a sector that operates to provide goods or services with the aim of making a profit to improve the welfare of shareholders (Mardiasmo, 2009) or an economic sector that excludes economic activities by the government and non-profits such as hotel businesses, buying and selling, banking, law offices, doctor's practice, etc. Having access to electricity will trigger the use of technology to increase output, either to speed up processes or save time, energy and use of raw materials in production.

The electricity infrastructure acceleration program currently underway is a 35,000 MW program. The program was launched by projecting economic growth of 7% and an increase in electricity demand of around 8.7% every year. This is also a form of integrated upstream-downstream economic transformation effort, especially preparing for industrial needs. Since its launch in May 2015, 431 generating units have been contracted with a total capacity of 34,355 MW (DJK, 2021).

Furthermore, electricity sales in the industrial and commercial sectors throughout 2017-2021 for the industrial sector increased to 71,716 GWh and commercial increased to 40,873 GWh. However, national electricity sales growth fell to 3.57% compared to the previous year. Electricity sales in these two sectors continued to increase until 2019 while still experiencing negative growth at 4.57%, lower than in 2018 of 5.14%. The peak decline in electricity sales growth by PT. PLN (Persero) was experienced since the Covid-19 pandemic occurred with sales dropping drastically to -0.79% (the lowest annual sales ever experienced by PT. PLN (Persero) nationally. The industrial and commercial sectors received a significant impact where sales in the two sectors fell to -8.7% and -7.3% respectively. The decline in sales in the industrial sector predominantly occurred in the textile, iron and steel, chemical, cement and automotive industries.This decline is partly due to the steel industry not having upstream processing (smelter), to the textile industry being invaded by imported products at lower prices.Meanwhile, for the commercial sector, this occurs especially in the tourism sector such as malls, hotels, restaurants, tourist attractions, etc.



Picture1. Data on Electricity Sales in the Industrial Sector, Commercial Sector and GDP Growth Per Capita ADHB 2010 for Provinces in Indonesia 2017-2021

Realized sales in the Sumatra region before being affected by Covid-19 grew higher than holding sales with an average of 5.9% in 2015-2019. In 2020, the impact of Covid-19 reduced sales to 3.34% where the commercial sector experienced a sales decline

of -4.7% while the industrial sector was still able to grow even though it was only 3.3%. In the Java, Madura and Bali (JMB) region, the decline in electricity demand or sales has been felt, especially in the industrial and commercial sectors. Industrial sector sales in 2019 were 0.2% compared to the previous year, namely 5.4%. In 2020, sales growth for the commercial and industrial sectors fell to -9.0% and -20.4% respectively with the longest expected recovery compared to other sectors. Similar to the JMB region, sales in the Kalimantan and Sulawesi regions, especially for the industrial and commercial sectors, experienced negative sales growth during the Covid-19 pandemic to 0.07% and -6.4%. Meanwhile for other sectors there is not much impact due to the government's policy to work from home.

Judging from electricity consumption in ASEAN countries, Indonesia's electricity demand is much lower than Malaysia and Singapore, and potentially even lower than Vietnam and Cambodia. Apart from the impact of the decline in electricity sales due to deindustrialization which has worsened due to the Covid-19 pandemic, in fact the infrastructure acceleration program has also missed projections, bThe large amount of electricity production due to the large number of PLTUs entering the system from the 35,000 MW program has caused an oversupply of electricity in recent years. On the other hand, in electricity sales and purchase contracts with private electricity developers or Independent Power Producers (IPP), PT. PLN (Persero) is subject to a scheme “Take or Pay” which requires PT. PLN (Persero) to take electricity supplies from the developer in accordance with the amount stated in the contract and if not, PT. PLN (Persero) will be subject to a penalty. Apart from that, another problem is that the decline in sales and the condition of electricity oversupply pose a risk to the financial condition of PT. PLN (Persero) and together they become obstacles to efforts to transition electricity towards greener renewable energy.

According to the opinion of (Yistiani, 2017),electricity demand in Indonesia very influenced by various factors, including is a factor income, growth residents and growth economy Indonesia. However, other studies have produced different conclusions regarding the relationship between electricity demand and economic growth.*K*The conclusion from (Novester & Nababan, 2022) is that economic growth has no effect on demand for electrical energy. A person's income level will influence electricity demand (Nilman and Mintargo, 2020). Meanwhile research conducted by (Rosadi & Amar, 2019) on electricity consumption in Indonesia by analyzing the influence of electricity prices, income, household customers and industrial customers using the panel data method for the 2004-2013 period shows that income, household customers and industrial customers have an influence positive and significant, while electricity prices have a negative but not significant effect. PT. PLN (Persero) prepares electricity demand predictions using the econometric regression method with the statistics-based Simple-E application. Variables that are considered include economic growth, population, inflation, electricity rates, number of customers and target electrification ratio.

There has been no research found that focuses on electricity demand using provincial panel data methods in Indonesia, especially comparisons in the industrial and commercial sectors with longer and more recent time series data. Next, the researchers attempted to look at the factors that influence electricity demand based on electricity demand projections carried out by PT. PLN (Persero) by analyzing economic factors such as GRDP per capita, number of customers and electricity tariffs and adding another variable, namely the realization of domestic investment. (PMDN) on electricity demand in the industrial and commercial sectors in Indonesia

RESEARCH METHODS

The research uses descriptive and quantitative analysis with panel data regression analysis tools. Data with panel characteristics is data that is structured as a time series as well as a cross section. This kind of data has advantages, especially because it is robust against several types of violations of Gauss Markov assumptions, namely heteroscedasticity and normality, according to(Wooldrige, 2005). In addition, according to(Ariefianto, 2012)with certain treatment data like this can be expected to provide more information (high informational content). The secondary data required is data from 34 provinces in Indonesia during 2017-2021 obtained from BPS and PLN Statistics sources.

Modeling using a panel data regression model can be done using three approaches, including: Common Effects Model (CEM), Fixed Effects Model (FEM) and Random Effects Model (REM). To determine the best model, several tests are required, namely the Chow Test, Lagrange Multipler (LM) Test and Hausman Test. The Chow test is carried out to determine which model is better between CEM and FEM, the LM test is carried out to determine the best method between CEM or REM, while the Hausman test aims to choose between the FEM and REM models. There are two model equations divided by sector, as follows :

Industrial Sector Electricity Demand

$$PLi = a + \beta_1 TLRi_{it} + \beta_2 PDRBi_{it} + \beta_3 PMDNi_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Commercial Sector Electricity Demand

$$PLk = a + \beta_1 TLRk_{it} + \beta_2 PDRBk_{it} + \beta_3 PMDNk_{it} + \varepsilon_{it} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Where :

PLi/PLk	: Industrial/Commercial Sector Electricity Demand
TLRi/TLRk	: Industrial/Commercial Sector Electricity Tariff
PDRBi/PDRBk	: Industrial/Commercial Sector GRDP
PMDNi/PMDNk	: Domestic Investment in the Industrial/Commercial Sector
a	: Constant or intercept
β	: Coefficient of determination for each independent variable
i	: Province i (34 provinces)
t	: year t (2017-2021)

Average electricity tariffs for the industrial/commercial sector are taken from PLN statistical data based on the determination of tariff adjustments for the industrial or commercial sector separately in each province throughout Indonesia in Rupiah units within a period of one year. The GDP of the industrial sector is calculated by adding up the added value of goods and services produced by the processing industrial sector in each province in billions of Rupiah, sourced from the Central Statistics Agency. Commercial sector GDP is calculated by adding up the added value of goods and services produced from the trade, motorbike and car repair sectors in each province in billions of Rupiah units sourced from the Central Statistics Agency. Domestic Investment (PMDN) in the industrial sector is the realization of domestic investment in Indonesia in the industrial sector, including the food industry; Textile industry; Leather goods and footwear industry; Wood industry; Paper and printing industry; Chemical and pharmaceutical industry; Rubber and plastic industry; Mineral and metal industry; Basic metal industry, metal goods, not machinery and equipment; Machinery, electronics, medical instruments, electrical equipment, precision, optics and clock industries; The motor vehicle and other

transportation industry from each province in Indonesia is calculated in millions of Rupiah for a period of one year. Domestic Investment (PMDN) in the commercial sector is the realization of domestic investment in Indonesia in the trade and repair sectors from each province in Indonesia calculated in millions of Rupiah over a period of one year throughout 2017-2021 sourced from the National Single Window for Investment (NSWI)-National Consumer Protection Agency (BKPN).

RESULTS AND DISCUSSION

Industrial Sector Electricity Tariffs do not have a negative and significant influence on industrial sector electricity demand in Indonesia with a P-value of 0.1451>0.05 and a coefficient of -0.590534. Meanwhile, the results of calculating the t-count and t-table values (1.465846<1.95) show a small correlation. This research is in accordance with research conducted by (Rosadi & Amar, 2019) which states that electricity tariffs are not significant to electricity demand. Consistent with research conducted by (Ginting, 2022) that electricity tariffs are significant and have a negative direction, (Mulyani, 2018) electricity tariffs have no statistical influence and have a negative direction at a confidence level of 95%.

Table 1. Regression Model Estimation Results

Model	C	TLRi	PDRBi	PMDNi
CEM	No Sig.	No Sig.	Significant	Significant
FEM	Significant	No Sig.	Significant	Significant
REM	No Sig.	No Sig.	Significant	Significant
Chow Test	FEM	FEM	FEM	FEM
Hausman Test	FEM	FEM	FEM	FEM

Data source: Processed data, 2023

GRDP in the industrial sector has a significant influence on electricity demand in the industrial sector in Indonesia with a P-value of 0.000>0.05 and a coefficient of 0.019221. This explains that if the GDP variable in the industrial sector increases by one billion Rupiah, it will increase electricity demand in the industrial sector by 0.019221 GWh.

Table 2. Industrial Sector Panel Data Regression Results

Variable	Coefficient	Std.Error	t-Statistic	Prob.	Significant
C	1433.108	546.8285	2.620763	0.0098	Significant
TLRi	-0.590534	0.402863	-1.465846	0,1451	No Sig.
PDRBi	0.019221	0.003143	6.115130	0.0000	Significant
PMDNi	6.98E-05	2.81E-05	2.487345	0.0141	Significant
R Squared	0.998073				
F- Statistic	1913.979				
Prob.(F-Statistic)	0.000000				

Data source: Processed data, 2023

Meanwhile, the results of calculating the t-count and t-table values (6.115130>1.95) show a large correlation. Consistent with research (Ginting, 2022)

which states that there is a positive and significant influence between GRDP and electricity demand and (Zam-zami, 2019) also shows that there is a positive and substantial relationship with a large correlation of the industrial sector GRDP variable on electricity demand in the sector. industry. (Damara & Yasa, 2019) produced the same conclusion that GRDP has a partially significant influence on energy demand at a confidence level of 95%.
Panel data regression model equation:

PLIit : 1433,1 – 590534 TLRIit + 0.019221 PDRBIit + 0. PMDNit + εit ……...(1)

Domestic investment in the industrial sector has a significant influence on electricity demand in the industrial sector in Indonesia with a P-value of 0.0141<0.05 and a coefficient of 6.98E-05. This explains that if domestic investment in the industrial sector increases by one billion million Rupiah, it will increase electricity demand in the industrial sector by 6.98E-05 GWh. Meanwhile, the results of calculating the t-count and t-table values (2.487345> 1.95) show a large correlation. The results of this research are in accordance with research conducted by (Ermawati & Kaluge, 2005) that there is no influence between investment and electricity consumption and (Lefaan, 2023) that there is no influence between investment and electricity consumption but has a positive value at a confidence level of 95%.

Table 3. Regression Model Estimation Results

Model	C	TLRi	PDRBi	PMDNi
CEM	No Sig.	No Sig.	Significant	Significant
FEM	Significant	No Sig.	Significant	Signifcant
REM	No Sig.	No Sig.	Significant	Significant
Chow Test	FEM	FEM	FEM	FEM
Hausman Test	FEM	FEM	FEM	FEM

Data source: Processed data, 2023

The average electricity tariff for the commercial sector does not have a significant influence on the electricity demand for the commercial sector in Indonesia with a P-value of 0.4320>0.05 and a coefficient of 0.009172. Meanwhile, the results of calculating the t-count and t-table values (0.788205 < 1.95) also show a small correlation.

Table 4. Commercial Sector Panel Data Regression Results

Variabel	Coefficient	Std.Error	t-Statistic	Prob.	Significant
C	661.2986	102.9618	6.422757	0.0000	Significant
TLRk	0.009172	0.011636	0.788205	0.4320	No Sig.
PDRBk	0.009786	0.001702	5.749275	0.0000	Significant
PMDNk	0.145423	0.028250	5.147773	0.0000	Significant
R-Squared	0.994210				
F-Statistic	6126433				
Prob.(F-Statistic)	0.000000				

Data source: Processed data, 2023

This research is in accordance with the results of (Rosadi & Amar, 2019) which states that electricity tariffs are not significant to electricity demand. Consistent with research conducted by (Mulyani, 2018) commercial sector electricity tariffs have a negative but not significant influence at the 95% confidence level. Because demand is inelastic to price increases, minimal price increases have no effect on electricity demand.

Panel data regression model equation:

$$PLKit = 661{,}2 + 0.009172\ TLRKit + 0.009786\ PDRBKit + 0.145423\ PMDNit + \varepsilon it \quad ..(2)$$

GRDP in the Commercial sector has a significant influence on commercial sector electricity demand in Indonesia with a P-value of 0.000>0.05 and a coefficient of 0.009786. This explains that if the commercial sector GRDP variable experiences an increase of one billion Rupiah, it will increase commercial sector electricity demand by 0.009786 GWh. Meanwhile, the results of calculating the t-count and t-table values (5.749275>1.95) show a large correlation. Consistent with research (Ginting, 2022) which states that there is a positive and significant influence between GRDP and electricity demand and (Zam-zami, 2019) also shows that there is a positive and substantial relationship with a large correlation of the industrial sector GRDP variable on electricity demand in the sector. industry. (Damara & Yasa, 2019) produced the same conclusion that GRDP has a partially significant influence on energy demand at a confidence level of 95%.

Domestic Investment in the Commercial Sector has a significant influence on commercial sector electricity demand in Indonesia at a confidence level of 95% with a P-value of 0.000<0.05 and a coefficient of 0.145423. This explains that if the commercial sector GDP variable experiences an increase of one million Rupiah, it will increase commercial sector electricity demand by 0.145423 GWh. Meanwhile, the results of calculating the t-count and t-table values (5.147773>1.95) also show a large correlation. This research is in accordance with research conducted by (Ermawati & Kaluge, 2005) that there is no influence between investment and electricity consumption and (Lefaan, 2023) that there is no influence between investment and electricity consumption but has a positive value.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The results of the analysis show that there has been development in a positive direction for electricity demand in the industrial and commercial sectors, however developments in 2020 saw negative growth which resulted in electricity oversupply. Then the results of the panel data regression analysis in the industrial sector show that there is a positive and significant influence from the Industrial Sector PDRB and Industrial Sector PMDN variables. In the commercial sector, it shows the influence of commercial sector GRDP and Commercial Sector PMDN on electricity demand in the commercial sector. Meanwhile, the Average Electricity Tariff variable for both the industrial and commercial sectors has no significant effect.

Recommendations

First, electricity supply: the government should pay attention to policies to adjust electricity supply for the industrial and commercial sectors when projected economic growth increases. The growth of the industrial and commercial sectors encourages

domestic investment so that it is necessary to be prepared to provide electrical energy sources. This electricity supply adjustment also applies when projected economic growth declines. This avoids the problem of excess electricity supply occurring again, where electricity is energy that can be lost if not distributed.

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