



Implementation of Clustering Methods to Know Electricity Energy Sold Average Customer Type

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ABSTRACT

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The need for electrical energy in Indonesia continues to increase from time to time. In realizing the need for electrical energy, it is important to order electrical energy based on the type of customer. In collecting this electrical energy, grouping is needed. The results of the gathering can be utilized by PT. PLN to anticipate disruptions in the supply of electrical energy. This investigation plans to determine the electrical energy sold by type of customer (KWH) in 2016 to 2019 in Indonesia and dissect the power requirements in 2019. The strategy used is group development using rapidminer. The variables that cause the utilization of the tourism industry in Indonesia are Population, Economic and Industrial Developments. To meet the need for the use of electrical energy which continues to increase from year to year, the matters and groupings of the use of electrical energy for the use of electrical energy were completed in 2014 to 2019. The information and targets used in the meeting were gross domestic electricity, group information and power information. (per customer type and power utilization). from 2011 to 2015. The side effect of ordering electrical energy in Indonesia using the fuzzy bunching strategy was 272,630 KWH in 2019, an increase of 85,089 KWH with an annual normal increase of 6.96%. the result group of the strategy has a normal of 18,730 KWH against RUPTL.

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1. Introduction

One of the fundamental requirements for the lives of today's individuals to complete their daily practice is strength. Isolated into several areas that utilize power, especially family, business or business areas, industry, and public offices. The power usage measure will sometimes generally expand, a measure that is not really resolved with confidence. If this vulnerability is not studied and collected, the utilization of electrical energy will become a problem, because the interest in power is increasing but the power reserve is lacking. This is because of the importance of power for the advancement of human existence in several fields, especially the monetary, mechanical, social, and social fields. Indonesia is one of the countries with a significant level of electricity utilization. The intensity of the use of electrical energy in Indonesia is influenced by higher financial movements in line with population growth, business and mechanical developments, and innovative advances. This expansion of utilization occurs because it drives the wheels of the economy such as industry, transportation, banking, and government. It is the individual's power requirements in performing daily exercises that give rise to a more prominent interest in power supply.

The family area is one of the largest and highest types of electrical energy customers. The total electrical energy sold in 2013 was 187,541 KWH, an increase of 7.79% compared to the previous year. Grouping by type of family customers consumes energy 77,211 KWH (41.17%), mechanical area 64,381 kwh (34.33%), Business 34,498 KWH (18.40%), and others (social, government structure and public street lighting) 11,451 KWH (6.11%). Electrical energy supply for various customer gatherings, particularly Industrial, Family, Business and Others, increased by 6.99%, 7.04%, 1.33% and 7.08%, respectively. The number of per type of PLN customers in 2013 for families was 50,116,127 customers (92.81%) of the total per type of PLN customers. The number of endorsers for the R1 type (450VA, 900VA and 1300VA) is



around 49,105,025 customers, with the power of association 39,952.37 MVA, and the energy sold is 69,067,615.58 KWH and pays Rp. 44,201,442,487,120. Explicitly for the type of customer R1 whose power is introduced is 450VA, there are 34,373,510 customers (70%) of complete customers in the family area, Manik Endiman(2018) [10]. Energy use in the family area differs from country to country. In Australia 25 38% of energy is used for warming and cooling, 25% of energy is used for heating water, 7% for lighting, 4% for cooking, 7% for refrigerators, 16 19% for other electrical appliances, Government of South Australia(2012)[2].

Innovative advances in all fields are developing so rapidly, these advances are the result of a collection of utilization of electric power needs. Power is probably the most needed type of energy, this is possible because electrical energy is not difficult to circulate and can be converted effectively into energy. Electricity is a basic need for the region, both in the mechanical and family fields, Saleh(2015) [5].

Currently, a technique for estimating electrical energy use has been applied using the Programmed Meter Perusing (AMR) framework, which is a framework that reads or recovers information from electrical energy estimates to local and remote buyers, where the reading schedule is not very specified. case by case. This AMR framework can be used ideally for issuing accounts, checking load per customer type, estimating catastrophe or catastrophe of transportation equipment, making arrangements for upgrading the electrical energy network, Yessy Asri (2020)[15]. Collecting tends to be solved by handling information using information mining procedures, especially grouping calculations. Bunch inspection (grouping information) is a technique used to classify information on the use of electrical energy that is not really regulated in the stone equation, Sangadji I., & Arvio Y.(2018)[9]

Given the basis of the problem above, to have the choice to carry out a measure of energy sold or used, the creator took and shared a final effort with the title "Implementation of the Clustering Method to Find out the Average Energy Sold per Customer Type (KWH)".

2. Method

2.1 Types of Research

This type of research uses the clustering method because the data obtained is based on the classification of electricity consumption. The data that has been collected is what becomes of electrical energy sold on average per type of customer.

2.2 Work Procedures

a. Identification of research needs

Collect and re-discuss national journals related to electrical energy sold on average per customer type using the clustering method.

b. Data grouping:

1) Generating data

Hydropower data already includes PLTM data, especially power plants with production units with a limit of 1,000 KWH and below (according to Circular No. 006/PST/88).

2) Customer data by class of electricity consumption rates.

a) According to customer group by customer type.

- i. The household group is the sum of the S-1, R-1, R-2, and R-3 tariff groups.
- ii. Business group, is the sum of tariff groups B-1, B-2, B-3, T, C and Multipurpose/Special Service tariffs.
- iii. Industry group, is the sum of tariff groups I-1, I-2, I-3, and I-4.
- iv. Social group, is the sum of the S-2 and S-3 tariff groups.
- v. Group of government office buildings, is the sum of tariff groups P-1 and P-2.
- vi. The general street lighting group is the P-3 tariff group.

b) According to the type of voltage.

- i. Low voltage type, is the sum of tariff groups S-1, S-2, R-1, R-2, R-3, B-1, B-2, I-1, I-2, P-1 and P-3.
- ii. Type of medium voltage, is the summation of tariff groups S-3, B-3, I-3, P-2, Traction (T) and C (Bulk).
- iii. High voltage type, is tariff group I-4.

- iv. Types of multipurpose tariffs, are tariffs that are intended only for electricity users who require special quality services that are not included in the S, R, B, I, P, T (Traction) and C (Bulk) tariff categories.
- c. Data testing
After the data we need have been collected effectively, then we tested our data using rapidminer 5.3, showing that the need for electricity represents an increase in electricity demand along with the growth of customer types, in order to get the results that researchers want.

2.3 Tools and Materials

- a. Tool
The tools used in this research are software and hardware.
 - 1) Software (Software).
 - a) Microsoft Office Excel 2010.
 - b) RapidMiner Studio 5.3.
 - 2) Hardware (Hardware)
 - a) Lenovo IdeaPad 330.
 - b) Processor: AMD A9-9425 RADEON R5, 5 COMPUTE CORE 2C+3G 3.10 GHz.
 - c) RAM: 8.00 GB.
 - d) Hard disk: 500 GB.
 - e) Operating System: Microsoft Windows 10 Pro.
- b. Materials
The data used in this study is in the form of grouping the use of electrical energy sold on average obtained by type of customer from PLN Indonesia. Data has been collected as many as 300 data on electricity consumption.

2.4 Data Analysis

The data in this study were obtained from the grouping of electrical energy sold by each type of customer from PLN Indonesia, the grouping of data containing the use of electrical energy per KWH which was implemented by the clustering method, the data was collected as many as 300 data. Some of the data used can be seen in Table 1

Table 1
Average Energy Sample Sold Per Type of Customer (kwh), 2017

PLN/Provincial Unit	Household	Industry	Business	Social	Government Office Building	Public street light	Total
Region of Aceh	1,277.95	45,878.11	3,710.78	3,959.46	9,799.46	68,378.98	1,772.53
Region of North Sumatera	1,500.44	600,309.96	11,418.23	5,520.16	12,992.83	26,486.36	2,791.49
Region of West Sumatera	1,381.22	2,269,968.85	4,219.76	4,080.54	10,491.23	28,729.15	2,527.08
Region of Riau	1,844.18	935,619.25	8,337.06	6,813.79	18,066.78	44,978.66	2,806.79
Riau	2,054.67	1,184,665.01	9,612.25	7,589.63	22,461.44	51,438.79	3,129.56
Riau Archipelago	497.35	102,392.06	2,443.56	1,824.27	4,898.00	9,598.29	810.40
Region of South Sumatera, Jambi & Bengkulu	1,512.02	957,763.05	10,196.80	4,363.04	13,131.10	21,479.62	2,350.35
South Sumatera	2,019.68	1,338,355.86	15,336.01	5,915.52	19,755.08	28,326.81	3,173.07
Jambi	413.06	118,738.71	2,440.23	1,302.05	3,682.91	3,728.68	640.04
Bengkulu	341.32	120,664.41	1,655.15	876.85	2,790.88	3,498.58	444.99
Region of Bangka Belitung	1,587.39	288,131.14	7,675.02	5,210.36	11,630.51	7,093.70	2,307.19

3. Results and Discussion

3.1 Results

In this study, the growth factor of the number of customers per type, economic growth, and the growth of the customer industry greatly affect the consumption and use of electrical energy very significantly. The following are the results of estimates and grouping of electrical energy consumption by annual customer type:



Table 2
Results of Data on the Number of Customers and Electricity Consumption of PLN

Year	Electrical Energy Consumption (KWH) (X_1)	Customer Type (X_2)
2015	7917,24	130,32
2016	8271,01	130,76
2017	8703,63	130,93
2018	9240,30	140,40
2019	9707,33	140,26

From Table 2. it can be seen that the growth in consumption of PLN's electricity consumption is in line with the increasing growth in the number of per type of customers in Indonesia from year to year which continues to experience a very significant increase. After knowing the electricity consumption data sold and population growth per customer type, the data will be processed to find out the growth in electrical energy consumption for each customer type in 2019 and has ANFIS clustering results which can be seen in Figure 1.

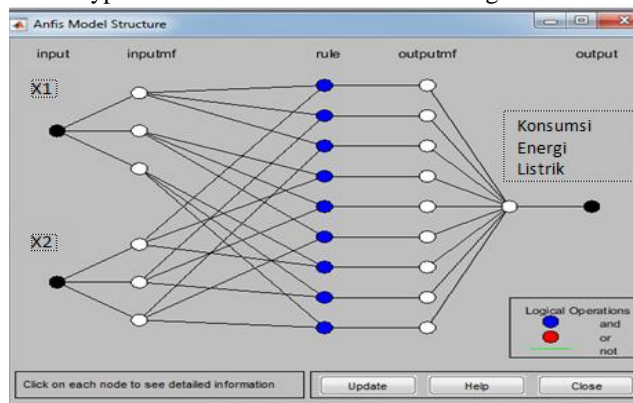


Fig 1. ANFIS Cluster Clustering Results

The following are the steps in processing data on population grouping and data on electricity consumption by type of customer:

a. Results of Grouping

Grouping the data can be seen in Table 3 and making a graph of the estimated consumption of electrical energy can be seen in Fig2 as follows:

Table 3
Results of Data Sharing With 2 Inputs

Data to	Input		Output
	X_1	X_2	$Y_{(t)}$
1	7917,24	130,32	8271,01
2	8271,01	130,76	8703,63
3	8703,63	130,93	9240,30
4	9240,30	140,40	9707,33

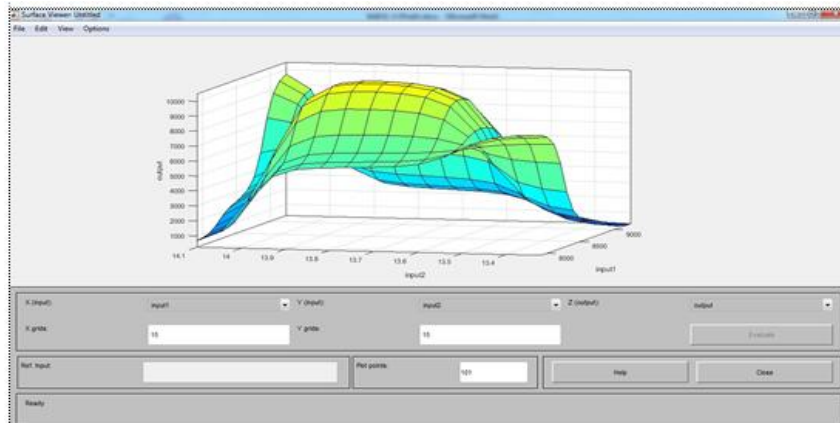


Fig 2. Graph Result of Estimated Electrical Energy Consumption Against Population GrowthFactor

b. Grouping Results Using Fuzzy C Means (FCM) Algorithm

Then the data is grouped using the fuzzy c means (FCM) algorithm on rapidminer. So, we get the results of the appropriate partition matrix in the 14th iteration:

$$U_{14} = \begin{bmatrix} 0,0287 & 0,06180,8572 & 0,9653 \\ 0,9713 & 0,93820,1428 & 0,0347 \end{bmatrix} \tag{1}$$

Grouping the above data into several clusters, can be seen in Table 4.

Table 4
Data Results of the Degree of Customer Type in Each Cluster With FCM

Data to	X ₁	X ₂	Data Membership Degrees on the Cluster		Data tends to enter the cluster	
			1	2	1	2
1	7917,24	130,32	0,0287	0,9713		*
2	8271,01	130,76	0,0618	0,9382		*
3	8703,63	130,93	0,8572	0,1428	*	
4	9240,30	140,40	0,9653	0,0347	*	

c. Clustering Results Degree Per Customer

Get results from clustering degrees per customer type, then calculate the mean and standard deviation:

1) Mean value:

$$C_{11} = \frac{7917,24+8271,01}{2} = 8094,12 \tag{2}$$

$$C_{12} = \frac{8703,63+9240,30}{2} = 8971,96 \tag{3}$$

$$C_{21} = \frac{130,32+130,76}{2} = 130,54 \tag{4}$$

$$C_{22} = \frac{130,93+140,40}{2} = 140,04 \tag{5}$$

2) Standard Deviation Value:

$$a_{11} = \frac{\sqrt{((X_{11}-C_{11})+(X_{12}-C_{11}))^2}}{2} + \frac{\sqrt{((7917,24-8094,12)+(8271,01-8094,12))^2}}{2} = 0,005 \tag{6}$$

$$a_{12} = \frac{\sqrt{((X_{13}-C_{12})+(X_{14}-C_{12}))^2}}{2} = 0,007 \tag{7}$$

$$a_{21} = \frac{\sqrt{((X_{21}-C_{21})+(X_{22}-C_{21}))^2}}{2} = 0 \tag{8}$$

$$a_{22} = \frac{\sqrt{((X_{23}-C_{22})+(X_{24}-C_{22}))^2}}{2} = 0,007 \tag{9}$$

It can be concluded as follows:

$$C = \begin{bmatrix} 8971,96 & 8094,12 \\ 140,04 & 130,54 \end{bmatrix}, a = \begin{bmatrix} 0,005 & 0,007 \\ 0 & 0,007 \end{bmatrix} \tag{10}$$

d. Result Of Inference Value Of Electrical Energy Usage

Calculating the inference value of grouping the use of electrical energy using the Adaptive Neuro Fuzzy Inference System method. The steps to calculate the inference value are as follows:

1) Calculating the output of the first layer in the form of degrees per customer type for each data using



the equation:

$$A_1 = \mu(X_1) = \frac{1}{1 + \left| \frac{X_1 - C_{11}}{a_{11}} \right|^2}, A_2 = \mu(X_1) = \frac{1}{1 + \left| \frac{X_1 - C_{21}}{a_{21}} \right|^2} \quad (11)$$

$$B_2 = \mu(X_2) = \frac{1}{1 + \left| \frac{X_2 - C_{12}}{a_{12}} \right|^2}, B_2 = \mu(X_2) = \frac{1}{1 + \left| \frac{X_2 - C_{22}}{a_{22}} \right|^2} \quad (12)$$

Data calculation to 1:

$$\mu(A_1) = \frac{1}{1 + \left| \frac{X_1 - C_{11}}{a_{11}} \right|^2} = \frac{1}{1 + \left| \frac{7917,24 - 8971,96}{0,005} \right|^2} = 0 \quad (13)$$

$$\mu(A_1) = \frac{1}{1 + \left| \frac{X_2 - 8094,12}{0,007} \right|^2} = \frac{1}{1 + \left| \frac{13,32 - 8094,12}{0,007} \right|^2} = 0 \quad (14)$$

$$\mu(A_2) = \frac{1}{1 + \left| \frac{X_1 - 14,01}{0} \right|^2} = \frac{1}{1 + \left| \frac{7917,24 - 14,01}{0} \right|^2} = 1 \quad (15)$$

$$\mu(A_2) = \frac{1}{1 + \left| \frac{X_2 - 13,54}{0,007} \right|^2} = \frac{1}{1 + \left| \frac{13,32 - 13,54}{0,007} \right|^2} = 0,0010 \quad (16)$$

For the results of the calculation of the 2nd to 4th data will be shown in the degree of membership can be seen in Fig 3.

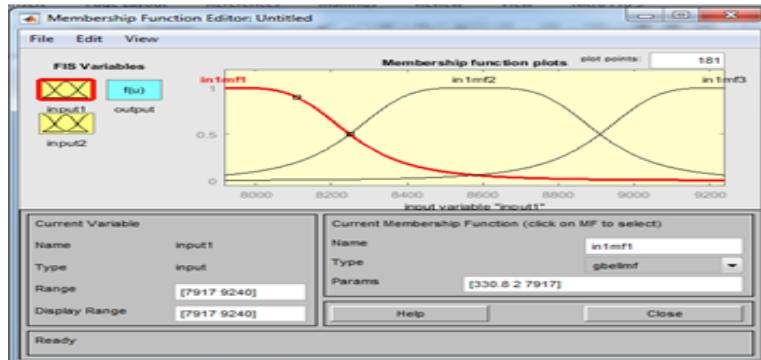


Fig 3. Membership Degree Graph Results With Type GBellmf

- 2) Look for the results of the first layer output, then calculate the layer 2 and 3 outputs, with the following equation: Layer 2 Data to 1:

$$W_1 = \mu(A_1) \times \mu(B_1) = 0 \times 0 = 0 \quad (17)$$

$$W_2 = \mu(A_2) \times \mu(B_2) = 1,0000 \times 0,0010 = 0,0010 \quad (18)$$

Layer 3 Data to 1:

$$\vec{G}_1 = \frac{W_1}{W_1 + W_2} = \frac{0}{0 + 0,0010} = 0,0010 \quad (19)$$

$$\vec{G}_2 = \frac{W_2}{W_1 + W_2} = \frac{0,0010}{0 + 0,0010} = 1 \quad (20)$$

- 3) calculating layer 4 output, which is calculating consequent parameters with the following equation:

Calculation of data to -1

$$p_1 = W_1 \times X_1 = 0 \times 7917,24 = 0 \quad (21)$$

$$q_1 = W_1 \times X_2 = 0 \times 130,32 = 0 \quad (22)$$

$$p_2 = \vec{G}_2 \times X_1 = 1 \times 7917,24 = 7917,24 \quad (23)$$

$$q_2 = \vec{G}_2 \times X_2 = 1 \times 130,32 = 130,32 \quad (24)$$

- 4) After getting the results from layer 4 output, then in layer 5 this will be calculated using the equation:

$$\Sigma F_i = (W_1 X_1) p_1 + (W_1 X_2) q_1 + (W_1 r_1) + (W_2 X_1) p_2 + (W_2 X_2) q_2 + (W_2 r_2) \quad (25)$$

Data Calculation to 1:

$$\Sigma F_1 = (0 \times 7917,24 \times 0) + (0 \times 130,32 \times 0) + (0 \times 0) + (1 \times 7917,24 \times 0,3075) + (1 \times 130,32 \times 0,0005) + (1 \times 0,00004) + 3.278,00 = 3.278,00 \quad (26)$$

The results of the 2nd and 3rd data calculations will be shown in Table 5.

Table 5
Layer 5 Output Results (Approximate Results)

Data To	Layer 5 Output(Approximate Result)
1	3.360,00
2	3.278,00
3	3.262,00
4	3.243,06
Total Estimated Subscription Electric Energy Consumption	13.143,06

Table 6
Energy Results Sold by Average Customer Group (kwh) 2011 - 2019

Year	Household	Industry	Business	Social	Government Office Warehouse	Public Street Lighting	Amount
2011	1.529,00	1.086.584,00	13.813,00	4.144,00	23.175,00	22.915,00	3.442,00
2012	1.561,00	1.142.704,00	13.969,00	4.353,00	23.838,00	21.905,00	3.494,00
2013	1.540,64	1.159.064,47	14.264,78	4.447,78	23.669,14	20.588,66	3.473,22
2014	1.577,00	1.129.540,00	13.816,00	4.609,00	23.811,00	19.812,00	3.454,00
2015	1.567,00	1.012.089,00	12.773,00	4.709,00	23.709,00	18.526,00	3.454,00
2016	1.581,00	978.692,00	12.370,00	4.897,00	23.729,00	16.984,00	3.360,00
2017	1.510,00	940.408,00	11.649,00	4.858,00	22.536,00	15.656,00	3.278,00
2018	1.481,00	872.558,00	11.739,00	4.988,00	22.226,00	14.549,00	3.262,00
2019	1.490,00	742.252,82	12.247,19	5.184,73	22.412,63	13.143,47	3.243,06

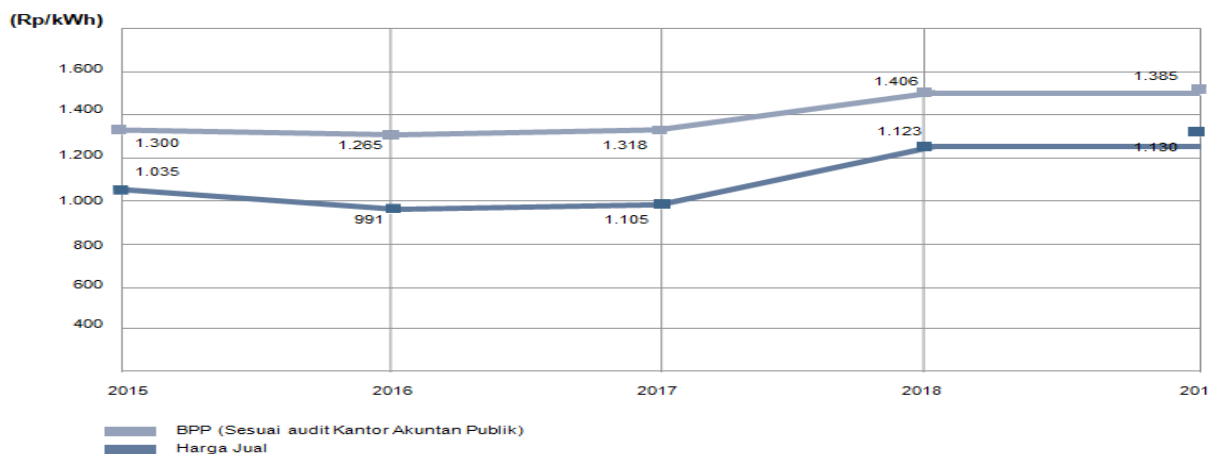


Fig 4.Graph Results of the Basic Cost of Electricity Supply (BPP) and Average Electricity Tariff

In Table 6 and Fig4 are the results of the data in the study obtained from the grouping of electrical energy sold by each type of customer from PLN Indonesia and the graph of the cost of providing the average electricity tariff. The data grouping contains the use of electrical energy per kwh which is implemented by the clustering method. Data collected as many as 300 data used.

3.2 Discussions

Total electrical energy sold in 2017 was 3,278.00 KWH, an increase of 4.65% compared to the previous year. Type of customer group Industry consumes 77,878.65 KWH (31.72%), Family 103,733.43 KWH (42.25%), Business 46,901.25 kwh (19.10%), and Others (social, government structure and street lighting general) 17.004.83 KWH (6.92%). Electrical energy supply for each type of customer, particularly Families, Companies, Organizations and Others, increased by 6.03%, 1.21%, 6.53% and 7.55%, respectively. The number of customers towards the end of 2019 was 75,705,614 customers, an increase of 5.27% from the end



of 2018. The normal electricity load per KWH during 2019 was 3,243.06 KWH, higher than the previous year of 3,262.00 KWH. With the development of the number of family customers from 66,071,133*) customers at the end of 2018 to 69,619,877*) customers at the end of 2019, the electrification ratio will be 95.75%.

4. Conclusion

To assess the results of the use of electrical energy can apply the fuzzy clustering method. The information is handled to obtain the value of the utilization of electrical energy. Information is handled using Rapidminer to determine the centroid value in the cluster, in particular the grouping of normally sold power usage levels per customer type. So the assessment depends on the 2016-2019 record of collecting electrical energy offers by customer type. The results of these explorations can be used to determine the payment and use of electrical energy at PT. PLN.

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