An Improving Electricity Wiring Safety Based Ecu-Design For Energy Consumption Monitoring Apartments In Medan

Erichand Ricahardo Sagala[1], Solly Aryza[2], Hamdani[3]
[1,2,3]Faculty of Science and Technology, Electrical Engineering Study Program,
Panca Budi Development University, Medan, North Sumatra, Indonesia
Email: erichansagala@gmail.com

Abstract

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In this era of information households, electrical energy consumption is divided into two, namely the low economy class which consumes the most electricity, around 20.00%, and the upper-middle economic class which consumes the most electricity. about 20.00 to 32.00% ac. Vertical living is widespread in the middle economy class, with occupancy increasing by 9.52% in 2017. In this situation, an analysis of energy consumption and savings is required. The problem of the simple rental apartment case in Medan Asia Mega Mas Indonesia is a clear example of the need for an energy monitoring system. this is due to the use of electricity that is not by the function of the apartment, such as air conditioning and washing machines. Energy meter systems measure the voltage and current of electrical equipment connected to the system. the voltage sensor used is zmpt101b5 and the current sensor used is acs712. The design of this energy meter system can measure the voltage and current of electrical equipment with an error rate of 4.40%. according to the measurement results, the air conditioning system is the most power-consuming resource in the 800kwh range.

Keywords: Building, Apartment Asia Mega Mas, Monitoring, Electrical Safety

1. Introduction

Building energy consumption data is divided into two categories: commercial building operations and residential (residential) building energy consumption. The energy consumption of various buildings and structures varies greatly depending on the type of building and climatic and environmental conditions(Indrianti, 2019). The consumption of electrical energy in the household sector can be divided into two parts(Lubis et al., 2015).

The first is low-economy households. The lighting system has the highest power consumption in its class, about 20.00%. Second, the middle to upper economy class with energy consumption of around 20.00% to 32.00% is used to cool the room with an air conditioning system(Ngafifi & Ngafifi, 2020). In commercial buildings, most of the electrical energy is used for the cooling system (cold).

This is 14.00%. In other systems, electricity consumption is 11.20% for ventilation systems, 10.60% for air conditioning and lighting systems, and 10.60% for total energy consumption in buildings. (Djaenudin et al., 2002).

In 2017, the occupancy rate of vertical residential types which are often called apartments in Medan increased by 9.52%. This is due to the limited land available for housing and residential areas. Rising land prices, especially in the cities of Medan, have shifted housing from country houses or single-family homes, or houses with courtyards, to apartments, one-story buildings with many residential units. (Bachtiar, 2006).

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An apartment residence is generally a relatively expensive residence because of its various facilities. Asia Mega mas cheap apartments do not all have many facilities, including lifts, so they are usually 5-7 floors high. Most of the cheap apartments whose prices are affordable by the middle to lower economic class are rental apartments, and sometimes they are called economical apartments(Waterfront & Centre, 2017).

The economy apartment is a government program that helps low-income people to get decent housing at affordable prices. The problem that arises in the implementation of economic apartments is the living culture of the residents who still inherit the old customs of single-family homes(Aryza et al., 2018).

House units with a limited area are usually filled with household items. The shape of the building, the layout of the residential units, and the density of occupancy limit the utilization of environmental potential such as natural ventilation through windows(Badriah et al., 2019).

Residents are advised to install air conditioning because it has an impact on not achieving livable comfort. On the other hand, the government imposes various restrictions on rental rights, such as the rental period, the type of electrical equipment to be installed, and physical changes to the rental space(Abrori, 2017). The types of electrical appliances used daily vary greatly from household to household, and managers often do not know how to use them(Butar, 2016).

At Economy Apartment, Medan, Indonesia, several cases of violations were found by residents of economical apartments in connection with the installation of high-level electrical equipment such as air conditioners and washing machines. This result is one of the energy audit data that shows the importance of developing an energy consumption monitoring tool for homes(Aryza et al., 2018)The frequent use of electrical energy, contrary to the lease agreement, increases the total electrical energy consumption of the apartment and is detrimental to building management. Violations of this rental agreement are generally caused by residents who have lived in the apartment longer than the previously agreed rental period (up to 5 years). According to a 2017 survey, around 48.00% of the population lived in apartments between 5 and 8 years, beyond the 3-year period that came into effect in 2018.

Economical apartment management can determine the total amount of energy consumed by a building each month from the monthly electricity price and electricity meter measurements issued by PLN and other power companies. The problem is, that the total electrical energy consumption of a building is determined not only by its electrical equipment but also by the behavior of its occupants. Another disadvantage of using traditional electricity meters is that they do not provide detailed profiles of energy consumption such as lighting, cooling, and operating load. However, currently, there are several apartments with separate electricity meters for each unit, making it easier to identify apartment units that violate wasteful behavior in installing equipment or using electrical energy. The results of the apartment energy audit which is the subject of this article indicate that the available data is limited to the total electrical energy of each building. These are also called blocks. Since each block consists of several residential units, you can see the average power consumption per unit per block/building. The illustration of this issue underscores the importance of having a more detailed way of reporting energy use so that energy use is handled with care.

Changes in the energy consumption reporting system are expected to influence consumer behavior. Currently, many energy consumption monitors can monitor consumption at a certain time interval of 1 hour in place of the conventional recording method.

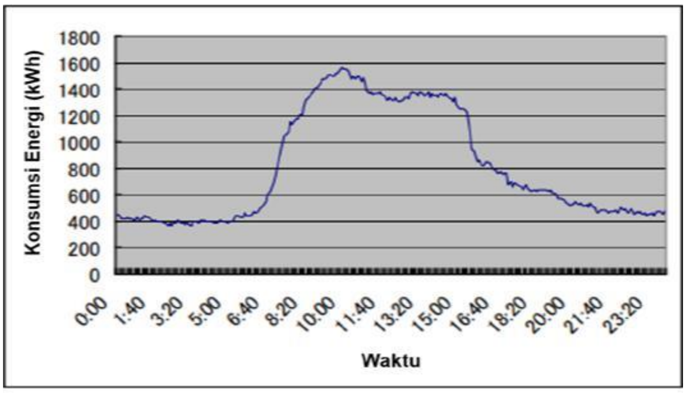


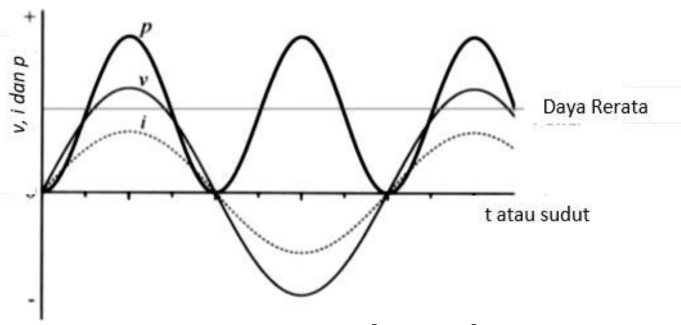
Figure 1.Daily load curve analysis

This paper will help you get real-time, ongoing, and detailed equipment and time data about your apartment's power consumption. The results of this paper will help residents change the use of inefficient electrical energy. Monitoring devices that can record consumption in a sustainable manner generate creative ideas to save and control these efficiency efforts, both in residential and building management.

2. Method

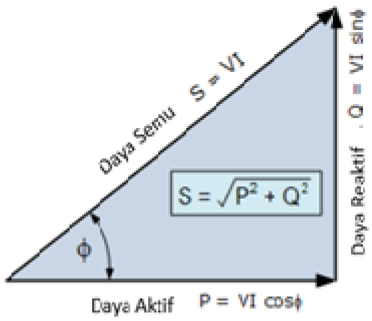
Most buildings in Indonesia usually monitor power consumption through an analog or digital kWh meter, which is recorded once a month. In skyscrapers, kWh meters are usually divided by floor to measure total power consumption. Individual kWh meters are rarely available for every building system. For example, the power consumption of the lighting network is monitored separately from the power consumption of the air conditioning system. In the case of Russia, supervision needs to be more accurately separated not only by floors but also by housing units. The main function of the energy monitoring system is to determine the efficiency of energy consumption in a building [8].

A survey was conducted to show household expenditure per day [9]. As shown in Figure 1, high consumption is from 10:30 to 15:30 [9]. The voltage and current of an AC-equipped electrical system are usually expressed as the square root of the mean (RMS). RMS is also known as the mean square. It is a statistical measure of the size of a function of various sizes. Changes in voltage and current can be calculated sinusoidally according to (1) [10]. is the amplitude of the sampled signal up to, the effective voltage or in RMS. (1)



Figures 2.AC current, voltage and power wave

Electrical power is defined as the rate at which electrical energy is delivered in an electric circuit. Electrical power is divided into three, namely active power, reactive power, and apparent power.

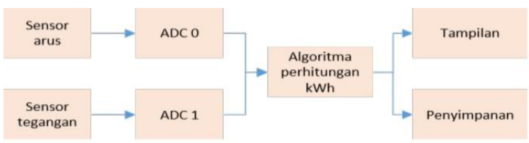


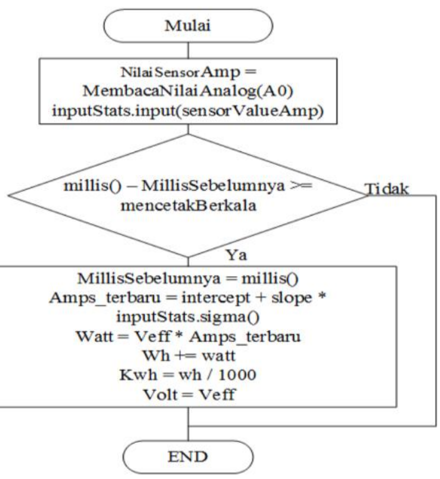
Figures 3.Power triangle relationship.

Figure 3 shows the relationship between active power and active power. Each energy meter usually has active and reactive power measurements. If you can read the actual power and reactive power information with an energy meter, you can find out the apparent power value. However, if you want to know the effective AC power, you need information about the power factor value. The power factor is not a direct measure of the output-to-input efficiency, but the power factor is a real measure of how the capacity of the power system is used. Power factor is defined as the ratio of active power in kW to actual power in kVA (apparent power). The accuracy of electrical measuring instruments that meet IEC No. standard. 13B23 is classified into eight classes, namely 0.05. 0.1; 0.2; 0.5; 1; 1.5; 2.5; 5. The respective grades are ±0.05%, ±0.10%, ±0.20%, ±0.50, ±1.00%, ±1.50%, ± 2, 50%, and ± 5.00 % Measurement Indicates the size of the device error. Of the eight classes, measuring instruments are divided into four groups according to their application areas, as follows:

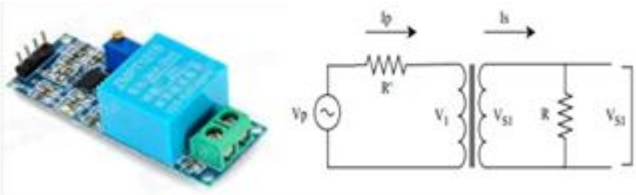
1. The class of 0.05, 0.10 and 0.20 includes the highest precision measuring instruments, which are commonly used in standard laboratories.
2. The class of 0.50 has an accuracy and subsequent level of precision of 0.20. This measuring instrument is commonly used in precision measurements. This measuring tool is usually portable.
3. Groups from class 1.5, 2.5, and 5. This measuring instrument is commonly used on panels that do not pay much attention to precision and accuracy.

In the designed system, 4. The system consists of two sensor units, one processor unit, one display unit, and one storage media unit. The energy measuring device builds on the current and voltage values measured by the sensor using the average power consumption. The sensors used in this system are ZMPT101B5 and ACS712.





Figures 4. System workflow



Figures 5.Voltage Sensor.

The ZMPT101B5 sensor has high accuracy, excellent resistance to voltage and power measurements, and can measure AC voltages up to 250V [13]. The sensor is read by the processor via the Analog to Digital Converter (ADC) block. The conversion principle uses the ZMPT101B voltage sensor. The current becomes using a simple transformer principle, as shown in Figure 5.

3. Result And Discussion

Hardware testing is carried out by measuring the operating voltage and current parameters of the microcontroller device, as instructed on the data sheet for each component. The obstacle in making measurements is the intrinsic value of the measurement results. This is because all measurements using measuring instruments only provide approximate values. Therefore, when designing a measuring instrument, there must be a comparison value obtained from the calculation results or the measurement results on a measuring instrument with a recognized function. The comparison value is used to determine the magnitude of the measurement error and to predict the accuracy of the measuring instrument produced.

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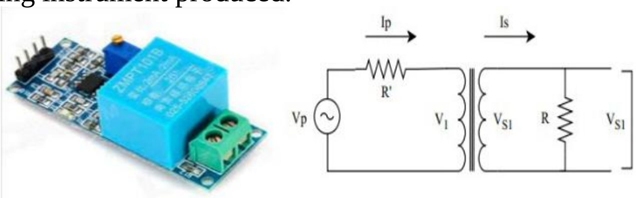


Table 1.Voltage Calibration Results

Measurement	**Multimeter (Volt)**	**Energy Meter (Volt)**	**Difference (Volt)**	***Error* (%)**
1	132.00	150.83	18.83	14.30
2	144.20	140.95	3.25	2.30
3	154.70	167.30	12.60	8.10
4	166.60	167.30	0.70	0.40
5	177.70	170,60	7,10	4.00
6	188.00	182.13	5.87	3.10

7	201,20	196.00	5.20	2.60
8	211.80	210.13	1.67	0.80
9	220.70	218.36	2.34	1.10
10	226.80	216.77	10.03	4.40
11	233.30	224.95	8.35	3.60
12	240,50	223.30	17,20	7.20
13	248.00	238.13	9.87	4.00
14	252.00	238.13	13.87	5.50
	Average			**4.40**

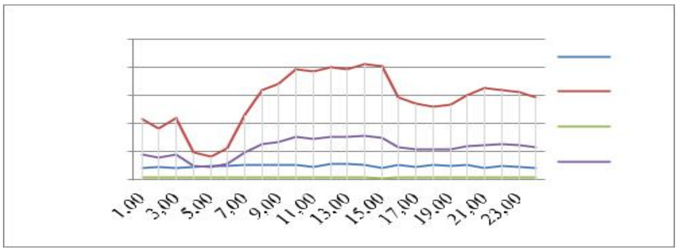
Figures 6.The results of the design of the energy meter system.

The results of the built system are shown in Figures 9 and 10. This system is implemented in Rusnawa units. The results of the monitoring of the energy meter system are used to determine the energy consumption of each electrical device in the unit, as shown in the figure. 11. The maximum consumption of 4,444 electrical energy in Figure 11 is AC, with peaks occurring between 10:00 and 15:00 WIB. This is because the outside temperature at the measurement site was 35°C at the time of measurement, and the living room was hot. The electric energy consumption of the refrigerator is relatively small compared to the air conditioning system, and does not fluctuate because it is always on.

From the measurement results, it can be seen that the energy meter system can predict the transition of energy consumption and maximum consumption over a certain period of time. The initial survey data can be used as considerations and recommendations for improving the performance of the energy meter system in terms of software and hardware. The next research subject is to design an energy meter system that is able to produce class errors of 0.05, 0.1, and 0.2, so that it is included in the measurement system that has the highest precision commonly used in certified laboratories.

Tables 2. Measurement Results using

1	09.05.18	12:42:32	0	0	0	0
2	09.05.18	12:42:33	0,06	215,07	12,28	0
3	09.05.18	12:42:34	0,07	213,42	14,54	0
4	09.05.18	12:42:35	0,06	211,77	11,67	0
5	09.05.18	12:42:36	0,05	198,6	10,43	0
6	09.05.18	12:42:37	0,05	211,77	11,56	0
7	09.05.18	12:42:38	0,07	206,83	14,22	0
8	09.05.18	12:42:39	0,07	203,54	13,48	0
9	09.05.18	12:42:49	0	0	0	0
10	09.05.18	12:42:50	0,05	195,3	10,61	0
11	09.05.18	12:42:51	0,04	198,6	8,56	0
12	09.05.18	12:42:58	0	0	0	0
13	09.05.18	12:42:59	0,04	198,6	7,59	0
14	09.05.18	12:43:00	0,04	198,6	8,09	0
15	09.05.18	12:43:01	0,04	193,66	7,48	0
16	09.05.18	12:43:02	0,04	198,6	7,95	0
17	09.05.18	12:43:03	0,04	195,3	8,35	0
18	09.05.18	12:43:04	0,05	200,24	9,2	0
19	09.05.18	12:43:05	0,05	200,24	10,88	0
20	09.05.18	12:43:06	0,04	192,01	8,02	0
21	09.05.18	12:43:07	0,06	198,6	11,44	0
22	09.05.18	12:43:08	0,04	193,66	6,89	0
23	09.05.18	12:43:09	0,06	193,66	11,3	0



Figures 7.Energy Consumption Results

4. Conclusion

The design of the electrical energy consumption measuring system, the energy meter, has been successfully compiled with an error rate of 4.40%. Based on the measurement results on the economy apartment unit, the largest consumption of electrical energy is generated by the air conditioning unit, with a value range of 800 kWh. This research is still in the early stages of a building energy consumption monitoring system, the output of which is still separate monitoring units that are not yet connected to a building system network. This research can be developed by adding features such as online monitoring at a lower cost and strengthening the sensor calibration method.

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