Instal : Jurnal Komputer

E-ISSN: 2808-683X
Edisi : Volume 16 Nomor 06 | 2025

Available online at https://journalinstal.cattleyadf.org/index.php/Instal/index

A Comparative Analysis Of Prepaid And Postpaid Kwh Meters In Improving Accuracy Of Electricity Usage Measurements To Customer Service Unit (Ulp) Customers Pt Pln In Peureulak, East Aceh

Rahma Sarita[1], Adisastra Pengalaman Tarigan[2], Siti Anisah[3]
Universitas Pembangunan Panca Budi

Keywords:
Kwh Meter, Prepaid, Postpaid, And Accuracy.

ABSTRACT

This study aims to analyze the comparison of prepaid and postpaid KWH meters in improving the accuracy of electricity usage measurements for customers of PT PLN's Customer Service Unit (ULP) in Peureulak, East Aceh. The prepaid system allows customers to control electricity usage based on previously purchased power, while the postpaid system records electricity consumption that will be billed after a certain period. This study was conducted through collecting primary and secondary data from customers and comparative analysis of the level of measurement accuracy, efficiency, and customer satisfaction. The results of the study indicate that the prepaid KWH meter system has a better level of accuracy compared to the postpaid system, especially in reducing the risk of incorrect manual recording and increasing transparency of electricity usage. These findings are expected to be a consideration for PT PLN in improving services to customers and encouraging the implementation of the prepaid system more widely.

Corresponding Author:
Rahma Sarita
Universitas Pembangunan Panca Budi
Email: rahmasaritax.3@gmail.com

INTRODUCTION

The electricity system in Indonesia continues to develop along with the community's need for better, more efficient, and more transparent electricity services. One of the important elements in the electricity system is the electricity consumption measuring instrument, namely the KWH meter. The KWH meter functions to record the amount of electricity used by customers, which then becomes the basis for calculating the costs to be paid. PT PLN, as the main electricity service provider in Indonesia, provides two types of electricity payment systems, namely prepaid and postpaid.

Prepaid KWH meters work with a "pay first, use later" system, where customers buy electricity tokens as needed and their usage is immediately recorded digitally. Meanwhile, postpaid KWH meters record customers' electricity usage for a certain period, which is then billed at the end of the period. Although both systems have the same goal, which is to record

Doi. 10.54209/jurnalinstall.v16i06.353

electricity usage, there are significant differences in the level of accuracy, efficiency, and customer satisfaction produced by each system.

On the other hand, one of the main challenges in measuring electricity usage is recording errors, both caused by technical and non-technical factors. These errors can result in inaccurate bills, which are often the source of customer complaints. Therefore, it is important to conduct a comprehensive analysis of both systems to determine the extent to which prepaid and postpaid KWH meters differ in improving the accuracy of electricity usage measurements.

This research was conducted at the Customer Service Unit (ULP) of PT PLN in Peureulak, East Aceh, as one of the areas with a growing number of electricity customers. This study aims to evaluate and compare the accuracy levels of prepaid and postpaid KWH meters, as well as provide strategic recommendations for PT PLN in improving service quality and customer satisfaction.

In this study, the basic theories used include the basic concepts of the electricity measurement system, the working principles of the KWH meter, as well as the advantages and disadvantages of each type of electricity payment system, namely prepaid and postpaid.

Electrical Measurement System

Measurement is a process of measuring which is basically an attempt to express the nature of a substance or object in the form of numbers or prices. The basis for giving numbers in measuring can be done by comparing the tool to be measured with a certain tool that is considered a standard or comparing the quantity to be measured with a scale that has been calibrated.(1)Electrical energy is the multiplication of power used by time or power usage during a certain time. Mathematically it can be written as follows:

$$E = P \times t$$

$$E = (V \times I \times \cos\varphi) \times t$$ (2)

The electricity metering system aims to record the amount of electricity consumed by users during a certain period. The electricity used is expressed in kilowatt-hours (kWh), which is the result of multiplying the electricity power (in kilowatts) by the time of use (in hours). Accuracy in this measurement is very important to ensure that customers only pay for the electricity they use.(3)

Measurement Accuracy

Accuracy of electrical measurement is the ability of a measuring instrument to record electrical energy consumption accurately according to actual usage.(6)

Factors that affect accuracy include:

1. Technology and quality of KWH meter devices.
2. Data recording procedures (manual or automatic).
3. Maintenance of measuring instruments to ensure their reliability.(6)(7)

Basically, prepaid (electronic energy meters) and postpaid (electromechanical energy meters) failures in the field have different characteristics.(5)Electromechanical Energy Meter (postpaid) becomes slow at certain time period or error in the meter counter register.(8)On the other hand, major errors in electronic meters (prepaid) are component failures and their testing using the consumer's on-site testing method, namely the Energy Comparison Method and by installing an On-Line Check Meter.(5)(8)Each kWh meter has a percentage of error, where the percentage of error on each kWh meter is different. This depends on the manufacture and type of kWh meter.(5)(7)The conclusion is that the percentage of error in analog kWh meters is greater than the percentage of error in digital kWh meters. This can be seen from the measurement results and from the calculation results that have been carried out.(9)

Doi. 10.54209/jurnalinstall.v16i06.353

Testing using the time calibration method, namely:

$e = \frac{td-t}{t} \times 100\%$ ……………………………(1) and

$td = \frac{n \times 3600 \times 1000}{P \times C}$ ……………………….. (2) (9)

Where:
e = % error
t = time required for the measured kWh for n revolutions (dt)
n = rotation (revolution)
c = number of revolutions per kWh (rev/kwh)
td = actual time required Kwh for n revolutions
P = measured power(3)(5)

Measurement using the electric power measurement method:

$e = \frac{Pterukur - Psebenarnya}{Psebenarnya} \times 100\%$............(3)

Where:
Pterukur = Power displayed by KWH meter (Watt)
Actual power = Actual power calculated based on voltage, current and power factor

KWH Meter

KWH meter is a measuring tool used to record customer electricity consumption.(4)There are two types of KWH meters that are commonly used:

Digital KWH meters work based on a program designed on the micro processor contained in the digital KWH meter device.(2) This prepaid kwh meter is designed using a new electric kwh meter. The payment system or filling of electricity bills is by using a chip card application.(2)This application greatly facilitates the community and PLN in terms of the effective electricity bill filling process. Chip card is a type of payment card that is increasingly popular along with the advancement of microelectronic technology and the increasing demands of the community for practical payment instruments.(2)The presence of chip cards is inevitable where their use is increasingly widespread both in volume and scope of application. One possible application of chip cards is as a means of paying for electricity consumption. This KWH meter works with a token or credit system. Customers buy electricity in a certain amount and enter the token code into the meter. Electricity usage will stop automatically if the purchased power has run out. This system allows customers to monitor electricity consumption in real-time.(5)

Figure 1. Prepaid KWH Meter

Doi. 10.54209/jurnalinstall.v16i06.353

Postpaid KWH Meter:

KWH Meter means Kilo Watt Hour Meter and if translated becomes n thousand watts in one hour. If you buy a KWH Meter then it will be listed X rotations per KWH, meaning to reach 1 KWH it takes x rotations per hour. For example if 1250 rotations per KWH then there must be 1250 rotations per hour to be said to be one KWH. The number of KWH is cumulatively calculated and at the end of the month the officer records the amount of usage then multiplied by the basic electricity rate or TDL plus the subscription fee and tax resulting in the amount of the bill that must be paid each month.(2)(3) In this system, the KWH meter records electricity consumption continuously, and customers pay bills based on usage in a certain period. Electricity usage data is usually recorded by PLN officers or using an automated system.(4)

Figure 2. Postpaid KWH Meter

Advantages and Disadvantages of Prepaid and Postpaid Systems

Prepaid System

Superiority: Customers can control electricity consumption, there are no bill arrears, and recording accuracy is higher because data is recorded directly on the device.(10)

Weakness: Requires periodic token top-ups, which can be a problem if the customer runs out of power at an inopportune time.(9)

Postpaid System

Superiority: More practical because customers do not need to top up tokens.

Weakness: The risk of manual recording errors is greater, as well as the potential for arrears in electricity bills.(9)

METHODS

This research uses quantitative and qualitative approaches.(11)to analyze the comparison of prepaid and postpaid KWH meters in improving the accuracy of electricity usage measurements. The following are the methodological steps applied:

Type of Research

This research is descriptive and comparative. The descriptive approach is used to describe the characteristics of prepaid and postpaid KWH meters, while the comparative approach is used to compare the level of measurement accuracy, efficiency, and its impact on customer satisfaction.(12)

Page : 312-322
Doi. 10.54209/jurnalinstall.v16i06.353

Location and Object of Research

The research location is the Customer Service Unit (ULP) of PT PLN in Peureulak, East Aceh. The research objects include household customers who use prepaid and postpaid KWH meters.

Population and Sample

Population: All ULP PT PLN Peureulak customers who use prepaid and postpaid systems.

Sample: Samples were taken using purposive sampling, namely selecting a number of customers based on certain criteria, such as the type of KWH meter used and the length of electricity usage.

Data Collection

The data collected in this study include:

Primary Data:

1. Interviews with customers and PLN officers regarding experiences and obstacles in using KWH meters.
2. Direct observation of the KWH meter to identify the level of measurement accuracy.

Secondary Data:

3. Documentation from PLN regarding customer electricity usage reports.
4. Previous literature and research relevant to this topic.

Data Analysis Techniques

1. Quantitative Analysis:
   Electricity usage data from prepaid and postpaid KWH meters were analyzed using descriptive statistics to compare measurement accuracy. Statistical tests were performed to determine whether there were significant differences between the two systems.
2. Qualitative Analysis:
   The results of interviews and questionnaires were analyzed to evaluate customer experiences and the factors that influence their level of satisfaction.

Assessment Indicators

Some indicators used to compare the two systems include:

1. Accuracy of electricity usage measurement.
2. Efficiency of data recording and bill management.

The research stages can be seen from the following flowchart:

Page : 312-322
Doi. 10.54209/jurnalinstall.v16i06.353

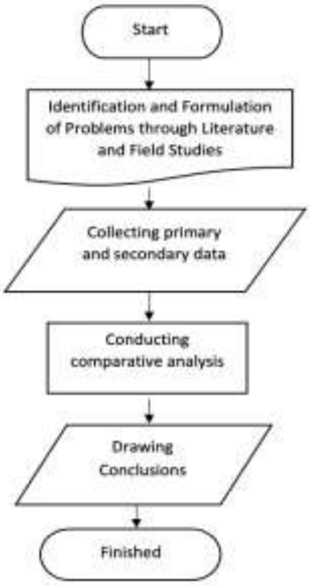

Figure 2. Research Flowchart

RESULTS AND DISCUSSION

From the research conducted, samples of customers using prepaid and postpaid electricity at the PT PLN Customer Service Unit (ULP) in Peureulak were obtained as in the following table:

Table 1. List of Prepaid Customers at the Customer Service Unit (ULP) PT PLN Peureulak

No	Customer ID	Name	Village
1	113330061244	Irwan Syarifuddin.SE	Alue Nibong
2	113330188382	Suryati Am. Kep	Alue Nibong
3	111750085696	Sulaiman A. Rani	Alue Nibong
4	111750082229	Syamrani Us	Alue Nibong
5	113330088679	Azim	Alue Nibong
6	111750112263	Aisha Abdullah	Alue Nibong
7	113330141003	Saifuddin	Alue Nibong
8	113330103409	Nurmala Ab	Alue Nibong
9	113330110468	Sharifah Usman	Alue Nibong
10	111750060003	Maswani.Hs	Kuala Bugak
11	111750115806	Aisha Ha	Uteun Dama
12	113330010325	Nilawati	Alue Nibong
13	113330137497	Pumping 4	Alue Nibong
14	111750102338	Ramli	Alue Nibong
15	113330054977	Marzuki	Alue Nibong
16	113330032430	Nuriyah Ibrahim	Alue Nibong
17	113330127464	Marzuki	Alue Nibong
18	113330129419	M. Daud Syamsyarif	Alue Nibong
19	113330185008	Zainabon	Alue Nibong
20	113330081553	Amiruddin	Alue Nibong

Table 2. List of Postpaid Customers at the Customer Service Unit (ULP) PT PLN Peureulak

No	Customer ID	Name	Village
1	113330089090	Safrizal	Alue Nibong
2	111750085696	Sulaiman A. Rani	Ule Tutue
3	111750164311	English	Dama Tutong
4	111750152348	Abdullah	Alue Nibong
5	111750088703	Hadith of Solomon	Alue Nibong
6	111750060003	Maswani.HS	Kuala Bugak
7	111750132969	Razali Amin	Alue Nibong
8	111750112263	Aisha Abdullah	Alue Nibong
9	111750149793	T Yusri	Alue Nibong
10	111750158044	Nazaruddin	Alue Nibong
11	111750144750	Abdullah Yusuf	Alue Nibong
12	111750118676	Ibn Hasan Zakaria	Alue Nibong
13	111750104480	Jailani Idris	Deep Loch
14	111750099109	Mustafa Abdullah	White sand
15	111750038732	Murtala	Deep Loch
16	111750131604	Abdullah Rasid	Deep Loch
17	111750004557	Tina Asmawati	Deep Loch
18	111750016325	Superman	L Health In
19	111750006091	Idris Amin	Deep Loch
20	111750006524	The Holy Spirit	Deep Loch

From the two tables above, one customer is taken as an example of calculation using prepaid and postpaid kWh meters. And the results can be seen in the following table:

Table 3. Measurement Results on Digital KWH Meter (Prepaid)

Customer ID	Voltage)	Current (Ampere)	Power Factor (Cosφ)	Power (Watts)
113330061244	220,741	0.936	0.85	285,316

From Table 3, we can find the error in the prepaid KWH meter using equations (1), (2) and (3) as follows:

$e = \times 100\% \frac{td - t}{t}$ (5) (9)

$td = \frac{n \times 3600 \times 1000}{P \times C}$ (5) (7)

$e = \times 100\% \frac{Pterukur - Psebenarnya}{Psebenarnya}$

From the experiment, the data taken were: n = 4, C = 1000 rev/kwh and t = 6.6 seconds, so to get the error, the actual time needed in kWh for n rotations is first sought, namely:

$td = \frac{n \times 3600 \times 1000}{P \times C}$

P = √3 x V x I x Cos Phi(10)
= √3 (220.741)(0.936)(0.85)
= 304,185 Watt

From this calculation, the error obtained is:

$e = \times 100\% \frac{Pterukur - Psebenarnya}{Psebenarnya}$

$e = \times 100\% \frac{285{,}316 - 304{,}185}{304{,}185}$

$e = \times 100\% = 6.2\% \frac{-18{,}869}{304{,}185}$

Meanwhile, if you use the time calibration method then:

Doi. 10.54209/jurnalinstall.v16i06.353

td $=\frac{4\times3600\times1000}{304.185\times1000}$
= 47.33

So the error is:

e= × 100%$\frac{td-t}{t}$

$e=\frac{47,33-6,6}{6.6}\times 100\% = 617.3\%$

Furthermore, errors in the Analog KWH meter (postpaid) are also calculated using equations (1), (2) and (3) with the following measurement table:

Table 4. Measurement Results on Analog KWH Meter (Postpaid)

Customer ID	Voltage)	Current (Ampere)	Power Factor (Cos)φ	Power (Watts)
111750132969	203,179	1,949	0.85	167,157

By taking the data: n = 4, C = 240 Rev/kwh and t = 6.6 seconds, the following calculation is obtained:

P = √3 x V x I x Cos Phi
= √3 (203.179)(1.949)(0.85)
= 583 Watt

So td $=\frac{4\times3600\times1000}{583\times240}$
= 103

So the error is:

e= × 100% = 71%$\frac{167,157-583}{583}$

Meanwhile, if you use the time calibration method, then

e= × 100%$\frac{td-t}{t}$

$e=\frac{103-6,6}{6.6}\times 100\% = 1.459\%$

Based on the KWH meter brand, it can be seen in the following table:

Table 5. Measurement Results on Prepaid KWH Meters with Various Brands

KWH Meter Brand	Voltage (V)	Current (A)	Power Factor (Cos)φ	Power (Watts)
A	240	2.5	0.85	900
B	230	2.6	0.85	905
C	220	2.5	0.85	898.5

From the experiment, the data taken were: n = 4, C = 900 rev/kwh and t = 6.6 seconds, so to get the error, the actual time needed in kWh for n rotations is first sought, namely:

1. Brand A

P = √3 x V x I x Cos Phi(10)
= √3 (240)(0.25)(0.85)
= 883.34 Watts

So the error is:

e= × 100%$\frac{900-883,34}{883.34}$
= 1.88%

2. Brand B

P = √3 x V x I x Cos Phi(10)
= √3 (230)(2.6)(0.85)
= 880.4 Watts

Doi. 10.54209/jurnalinstall.v16i06.353

So the error is:

$e = \times 100\% \frac{905-880,4}{880,4}$

$e = 2.79\%$

3. Brand C

P = √3 x V x I x Cos Phi(10)

= √3 (220)(2.5)(0.85)

= 809.73 Watts

So the error is:

$e = \times 100\% \frac{898,5-809,73}{809,73}$

$e = 10.96\%$

Table 6. Measurement Results on Postpaid KWH Meters with Various Brands

KWH Meter Brand	Voltage (V)	Current (A)	Power Factor (Cos)φ	Power (Watts)
A	204.3	2.1	0.85	700
B	203	1.8	0.85	700
C	203.4	1.94	0.85	620

1. Brand A

By taking the data: n = 4, C = 240 Rev/kwh and t = 6.6 seconds, the following calculation is obtained:

P = √3 x V x I x Cos Phi

= √3 (204.3)(2.1)(0.85)

= 631.63 Watts

So the error is:

$e = \times 100\% \frac{700-631,63}{631,63}$

$e = 10.82\%$

2. Brand B

P = √3 x V x I x Cos Phi

= √3 (203)(1.8)(0.85)

= 537.95 Watts

So the error is:

$e = \times 100\% \frac{700-537,95}{537,95}$

$e = 30.12\%$

3. Brand C

P = √3 x V x I x Cos Phi

= √3 (203.4)(1.94)(0.85)

= 580.94 Watts

So the error is:

$e = \times 100\% \frac{620-580,94}{580,94}$

$e = 6.72\%$

With the calculations and analysis above, we can see the difference in errors in each KWH meter used.

For more details, the results of the analysis above can be seen in the following table:

Doi. 10.54209/jurnalinstall.v16i06.353

Table 7. Comparison of Errors of KWh Meters of Various Brands

KWh Meter	Brand	Error (%)
Prepaid	A	1.88
	B	2.79
	C	10.96
Postpaid	A	10.82
	B	30.12
	C	6.72

CONCLUSION

From the analysis conducted using the power measurement method and the time calibration method, there is a significant difference in error. In the measurement using a prepaid KWH meter with the power measurement method, the error obtained was 6.2%. While with the time calibration method, the error obtained was 617.3%. Furthermore, for measurements using analog KWH meters (postpaid) with the power measurement method, an error of 71% was obtained. While with the time calibration method, the error obtained was 1,459%. Error analysis with various brands also shows that the error on prepaid KWH meters is smaller than the error on postpaid KWH meters. Errors in both types of KWH meters are influenced by the accuracy in calculating electrical power, which involves voltage, current, and power factor parameters. Analog KWH meters (postpaid) show a much higher error rate than digital KWH meters (prepaid), indicating differences in the accuracy of the technology used. This conclusion shows the importance of evaluating the measurement technology used to improve the accuracy of recording customer electricity consumption.

REFERENCES

[1] Ahmad, H., & Santoso, D. (2021). Efficiency and Performance of Solar Power Generation Systems in Tropical Regions. Journal of Renewable Energy, 12(3), 45-54

[2] Aryza, S, et al (2024) A ROBUST OPTIMIZATION TO DYNAMIC SUPPLIER DECISIONS AND SUPPLY ALLOCATION PROBLEMS IN THE MULTI-RETAIL INDUSTRY. *Eastern-European Journal of Enterprise Technologies*, (3).

[3] Aryza, S., Wibowo, P., & Saputra, D. (2022, July). Rancang Bangun Alat Pengontrolan Proses Pemanasan Produksi Biodisel Dari Minyak Jelantah Berbasis Arduino Mega. In *Prosiding Seminar Nasional Sosial, Humaniora, dan Teknologi* (pp. 121-127).

[4] Anisah, S., Fitri, R., Taro, Z., & Wijaya, R. F. (2022). Comparison of Lighting Efficiency (Led-CFL) based on Environmentally Friendly Technology. *Journal of Applied Engineering and Technological Science (JAETS)*, *4*(1), 568-577.

[5] Darma S. Study of kwh meter calibration system. 2019;4(3):158–65.

[6] Duffie, J. A., & Beckman, W. A. (2013). Solar Engineering of Thermal Processes (4th ed.). New York: John Wiley & Sons.

[7] Farid, A. (2020). Optimization of Solar Power Plant System for Household Applications. Journal of Electrical Engineering, 18(2), 99-107.

[8] International Renewable Energy Agency (IRENA). (2020). Renewable Energy Statistics 2020. Abu Dhabi: IRENA.

[9] Ministry of Energy and Mineral Resources (KESDM). (2023). Technical Guidelines for Solar Power Plant Installation. Jakarta: Directorate General of New, Renewable Energy and Energy Conservation.

[10] Rahman, MT, & Fitriani, N. (2019). Reliability Analysis of Solar Energy Systems in Rural Areas. Journal of Energy and Environment, 10(1), 65-72.

[11] Sukarno, D., & Nugroho, A. (2022). Utilization of Solar Energy in Tropical Regions: Case Study of Indonesia. Journal of Energy Technology, 15(4), 210-218.

Page : 312-322
Doi. 10.54209/jurnalinstall.v16i06.353

[12] Wenham, S. R., Green, M. A., Watt, M. E., & Corkish, R. (2011). Applied Photovoltaics (2nd ed.).
[13] Setiawan, A., et al. (2021). "Performance Analysis of Solar Power Plant Systems for Tropical Regions in Indonesia." Proceedings of the National Seminar on Renewable Energy, 10(2), 45-50.
[14] Sudrajat, A., & Suryadi, S. (2020). "Solar Panel Efficiency in Various Environmental Conditions." Journal of Energy Technology, 15(1), 23-31.
[15] Wahyu Ridwan, Zuraidah Tharo, Rahmaniar (2024). “Planning of Off-Grid Solar Power Plant in the Multipurpose Building of Sejahtera Islamic Boarding School”. JOURNAL OF ELECTRICAL AND SYSTEM CONTROL ENGINEERING, 8(1), 173–180.
[16] Z Tharo, H Hamdani (2020). “Cost Analysis of Household-Scale Solar Power Plants (PLTS). JESCE
[17] 17.Tharo Z et al. COMPARATIVE ANALYSIS OF PREPAID AND POSTPAID KWH METER PERFORMANCE. In: National Conference on Social and Engineering of Medan State Polytechnic 2021. 2021. p. 358–65.
[18] Tharo, Z., Syahputra, E., & Mulyadi, R. (2022). Analysis of Saving Electrical Load Costs With a Hybrid Source of PLN-PLTS 500 Wp. Journal of Applied Engineering and Technological Science (JAETS), 4(1), 235–243.