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STUDY OF RELIABILITY VOLTAGE PROTECTION SYSTEM KWN METER TURN AT PT PLN

Densyaf Dwipa[1], Adi Sastra P Tarigan[2], Hamdani[3]
Faculty of Science and Technology
Universitas PembangunanPancabudi Development University Medan

ABSTRACT

Postpaid and Prepaid kwh meters are a measuring tool for consumer power consumption, there is a thought that Prepaid kwh meters are more expensive than Postpaid kwh meters. This research is to compare between Postpaid kwh meters and Prepaid kwh meters by using varied loads with voltage drop treatment with voltages of 230 volts, 220 volts, 198 volts and 165 volts. So on the load of the induction motor, LHE and the load of LHE variations and incandescent lamps with source voltages of 230 volts, 220 volts, 198 volts and 165 volts, it can be said that the Prepaid KWH-meter has a better KWH rotation than the Postpaid KWH-meter. In varying loadings on the kwh meter rotation test, the prepaid rotation speed is longer than the postpaid rotation speed with a rotation difference of 0.53 hours or 32 minutes.
Keywords: Electrical energy, post-paid kwh meter, prepaid kwh meter, kwh meter rotation, electrical load.

1. INTRODUCTION.

Electricity plays a very important role in life. It can be said that electricity has become the main source of energy in every activity, both at home and in industry. PT. PLN (Persero) is the largest electricity service provider company in Indonesia. This company has contributed greatly in supplying electricity for the community.

PT. PLN (Persero) previously received postpaid electricity program services, namely using electrical energy first and then paying the following month. Every month PT. PLN(Persero) must record meters, calculate and issue accounts that must be paid by customers.

PLN carries out billing to customers sometimes there are customers who are late or do not pay, so that PLN will cut off electricity to customers if they are in arrears or late for a certain period of time (PLN, 2013).

To develop services to the community and reduce disconnections, the company is trying to innovate by issuing a prepaid electricity program or also known as Smart Electricity. The prepaid electricity program is where the community pays in advance to buy electrical energy that they will consume in the form of a deposit (TOKEN), then the community can measure and calculate their own electricity consumption every day.

Customers do not need to deal with meter loggers that record electricity consumption every month and do not need to queue to pay for electricity at the electricity payment counter.

However, the form of innovation offered by PT. PLN (Persero) is not as smooth as expected, because users are still reluctant to use a prepaid kWh meter because it is considered a bit expensive compared to postpaid. PLN in responding to customers who do not switch to prepaid can replace the new kWh meter as postpaid but use a digital system in recording electricity usage.

2. Basic theory

Postpaid Kwh Meters

Kwh meter is a tool used by PLN to calculate consumer power consumption. This tool is very common in society. The main parts of a kwh meter are voltage coils, current coils, aluminum discs, a permanent magnet whose job is to neutralize the aluminum disc from magnetic field induction and mechanical gear that records the number of rotations of the aluminum disc. This tool works using a magnetic field induction method where the magnetic field moves a disc made of aluminum. The rotation of the disc will move the digit counter as a display of the number of kwh.

Figure 2.1 Kwh Meter Postpaid.

Prepaid Kwh Meters

This prepaid kWh meter is designed using a new electric kWh meter. The payment system or electricity account filling is by using a chip card application. This application greatly facilitates the public and PLN in terms of the process of charging an effective electricity bill. Chip card is a type of payment instrument card that is increasingly popular along with advances in microelectronic technology and the increasing public demand for practical payment instruments. The presence of chip cards cannot be avoided where their use is getting wider both in volume and scope of application. One possible application of the chip card is as a means of paying for electricity consumption. Some of the benefits that can be obtained by the Building Manager from the use of pre-paid KWh meters include:

1. Get cash early before electricity is produced and used, so it can increase the company's liquidity.

2. Easier transaction control thereby reducing the possibility of unpaid bills and electricity theft. Marketing of prepaid electricity can also be left to third parties.
3. Reduction of overhead or costs needed to check electricity consumption to homes or other consumers. As for consumers, this system can also be beneficial, namely:
   a) Control of electricity use can be better, because payments made in advance can be used to limit consumption
   b) Improvement of the measurement system because the electronic devices used are electronic with higher accuracy and security
   c) Reduce billing errors caused by human error.

Figure 2.2 Kwh Meter Prepaid**Working Principle of Prepaid Kwh Meter**

Electricity from PLN, which will be supplied to households (the load), is first channeled through the MCB which functions as a current limiter as well as safety in the event of a short circuit. Then it is also flowed into the KWHmeter which functions to calculate the power used. This prepaid system continues to use the existing KWH meter with minor modifications to install sensors and system units. It aims to better utilize the existing KWH meter equipment. The following tools in the digital KWH meter system include: KWH meter, microcontroller, LCD, keypad, RTC, EEPROM, usbasp downloader. The block diagram of the digital KWH meter system can be seen in Figure 2.6 below.

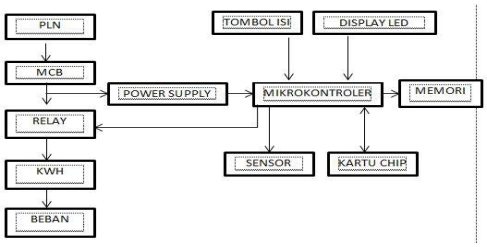

Figure 2.3 Block Diagram of Prepaid KWH Meter System

Prepaid KWH meters are included in static KWH meters that use electronic components as the main processor.

Electronic components detect instantaneous voltages and currents are processed to produce pulses that have a frequency proportional to the measured energy (KWH). This digital KWH meter has four main parts, namely:
1. Voltage and current sensor section
2. Processing part
3. Multiplier section
4. Display section

3. MethodStudy

Conducting tests on the effect of voltage variations on postpaid kwh and prepaid kwh on the number of kwh rotations using varying loads.

KWH Meter Data

Below is the specification data*Prepaid Kwh Meters*used in the test are as follows:

Table 3.1. Prepaid kWh meter specifications

Merek	Smart Meter
Tegangan (V)	230 volt
Kapasitas	5(60) A
Type	Smi-810
Putaran	1600 putaran 1 kWh

Below is the specification data*Postpaid Kwh Meters*used in the test are as follows:

Table 3.2. Specifications of postpaid kwh meters

Merek	Melcoinda
Tegangan (V)	230 volt
Kapasitas	5(25) A
Type	M2XS4V2
Putaran	1250 putaran 1 kWh

The test circuit from source to load is arranged as shown in the figure below:

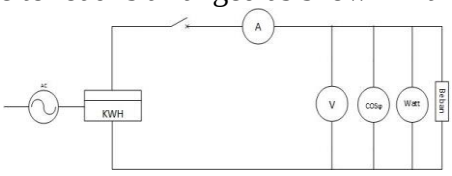

Figure 3.1 Load circuit kwh meter

The input voltage is given by the source using a voltage regulator and connected to the kwh meter, from the output of the kwh meter it is connected to the MCB (Miniature Circuit Breaker). The output of the MCB is serialized with the ampere meter (I) measuring instrument, then parallelized with the voltage, cos , watt meter, and load.

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4. Results and Discussion

Tests using an unloaded induction motor, energy-saving lamps and a combination of energy-saving lamps and incandescent lamps with a normal source voltage of 220 volts, the test data obtained are as follows.

Table 4.1. measurement results at a voltage of 220 volts

NO	Beban	Arus (A)	Tegangan (V)	Cos φ	Daya (Watt)	Kwh Prabayar Detik/putaran	Kwh Pascabayar Detik/putaran
1	Motor induksi	1.6	220	0.4 lag	198	11.22 detik	13.45 detik
2	LHE	0.25	220	0.98 lead	56	38.41 detik	41.43 detik
3	LHE dan Pijar	0.5	220	0.98lead	132	16.79 detik	20.13 detik

Calculation using manual:

$$tp = \frac{n.k}{3600}$$

Where:

tp = The amount of time for 1 (one) round kwh
N= The number of one rotation of the constant in seconds
t = total time in hours 3600
K = constant meter rotation / kwh. for Prepaid kwh meters 1600 inputs / kwh and for Postpaid kwh meters 1250 inputs / kwh

To find the value of the time difference, the following formula is obtained:

$$ts = t_{max} - t_{min}$$

where:

t_s = Total time difference
t_{max} = The largest number of time values
t_{min} = The smallest number of time values

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Calculation of the amount of time needed for 1 (one) Kwh Meter rotation using a 220 Volt source voltage with a load: 38

a. measurement of induction motor load

Kwh meter Prepaid
11.22 seconds x 1600 = 17,952 seconds
=299.8 minutes =4.98 hours

Kwh meter Postpaid
13.45 seconds x 1250 = 16,812 seconds

=280.2 minutes =4.67 hours

t maximum – t minimum= 299.8 – 280.2 = 19.6 minutes or 0.32 hours, so the total difference between the rotation time of the Postpaid kwh meter and the Prepaid kwh meter is 19 minutes or 0.32 hours

a. measurement of energy saving lamp (LHE) load
Kwh meter Prepaid
38.41 Seconds X 1600 =61,456 seconds
=1024.2 minutes =17.07 hours

Kwh meter Postpaid
41.43 seconds x 1250 = 51.787 seconds = 863.125 minutes = 14.38 hours
maximum t – minimum t= 1024,2 – 863,125 = 161 minutes or 2.68 hours, so the total difference between the rotation time of the Postpaid kwh meter and the Prepaid kwh meter is 161 minutes or 2.68 hours

b. measurement of the load of energy-saving lamps (LHE) and incandescent lamps with a source voltage of 220 volts
Kwh meter Prepaid16.79 Seconds x 1600 =26.864 seconds =447.7 minutes = 7.46 hours

Postpaid kWh meter20.13 seconds x 1250 = 25.162 seconds = 419.3 minutes = 6.98 hours

tmaximum – tminimum = 447.7 – 419.3 = 29 minutes or 0.48 hours, so the total difference between the rotation time of the Postpaid kwh meter and the Prepaid kwh meter is 29 minutes or 0.478 hours

To calculate the current and electric power based on the analysis can be calculated based on the load as follows:

a. Induction motor load

$$I=\frac{P}{V}$$

$$I = \frac{195}{220}$$

$$I = 0{,}9A$$

and the amount of electric power is:

$$P = I.V.cos\varphi$$

$$P = 0.8x220x\ 0.4$$

$$P = 78\ watt$$

b. Energy saving lamp load

$I = \frac{P}{V}$

$I = \frac{59}{220} = 0.26\ A$

The amount of electric power is:

$P = I.V.\cos$

$P = 0.26\ x220$x 0.98 leads

$P = 57.82\ watt$

c. Variation load of energy-saving lamps (LHE) and Incandescent lamps

$I = \frac{P}{V}$

$I = \frac{139}{220} = 0{,}63\ A$

The amount of electric power is:

$P = I.V.\cos$

$P = 0.63\ x220x0.98\ lead$

$P = 136.2\ watt$

Using Voltage 230 volts

Below are the results of testing and measuring the Prepaid kwh meter and Postpaid kwh meter using a source voltage of 230 volts at the load of induction motors, energy saving lamps (LHE), and incandescent lamps varying LHE are as follows;

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Table 4.2. measurement results at a voltage of 230 volts

NO	Beban	Arus (A)	Tegangan (V)	Cos φ	Daya (Watt)	Kwh Prabayar Detik/putaran	Kwh Pascabayar Detik/putaran
1	Motor induksi	1.7	230	0.4 lag	232	09.22 detik	11.40 detik
2	LHE	0.25	230	0.99 lead	58	37.94 detik	40.39 detik
3	LHE dan Pijar	0.5	230	0,98lead	138	16.02 detik	19.41 detik

a. measurement of induction motor load

Kwh meter Prepaid

09.43 seconds x 1600 = 15,088 seconds = 251.4 minutes = 4.19 hours

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Kwh meter Postpaid

11.40 seconds x 1250 = 14,250 seconds = 237.5 minutes = 3.95 hours

tmaximum – tminimum= 251.4 – 237.5 = 14 minutes or = 0.23 hours, so the total difference between the rotation time of the Postpaid kwh meter and the Prepaid kwh meter is 14 minutes or 0.23 hours

b. Measurement of energy saving lamp (LHE) load

Kwh meter Prepaid

37.94 seconds x 1600 =60.704 seconds =1.011 minutes= 16.86 hours

Kwh meter Postpaid

40.39 seconds x 1250 = 50,487 seconds = 841 minutes = 14.02 hours

tmaximum – tminimum= 1.011 – 841= 170 minutes or = 2.83 hours, so the total difference between the rotation time of the Postpaid kwh meter and the Prepaid kwh meter is 170 minutes or = 2.83 hours

c. Measurement of the load of Energy Saving Lamps (LHE) and Incandescent

Kwh meter Prepaid

16.02 seconds x 1600 = 25,632 seconds = 427.2 minutes = 7.12 hours

Kwh meter Postpaid

19.41 seconds x 1250 = 24,262 seconds = 404.3 minutes = 6.73 hours

tmaximum – tminimum= 427.2 – 404.3 = 24 minutes or = 0.4 hours, so the total difference between the rotation time of the Postpaid kwh meter and the Prepaid kwh meter is 24 minutes or 0.4 hours.

To calculate the current and electric power based on the analysis can be calculated based on the load as follows:

a. Induction motor load

$I = \frac{P}{V}$

$I = \frac{232}{230}$

$I = 1\,A$

And the amount of electric power is:

$P = I.V.\cos$

$P = 1x230x\ 0.4lag$

$P = 92{,}8\,watt$

b. Energy saving lamp load

$I = \frac{P}{V}$

$I = \frac{59}{220}$

$I = 0{,}25\,A$

The amount of electric power is:
$P = I.V.\cos$
$P = 0{,}25\ x230$ x 0.99 leads
$P = 58.41\ watt$

c. Variation load of energy-saving lamps (LHE) and Incandescent lamps
$I = \frac{P}{V}$
$I = \frac{139}{230}$
$I = 0{,}60\ A$
The amount of electric power is:
$P = I.V\cos$
$P = 0{,}60\ x230$ x 0.98 leads
$P = 136{,}22\ watt$

Based on the results of measurement tests on the three loads above with the use of a voltage of 230 volts and an induction motor load capacity ofpower 92.8 watts,energy saving lamp (LHE) with a power capacity of 59 watts. For the power of incandescent lamps and LHE lamps with a power capacity of 139 watts, from the observations obtained, the time required for 1 (one) rotation of the Postpaid kwh meter is faster than the time of the Prepaid kwh meter, and when the energy saving lamp (LHE) load is very much the difference in time for Postpaid kwh meter rotation with prepaid kwh meter is 170 minutes or 2.83 hours. For the induction motor load, 14 minutes or 0.23 hours and the load variation of incandescent lamps and energy-saving lamps (LHE) is only the difference in rotation time of 24 kwh or 0.4 hours.

Using Voltage 165 volts

Below are the results of testing and measuring the Prepaid kwh meter and Postpaid kwh meter using a source voltage of 165 volts at the load of induction motors, energy saving lamps (LHE), and incandescent lamps varying LHE are as follows:

Table 4.3 measurement results at a voltage of 165 volts

NO	Beban	Arus (A)	Tegangan (V)	Cos φ	Daya (Watt)	Kwh Prabayar Detik/putaran	Kwh Pascabayar Detik/putaran
1	Motor induksi	1.2	165	0.35 lag	74	29.13 detik	31.41 detik
2	LHE	0.25	165	0.98 lead	42	53.52 detik	59.13 detik
3	LHE dan Pijar	0.5	165	0.98lead	92	24.39 detik	29.71 detik

Kwh Meter Turn Calculation With 165 Volt Voltage

a. At a voltage of 165 votl measurement of the induction motor load
Kwh meter Prepaid

29.13 seconds x 1600 = 46,608 seconds = 776.8 minutes= 12.94 hours

Kwh meter Postpaid
31.41 seconds x 1250 = 39.262 seconds = 654.3 minutes = 10.90 hours

tmaximum – tminimum= 776.8 – 654.3 = 122 minutes or = 2.03 hours, so the faster rotation of the postpaid kwh meter is 122 minutes or 2.03 hours

b. At a voltage of 165 volts, the measurement of the energy-saving lamp load (LHE)
Kwh meter Prepaid
53.52 Seconds X 1600 = 85,632 seconds = 1,427,2 minutes = 23.78 hours

Kwh meter Postpaid
59.13 seconds x 1250 = 73.912 seconds = 1.231.8 minutes = 20.53 hours

tmaximum – tminimum= 1,427,2 – 1,231,8 = 196 minutes or 3.26 hours, so Postpaid kwh meter rotation is faster by 196 minutes or 3.26 hours

c. At a voltage of 165 volts the measurement of the load of Energy Saving Lamps (LHE) and Incandescent
Kwh meter Prepaid
24.39 Seconds X 1600 = 39.024 seconds = 650.4 minutes = 10.84 hours

Kwh meter Postpaid
29.71 seconds x 1250 = 37.137 seconds = 618.9 minutes = 10.31 hours
tmaximum – tminimum= 650.4 – 618.9 = 32 minutes or = 0.53 hours, so the postpaid kwh meter rotation is faster by 32 minutes or 0.53 hours

To calculate the current and electric power based on the analysis can be calculated based on the load as follows:

a. Induction motor load

$I = \frac{P}{V}$

$I = \frac{74}{165}$

$I = 0{,}44\ A$

And the amount of electric power is:

$P = I.V.\cos$

$P = 0{,}44x165x\ 0{,}35lag$

$P = 25{,}9\ watt$

b. Energy saving lamp load

$I = \frac{P}{V}$

$I = \frac{59}{165}$

$I = 0{,}35\ A$

The amount of electric power is:

$P = I.V.\cos$

$P = 0{,}35\ x165x0.98$ leads

$P = 57{,}82\ watt$

c. Variation load of energy-saving lamps (LHE) and Incandescent lamps

$I = \frac{P}{V}$

$I = \frac{139}{165}$

$I = 0{,}84\ A$

The amount of electric power is:

$P = I.V.\cos$

$P = 0{,}84\ x165x0.98$ leads

$P = 136{,}22\ watt$

Based on the results of measurement tests on the three loads above with the use of a voltage of 165 volts and an induction motor load capacity ofpower 25.9 watts,energy saving lamp (LHE) with a power capacity of 59 watts. for the power of incandescent lamps and LHE lamps with a power capacity of 139 watts, then from the observations obtained the time required for 1 (one) rotation of the Postpaid kwh meter is faster than the time of the Prepaid kwh meter and when the load of energy saving lamps (LHE) is very much the difference in time for The rotation of the postpaid kwh meter with the prepaid kwh meter is 196 minutes or 3.26 hours and the induction motor load is 122 minutes or 2.03 hours, for the load variation of incandescent lamps and energy-saving lamps (LHE) there is only a difference in rotation time of 32 kwh minutes or 0, 53 hours.

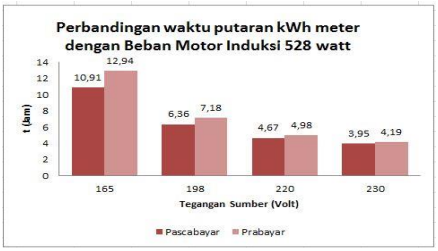

Figure 4.1 Comparison of prepaid and postpaid kwh rotation with induction motor load

The picture above shows the rotation of the postpaid kwh meter is slower than prepaid when using a 165 volt source voltage. However, at a normal source voltage of 220 volts, the rotation between postpaid and prepaid is not too far apart

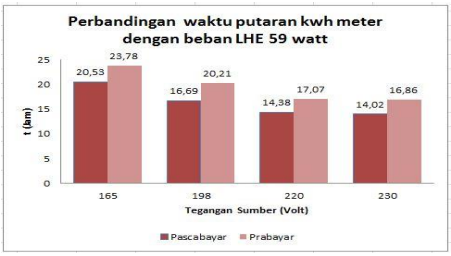

Figure 4.2 Comparison of prepaid and postpaid kwh meter rotation using LHE load

The graph above shows the rotation of the kwh meter with a voltage of 165 volts, there is a difference between postpaid and prepaid, while at normal voltage of 220 volts there is also a difference between the two.

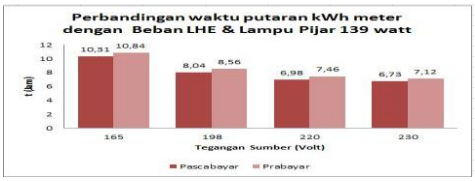

Figure 4.3 comparison of the number of rounds of postpaid and prepaid kwh meters using energy-saving lamps with incandescent lamps

5. CONCLUSION

Based on the results of research and measurements that have been carried out, the effect of voltage variations on Prepaid and Postpaid KWH meters on the number of KWH rotations can be concluded that:

1. When the induction motor, LHE load and Variation LHE and incandescent lamps load with source voltages of 230volt, 220volt, 198 volt and 165 volt, it can be said that the Prepaid KWH-meter has better KWH rotation than the Postpaid KWH-meter.
2. Loads that vary in the kwh meter rotation test, the prepaid rotation speed is longer than the postpaid rotation speed with a rotation difference of 0.53 hours or 32 minutes
3. From the results of the study, there is a very significant difference between the rotation of the kwh meter with a voltage of 198 Volt and the LHE load for 3.53 hours or 212 minutes between prepaid and postpaid, so prepaid is better than postpaid.

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