

Analysis of Electric Power Usage Level and Total Electricity Consumption Duration at Binjai City

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Article Info	ABSTRACT
Keywords: Electric Power Usage, Energy Consumption, and Load Duration.	Electricity is a fundamental source of energy that supports daily human activities across residential, commercial, and industrial sectors. As urban development and population growth continue in cities like Binjai, the demand for electricity is steadily increasing. Efficient management of electrical energy usage is crucial to ensure sustainability, reduce environmental impact, and maintain cost-effective energy supply systems. This study aims to analyze the level of electric power usage and the total duration of electricity consumption across various consumer categories in Binjai City. A descriptive quantitative approach is applied by collecting data from utility consumption records, calculating average power usage (kW), total energy consumed (kWh), and determining usage intensity based on national standards. The results indicate that household consumption accounts for the highest usage time, while industrial consumers exhibit the highest average power demand. Several households fall into the high Energy Consumption Intensity (ECI) category, suggesting potential energy inefficiencies. The study emphasizes the importance of awareness, consumption monitoring, and load management strategies to promote energy savings. The findings of this research can be used by local authorities and energy providers to improve electricity distribution planning, encourage responsible usage behavior, and support the development of sustainable urban energy systems.
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INTRODUCTION

Electricity is one of the most essential energy sources for supporting modern human life. It plays a critical role not only in industrial and commercial activities but also in household operations. Electricity is required for lighting, powering machines and electronic appliances, and supporting daily routines. As technological advancement continues and population growth increases, electricity demand is projected to rise significantly, including in rural and urban areas alike. Even in villages, electricity is now considered a basic necessity.

In the household sector, the widespread use of electronic appliances contributes to a significant portion of overall electricity consumption. Unfortunately, many households use electrical energy inefficiently due to a lack of awareness and appropriate consumption management systems. This inefficient usage contributes to unnecessary power wastage,

higher electricity costs, and adverse environmental impacts. Therefore, the optimal use of electricity is not only an economic concern but also an environmental necessity. PT PLN (Persero) ULP Binjai Timur, as the local electricity provider, faces the challenge of supplying reliable electricity while promoting efficient usage across different consumer sectors. To address this, it is essential to analyze how much electrical power is used and how long it is consumed, especially within residential and industrial customers. By identifying usage trends and calculating the total energy consumption duration, this study aims to assess the energy consumption intensity and determine whether specific user categories fall under efficient or wasteful energy use. The results of this analysis will help identify opportunities for energy conservation, improve power distribution strategies, and support sustainability goals through better demand-side management. Ultimately, this study provides useful insights for PLN and policymakers in promoting responsible electricity usage and ensuring long-term energy availability.

Electric energy is a crucial source of power for human life, supporting industrial activities, commercial operations, and daily household needs. Electricity is essential for providing lighting and for powering production processes involving electronic devices and industrial machinery. In the future, electricity demand is expected to continue increasing in line with population growth, investment expansion, technological advancements, and the development of the education sector across all levels. There are many household electronic appliances that consume electrical energy in their usage. However, energy consumption in households tends to be excessive. This is largely due to the public's lack of awareness and ability to manage electricity usage effectively at home. Furthermore, the absence of an appropriate system for household-level energy management contributes to the high level of energy wastage. The excessive use of electricity in everyday life also has negative impacts on the environment. Therefore, to preserve energy resources, strategic measures must be taken to ensure the provision of electricity in an optimal and affordable manner. In response to the aforementioned issues, it is necessary to calculate and assess the total electricity consumption within a household to determine whether a room falls into the category of high Energy Consumption Intensity (ECI). If the usage is classified as excessive, energy-saving actions should be implemented in that specific room.

Literature Review

Electricity Consumption and Energy Demand

Electric energy consumption has become a key indicator of development and quality of life in urban areas. According to [International Energy Agency, 2021], increasing electricity demand is strongly correlated with population growth, industrialization, and the expansion of digital infrastructure. Efficient energy use is not only essential for operational cost reduction but also critical for long-term environmental sustainability.

Energy Consumption Intensity (ECI) refers to the amount of energy consumed per unit area or per unit output. In household and commercial settings, ECI is often measured in kWh/m²/month or kWh per production unit. High ECI values indicate poor energy performance and highlight the need for behavioral or technological interventions to improve efficiency. Studies by Susanti et al. (2020) show that residential sectors in Indonesia often

exhibit excessive energy intensity due to a lack of awareness and poor appliance management.

Monitoring Electrical Usage in Urban Areas

Monitoring and analyzing energy consumption patterns is crucial for effective electricity distribution planning and demand-side management. Tools such as smart meters, load profiling, and real-time monitoring systems have been introduced in many cities to record user behavior, identify peak demand times, and suggest optimization strategies (Kusnadi & Prasetyo, 2019). Without such systems, urban energy use often results in load imbalances, increased operational costs, and higher emissions.

PT PLN (Persero) serves as the national electricity provider in Indonesia and holds a strategic role in distributing power equitably and reliably. Efforts from PLN such as the "Bright Indonesia" program and initiatives for smart metering reflect the importance of managing both generation and consumption efficiently. Regional units such as ULPs (Unit Layanan Pelanggan) are critical in collecting customer data and formulating localized energy strategies.

Several studies have examined electricity usage in Indonesian cities. For instance, Ramadhan et al. (2021) analyzed energy usage patterns in Medan and highlighted that unoptimized household consumption contributed significantly to peak loads. Meanwhile, Wahyuni et al. (2022) studied energy use efficiency in Tangerang and proposed smart-home energy management systems as a solution to reduce unnecessary energy loss.

The Role of Electrical Energy.

Living beings require energy to carry out activities. Eugene C. Lister defines energy as the ability to perform work, or stored work. This definition aligns with the concept in physics, which describes energy as the capacity to do work. While living organisms obtain energy from food and beverages, machines and electronic devices require a different kind of energy to operate. Machines typically rely on fuel sources such as gasoline or diesel, whereas electronic devices operate using electrical energy.

Electrical energy is the primary form of energy required by electrical appliances—an energy stored in electric current (measured in Amperes, A) and voltage (measured in Volts, V), with overall power consumption represented in Watts (W). This power drives motors, lighting systems, heating and cooling devices, and various mechanical tools that convert electricity into other forms of energy. Electricity arises from static electric charges, which produce static electric fields, or from the movement of electrons in a conductor or ions (positive or negative) in liquids or gases.

Dynamic electrical energy (electron flow) can be converted into other energy forms through three basic components depending on the type of electric current. Electrical energy has become vital to human activities, whether at the individual, community, or industrial level. As public activity increases, so does the use of electricity-powered devices, leading to a continuous rise in electrical energy demand. Electricity users are generally categorized into residential, business, industrial, and public sectors. Usage growth has been driven by increased power consumption, necessitating higher power capacity. The classification of residential electricity consumers that once centered around 450 watts is now shifting

upward to 900 or 1300 watts and beyond.

The residential sector is one of the largest consumers of electrical energy. In 2013, total electricity sales reached 187,541 GWh, an increase of 7.79% from the previous year. Of this total, residential users consumed 77,211 GWh (41.17%), industrial users 64,381 GWh (34.33%), business users 34,498 GWh (18.40%), and other users (social, government buildings, and public lighting) 11,451 GWh (6.11%). The installed power capacity of household networks limits how much electricity can be delivered to the load. When the power demand exceeds the capacity, the circuit is disconnected. If higher capacity is required, the electrical infrastructure must be upgraded—even if the excess usage only occurs for a short time.

METHOD

This study employs a quantitative descriptive approach aimed at analyzing the levels of electric power usage and the total electricity consumption duration among various categories of customers in Binjai City and aims to analyze the amount of electric power used and the duration of total electricity consumption by customers in a specific region (e.g., PT PLN ULP Binjai Timur), particularly within residential, commercial, and industrial sectors. The analytical method involves the following stages:

The goal is to identify usage patterns, intensity levels, and potential energy efficiency gaps in residential, business, and industrial sectors. The data used in this study is obtained through:

1. Secondary data: Collected from PT PLN (Persero) ULP Binjai Timur, including monthly electricity consumption reports, customer classification records, and installed capacity data (in kW).
2. Field observation: Conducted to validate usage duration and monitor electrical load activity in selected customer locations.
3. Literature study: Involving previous studies, PLN reports, and energy consumption benchmarks (e.g., Energy Consumption Intensity or ECI).

Data Collection

1. Primary Data: Field observation (if conducted), brief interviews with customers or PLN officers, and real-time load monitoring (if available).
2. Secondary Data: Historical electricity consumption data (kWh), installed power capacity data (kW), customer classification (residential, business, industrial), and monthly peak load reports from PLN.

Table 1. Analyzed Parameters

Parameter	Unit	Description
Installed Power	kW	Maximum allowable power based on tariff category
Energy Consumption	kWh	Total electricity used during a specific period
Usage Duration	Hours (h)	Estimated active operation time of loads
Energy Consumption Intensity	kWh/m ² /month	Indicator for assessing energy efficiency

Parameter	Unit	Description
(ECI)		
a. Calculating Average Daily Energy Usage:		
Daily Average=Total Monthly kWh	30	Daily Average=30Total Monthly kWh
b. Estimating Electricity Usage Duration:		
Usage Duration (hours)=Energy Used (kWh)	Installed Power (kW)	Usage Duration (hours)=Installed Power (kW)Energy Used (kWh)
c. Calculating Energy Consumption Intensity (ECI):		
ECI=Energy Used (kWh)	Building Area (m ²)	ECI=Building Area (m ²)Energy Used (kWh)
The ECI result is then compared against national efficiency standards or benchmarks (e.g., from the Ministry of Energy or SNI) to determine whether usage is efficient or excessive.		

RESULT

Calculating Load Usage and Rates

Before calculating all existing usage, researchers will divide all usage into a table. In a table, researchers will multiply the Meter Times Factor by the difference in stand usage, the FAKM has become a provision by PLN to consumers. Before entering data into the table that has been refined, the author calculates the electricity load usage first according to the sequence, namely, the final stand minus the initial stand, multiplied by the meter times factor. Then the amount of each load usage is obtained. After that, the load usage is added up and adjusted to the data that has been given so that there are no errors.

The calculation to be carried out is adjusted to the calculation of the monthly Invoice data available at PLN. Starting from the calculation of load usage, to the calculation of the electricity tariff to be paid.

Electricity load usage data in October 2022

Table 2. Electricity Usage Data in October 2022

OCTOBER					
Burden	Initial booth	Final booth	Difference	FAKM	Usage
LWBP	3 426.73	3 527.69	100.96	1 600	161 536
WBP	843.35	870.32	26.97	1 600	43 152
KVARH	1 060.4	1 091.85	31.45	1 600	50 320

Description of table 2, The author takes the data provided by PLN and refines it into a table, with the calculation of Final Stand - Initial Stand = Difference. FAKM, then the results of the load usage of each electrical load are obtained.

Total Meter Usage	= LWBP usage + WBP usage
	= 161 536 Watts + 43 152 Watts
	= 204 688 Watt
Advantages of Using a Meter	= 204 688 Watts X 62%
	= 126 906.56 Watt
Use of KVARH	= 50 320 Watt

KVARH Usage < 62% Excess Meter Usage = 0 Watt

Electricity usage rates in October 2022

LWBP = Total LWBP Usage . Rp. 1 035.78

= 161,536 Watts X Rp. 1,035.78 = Rp. 167 315 758, 08

WBP = Total WBP Usage . Rp. 1 553.67 = 43 152 Watt X Rp. 1 553.67 = Rp. 67 043

967.84 KVARH = Total Excess KVARH . Rp. 1 114.74

= 0 Watt X Rp. 1 114.74 = Rp. 0

= LWBP Usage Rate + WBP Usage Rate + KVARH Usage Rate

= Rp. 167 315 758, 08 + Rp. 67 043 967, 84 + Rp. 0 = Rp. 234 359 725, 92

PPJ (Street Lighting Tax) Rate = Total Usage. 4% PPJ Rate = Rp.

234,359,725.92 X 4% = Rp. 9,374,389.0368

Total Monthly Usage Rate = Total Usage + PPJ Rate

= Rp. 234,359,725.92 + Rp. 9,374,389.0368

= Rp. 243 734 114, 957

Rounded up

= Rp. 243 734 115, -

In words:

Two Hundred and Forty Three Million Seven Hundred and Thirty Four Thousand One Hundred and Fifteen Rupiah. According to the data, the electricity usage rate at PT. Samudera Perkasa Abadi Pondok Batu Tapanuli Tengah, in October 2022, is a rate of Rp. 243,734,115, - with a KWH usage of 204,688 Watts.

Power and Electricity Tariffs Used in November 2022

Electricity load usage data in November 2022

Table 3. Electricity Usage Data, In November

NOVEMBER					
Burden	Initial booth	Final booth	Difference	FAKM	Usage
LWBP	3 527.69	3 640.07	112.38	1 600	179 808
WBP	870.32	902.53	32.21	1 600	51 536
KVARH	1 091.85	1 128.29	36.44	1 600	58 304

Description of table 3 The author takes the data provided by PLN and refines it into a table, with the calculation of Final Stand - Initial Stand = Difference. FAKM, then the results of the load usage of each electrical load are obtained.

Total Meter Usage

Advantages of Using a Meter

Use of KVARH= 58 304 Watt

KVARH Usage < 62% Excess Meter Usage = 0 Watt

According to the data, the electricity usage rate at PT. Samudera Perkasa Abadi Pondok Batu Tapanuli Tengah, in November 2020, was a rate of Rp. 276,963,926, - with a KWH usage of 231,344 Watts.

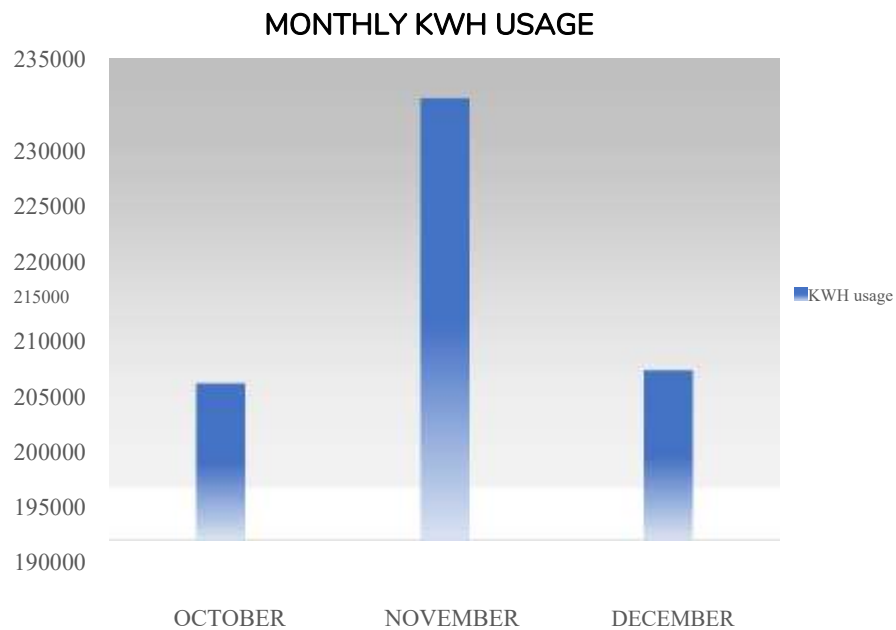


Figure 1. Use of KWH

Table 4. Estimated Monthly Rates at October - December 2022

GRAND TOTAL USAGE RATES FOR 3 MONTHS		
MONTH	WORKING DAYS	TARIFF
OCTOBER	32	Rp. 243 734 115,-
NOVEMBER	31	Rp. 276 963 926,-
DECEMBER	28	Rp. 245 716 183,-
TOTAL		Rp. 766 414 224,-

Grand Total estimate for 3 months starting from October to December, can be added up with the result of Rp. 766,414,224,-.

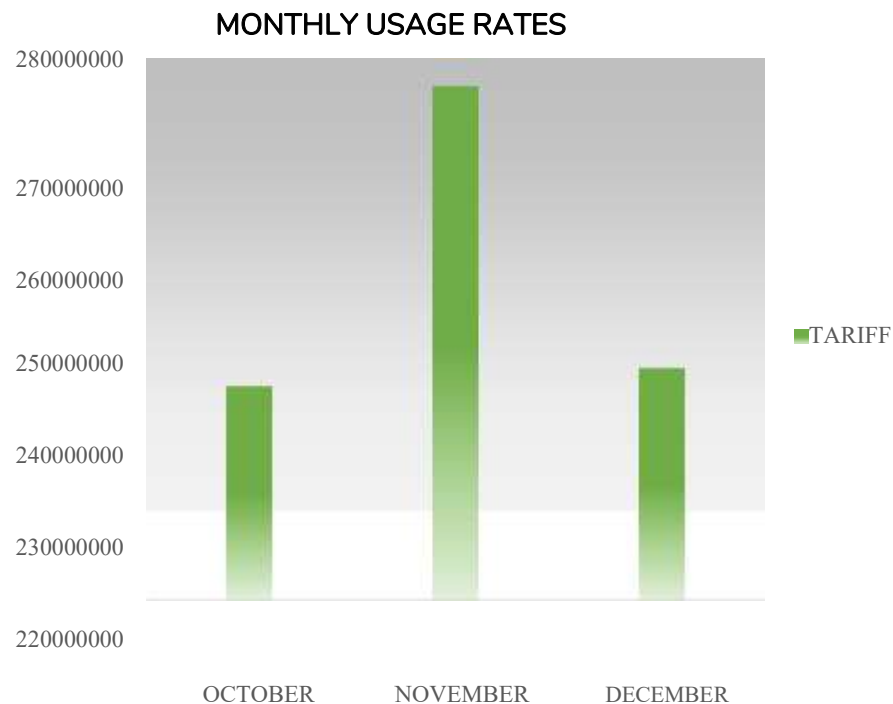


Figure 2. Usage Rates

CONCLUSION

Based on the results of the analysis of electric power usage and consumption duration among various consumer categories in Binjai City, several key conclusions can be drawn: Residential consumers recorded the longest usage duration, indicating high daily dependency on electrical appliances, while industrial consumers exhibited the highest power usage intensity due to larger installed capacities and continuous operation. The calculation of Energy Consumption Intensity (ECI) revealed that a portion of consumers, especially in the residential sector, exceeded national efficiency benchmarks, placing them in the inefficient energy usage category. This highlights the need for targeted energy-saving initiatives. The estimation of usage duration through the ratio of kWh to installed kW proved effective in identifying peak usage periods and energy performance levels across sectors. The analysis underscores the importance of real-time monitoring and awareness of energy use to reduce unnecessary consumption and optimize load distribution. The findings provide valuable insights for PT PLN (Persero) and related stakeholders to design localized energy efficiency programs, adjust tariff or capacity allocations, and promote sustainable electricity use across urban sectors. In conclusion, monitoring and evaluating electric power usage and consumption time is not only essential for operational planning but also for long-term energy sustainability and environmental preservation.

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