BirEx JOURNAL
Budapest International Research in Exact Sciences
Medical, Biological, Argiculture, Engineering
Science and other related areas
e-ISSN : 2655-7827
p-ISSN : 2655-7835
http://www.bircu-journal.com/index.php/birex

Prototype Measuring Device for Electric Load in Households Using the Pzem-004T Sensor

Partaonan Harahap[1], Faisal Irsan Pasaribu[2], Muhammad Adam[3]
[1,2,3]*Faculty of Engineering, Universitas Muhammadiyah Sumatera Utara, Indonesia*
partaonanharahap@umsu.ac.id

Abstract: *Electrical energy has become a basic need for all people in the world, alternative energy as described above can be applied to households that are supplied by two energy sources namely energy sources from solar panels and PLN need to be accompanied by a system of regulating the supply of electric load power (control systems), so that the change of electrical energy supply to the load can work automatically. Along with the continued increase in the Basic Electricity Tariff (TDL) it is necessary to design a measurement of the use of electrical loads in households using the Pzem-004T Sensor to determine the amount of power from an electrical load and can be monitored from a certain distance. From the results of tests and measurements with various household loadings for 0 days, a very significant comparison from the previous TDL of Rp. 159,000.00, - and* after using the Pzem-004T Sensor, the result of the TDL tariff calculation is Rp. 109,308.

Keywords: *arduino; sensor PZEM-004T; KWH meter*

I. Introduction

Electrical energy has become a basic need for all people in the world. Fossil energy which has been used as a fuel is running low and expensive so PLN has difficulty in providing it and resulting in power outages. Alternative energy as described above can be applied to households. Households that are supplied by two energy sources, namely energy sources from solar panels and PLN, need to be accompanied by a regulator of the electrical load power supply system (control system), so that the switching of electrical energy supply to the load can work automatically.

Logic control program (PLC) when the energy source from the solar panel is sufficient to be supplied to the load, the condition of the solar panel switch will be ON and when the energy produced is unable to be supplied to the household load, the solar panel switch will be OFF. While the source from PLN will be used as long as there is no blackout (PLN ON), if there is a blackout then the energy supply from PLN will be OFF (PLN OFF). Factors that encourage the implementation of this research is the condition of electricity with two energy sources requires a more effective way to supply energy to the electricity load, then regulating the supply of smart home electricity can be a solution to improve household electrical reliability in terms of continuity of supply of electric power and can avoid dependence on PLN sources.

So that human operators are always needed in charge of recording data by visiting the location where the device is installed. From the measurement results, the tool shows how much electricity is used within a certain period so that the electricity officer can find out the amount of electricity that will be processed to find out how much the cost must be incurred by the customer. KWH meter is needed in the industrial world which uses a lot of tools to support production activities. In addition, KWH meters are also needed in Flats which are very effective when installed in each room, because thus both the owner or the occupants can directly control electricity usage in each month. So that it will make it easier to provide electricity tariffs to be paid to managers and to PLN later.

DOI: https://doi.org/10.33258/birex.v2i3.1074

Along with the continued increase in the Basic Electricity Tariff (TDL), the use of electricity must be given more attention to avoid electricity cost overruns, in addition to checking time efficiency also needs to be done so that work is faster and easier. From some of the problems above, it is necessary to design a tool to measure the use of electrical loads in households using the Pzem-004t Sensor from a Solar Power Plant (PLTS), to determine the amount of power from an electrical load and can be monitored from a certain distance. In this study aims to determine the work of the Electricity Load Measuring Tool in Households used PZEM-004T sensor and can integrate between arduino uno, PZEM-004T sensor and LCD as a useful measurement tool that can save electricity consumption.

The use of microcontrollers made using ultrasonic sensors to detect the direction of movement of users so that the trolley can follow the user and control the distance so that speed and movement can be controlled. The controller used is the Arduino Uno microcontroller board such as the prototype of an automatic trolley that follows human movements is a robot that functions as a trolley to carry groceries that follow humans automatically, without the need to be pushed or pulled, so that this movement can make it easier for humans to shop. The trolley prototype has the ability to detect the whereabouts of the user and follow the direction of the user's movements.

Solar power generation (PLTS) is the development of solar energy technology that is affordable, not exhausted, and clean will provide great long-term benefits, at this time many are utilizing solar panels as independent electricity generation without having to depend entirely on PLN, every year the needs electricity in the world will experience growth. Utilization of solar energy as electricity generation has been widely carried out using solar panels. Solar panels installed so far are still static (do not follow the movement of the sun), Under these conditions, the solar panel cannot capture light optimally. Limitations on the static solar panel can be overcome by testing with a Solar Panel with Dynamic Rotation (can follow direction of movement of the sun). Acquisition of current and voltage on solar panels is more effective, namely by obtaining the average value of the resulting output power of 34.93 W. [4]. Research on the design of electrical energy control devices using ATmega 328P microcontroller. The tool was made aiming to control the use of electrical energy at home by using a system password administrator and SMS administrator. The device is equipped with GSM SIM 900 Module as a provider of information and remote control of the device. The equipment system can work well because of the support of several electronic components such as the 328P ATmega microcontroller which has been packaged with a minimum Arduino UNO system, current sensor, voltage sensor, GSM SIM900 module, relay, Liquid Crystal Display (LCD), and keypad. Tool testing is divided into two stages, namely, testing each sensor and testing the overall tool. Current and voltage sensors are compared to multi function meters. The percentage of error current sensor is 1.27% and the voltage sensor is 2.05%. Overall tool testing is carried out by giving a constant load. The constant load used is 6 lamps with a total power of 660 watts. The test results are compared with theoretical energy calculations with a percentage error of 3.44%. Overall the system designed can work well.

Arduino is an open source single-board micro controller, derived from the Wiring platform, designed to facilitate the use of electronics in various fields. The hardware has an AtmelAVR processor and the software has its own programming language. Arduino is also an open hardware aimed at anyone who wants to make a variety of interactive electronic equipment based on hardware and software that is flexible and easy to use. Microcontrollers are programmed using the arduino programming language which has syntax similarities to programming language C. For flexibility, the program is loaded through the bootloader even though there is an option to bypass the bootloader and use the downloader to program the microcontroller directly through the ISP port.

II. Review of Literatures

2.1 Hardware Section

In the form of a board containing I / O, like Figure 1

Figure 1. *Arduino Board*

Arduino has 14 input / output pins of which 6 pins can be used as PWM (Pulse Width Modulation) outputs, 6 analog inputs, 16 MHz crystal oscillators, USB connections, power jacks, ICSP heads, and reset buttons. Arduino is able to support a microcontroller, it can be connected to a computer using a USB cable.

2.2 PZEM-004T sensor

The PZEM-004T module is a multifunctional sensor module that functions to measure power, voltage, current and energy contained in an electric current. This module is equipped with an integrated voltage and current sensor (CT) sensor. In its use, this tool is specifically for indoor use (indoor) and the installed load is not allowed to exceed the specified power.

Figure 2. *Sensor PZEM-004T*

1. Measurement function (voltage / current, current / active power).
2. Power button clear / reset energy (PZEM-004T V2.0)
3. Power-down data storage function (cumulative power down before saving)
4. TTL Serial Communication
5. Power measurement: 0 ~ 9999kW
6. Voltage Measurement: 80 ~ 260VAC
7. Current Measurement: 0 ~ 100A
8. Working voltage of 5 VDC.
9. Equipped with operational amplifier to increase external sensitivity.

The circuit that converts AC current into DC is called a DC Power Supply or in Indonesian is called a DC power supply. DC Power Supply or Power Supply is also often known as an Adapter.

2.3 How LCD works

In general applications RW is given a low logic "0". The data bus consists of 4 bits or 8 bits. If the 4-bit data path is used DB4 to DB7. As seen in the description table, the LCD interface is a parallel bus, in this case very easy and very fast in reading and writing data from or to the LCD. The ASCII code that is displayed as long as 8bit is sent to the LCD 4bit or 8bit at a time. If 4bit mode is used, then 2 nibble data is sent to make it fully 8bit (first sent is 4bit MSB then 4bit LSB with EN clock pulses per nibblenya). The EN control line is used to tell the LCD that the microcontroller is sending data to the LCD. To send data to the LCD the program must set EN to high condition "1" and then set two other control lines (RS and R / W) or also send data to the data bus path. When the other line is ready, EN must be set to "0" and wait a few moments, and set EN back to high "1". When the RS line is in a low "0" condition, the data sent to the LCD is considered as a special command or instruction (such as cleaning the screen, cursor position, etc.). When RS is high or "1", the data sent is ASCII data that will be displayed on the screen. For example, to display the letter "A" on the screen, the RS must be set to "1". The R / W control line must be in the low (0) state when information on the data bus will be written to the LCD. If the R / W is in a high condition of "1", the program will query the data from the LCD. The reading instructions are only one, namely Get LCD status, the other is the writing instruction, so almost every application that uses the LCD, the R / W is always set to "0". Data paths can consist of 4 or 8 paths. Sending data in parallel either 4bit or 8bit are 2 primary operating modes. To create an LCD interface application, determining the operation mode is the most important thing.

2.4 KWH meter

Kilo Watt Hour Meter (KWH Meter) is a measure of electrical energy that utilizes a current coil to sense current and a voltage coil to sense the electrical voltage to be induced on a disk so that it rotates over time showing the value of electrical energy that is monitored. The process of sampling data through a disk system does not display the value of the electric power factor (Cos phi) so that in reality it sometimes does not match the actual measurement results. This is very detrimental to customers when the energy consumed by those paid to electricity service providers is different. Along with the development of technology, many methods of sensing current and voltage and power factor were developed. Security systems that are still insulated from power grids are the reason for this development. In addition, data retrieval space that takes too long causes the level of accuracy of the data to decline even after using a digital data retrieval system using Analog to Digital Converter (ADC). The use of two microcontrollers with one viewer system and one for data processing makes another waste. The power factor measured was not as expected before.

The ease of processing digital data is another reason for using this microcontroller so that the resulting data is expected to be more accurate than analog system data. ADC resolution really determines the value of this data processing and has been available in an integrated circuit (IC) package from various companies including ATMEL Corporation which has ATMEGA 16. This product has a RISC system in the AVR product family that will further increase data processing speed compared to the system formerly CISC..

III. Research Methods

The method used in this study is starting from collecting data, tool design and tool manufacturing, and analyzing. Measurements are made to obtain the output voltage and current that occur on the equipment. The stages carried out in this research are in the form of literature studies, tool design and tool making, results and data analysis.

3.1 Needs Analysis

a. Hardware Design

In making measuring devices using 1300 watts of electricity to determine the cost of using electricity in a boarding room, hardware and software are needed, among others. The hardware design using the block diagram of the system designed is as shown in Figure 3

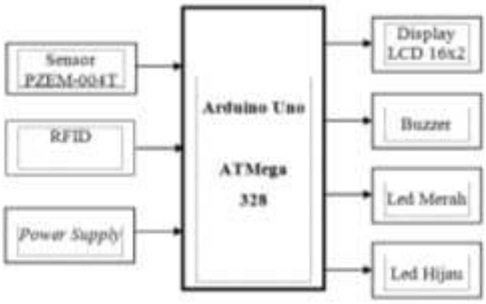

Figure 3. *Tool System Block Diagram*

The explanation and function of each block is as follows.

1. The ATMega 328 Microcontroller IC functions as the control center of the entire circuit work system.
2. Current sensor used is the type PZEM-004T which functions to read current, voltage and frequency data.
3. RFID functions to change the KWH value to zero.
4. The display used is LCD (Liquid Crystal Display) with a size of 20x4 characters to display sensor input data and other writing information.
5. A red LED is an indicator if the usage value is more than Rp. 5,000.
6. Green LED as a mark of usage value less than less than 5,000.
7. Buzer functions as a marker if the cost of electricity usage is more than Rp. 5,000.
8. Power Supply used in the form of a 12-5 Volt DC 1 Ampere adapter as an energy source or voltage of all electronic circuits that have been made to work according to the design.

b. Software

Software used in making this tool include:

1. Proteus 8.1
2. This software is used to draw a series schematic.
3. Arduino IDE 1.6.5
4. This software is used for writing programs.
5. Ms. Office Visio
6. This software is used to draw the flowchart of the tool to be made.

c. Hardware Design

In this hardware design will be explained how the schematic series of each block that has been described previously. The hardware design parts include:

d. Arduino Uno ATMega328 Minimum I / O System Design

The minimum Arduino Uno system has 14 digital I / O pins, 6 analog I / O pins and 1 pin RX, TX. These pins can be used as input from the PZEM-004T sensor, 20x4 character LCD, buzzer and output to the buzzer and LED for the indicator or indicator. In Figure 4. there are paths connecting each I / O pin to the microcontroller or feature path the other is the minimum arduino uno system.

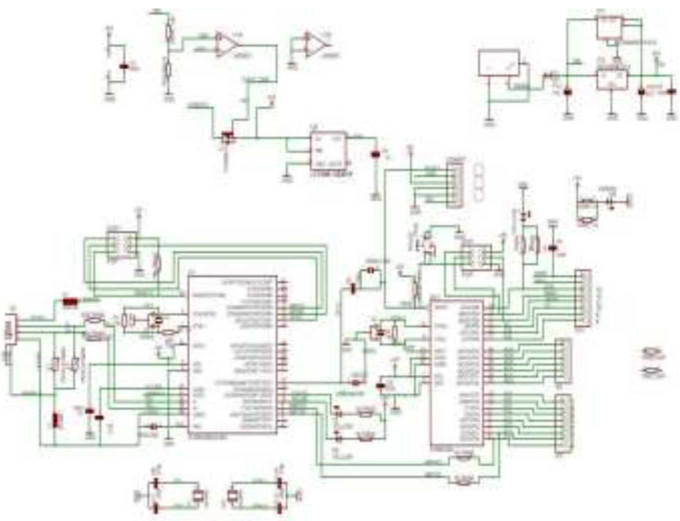

Figure 4. *Schematic Arduino Circuits*

This overall sequence consists of Arduino, LCD, PZEM-004T sensor, LED, RFID and buzzer, assembled to measure 1300 watts of electricity consumption

3.4 Overall Sequence

The overall set of tools designed as shown in Figure 5.

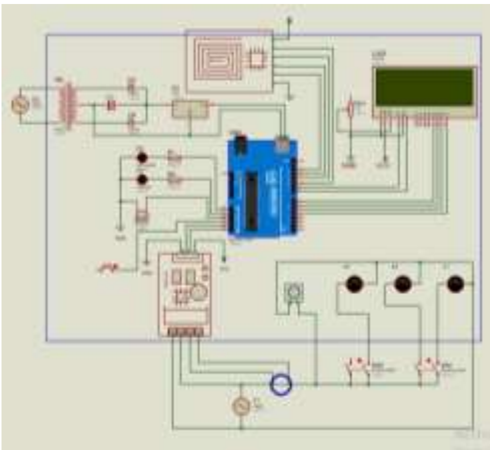

Figure 5 *Overall Series*

This overall sequence consists of Arduino, LCD, PZEM-004T sensor, LED, RFID, buzzer, 5 volt power supply, series switch, incandescent lamp and socket. Arranged as a measuring tool for 1300 watt electricity consumption. The work of the circuit above is Input / Output Initialization, this is intended whether the device is correctly installed correctly in accordance with the schematic circuit, Read the sensor PZEM-004T, display the sensor value on the LCD, read the sensor readings, where the sensor reads will be inputted to LCD, Conversion of the number of KWH to Rupiah, where this process changes the value of KWH into Rupiah using the correct calculation. If the KWH usage is more than Rp. 5,000, if the command is fulfilled then the red LED lights up and the buzzer is active, if not the green LED is active.

IV. Discussion

In testing and analysis based on the planning of the tools made. The testing program is simulated in a suitable system. This test is carried out to determine the reliability of the tool and to find out whether it is in accordance with the plan or not. Testing is first done separately, and testing and analysis as a whole.

The testing is done.

1. Arduino uno testing with LCD.
2. Testing the PZEM-004T sensor with LCD.
3. Testing the loading of the PZEM-004T sensor with LCD.
4. Testing the LED with buzzer.
5. Testing with incandescent lamps.
6. Testing loading with incandescent lamp load.
7. Analysis and measurement of fan and 26 wat lamps.
8. Analysis and measurement of the fan, and 26 watt lamps.
9. Analysis of results and measurements using a fan, rice cooker, 26 watt lamps and an iron.
10. Analysis of results and measurements in the room

4.1 Testing Arduino Uno with LCD

The LCD circuit in this study serves to display information in the form of text and data from the PZEM-004T sensor data and the voltage that is read by Arduino.

The equipment needed to carry out this test is.

1. Arduino uno.
2. Arduino Uno data cable.
3. 20 x 4 LCD circuit.
4. Arduino IDE Software.

Steps for testing the LCD circuit.

1. Open the Arduino IDE application
2. Next will appear the initial screen "sketch_xxxxxx" automatically as in the previous step.
3. Type the program listing for testing the LCD circuit as shown in Figure 6.
4. Click SketchàVerify. Then a box will appear to save the newly created project file.
5. If there are no errors, then click the àUpload or Ctrl + U icon. Can be seen in the following figure

Figure 6. *Listing of LCD Testing Programs*

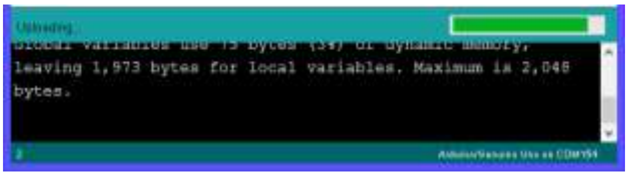

***Figure 7**. Uploading Process Program from Computer to Arduino*

a. Perogram Test Results

In testing the Arduino Uno circuit connected to the LCD, calling the # include <LiquidCrystal.h> library and also "LiquidCrystal lcd (7,6,5,4,3,2);" which functions to add program functions to display characters on the LCD. Then "lcd.begin (20.4);" is a program listing for setting the LCD address and the size of the LCD number of rows and columns according to the LCD used. Because the LCD 20x4 characters are used, then lcd_begin (20.4);.

4.2 PZEM-004T Sensor Testing With LCD

Current sensor used is the type PZEM-004T with a maximum current that can be read that is 100 Amperes. This sensor is used to read current data, voltage, frequency and power factors. In this test carried out by providing a program on Arduino to display current and voltage data. Equipment needed to test PZEM-004T sensors.

1. Arduino uno.
2. 20 x 4 LCD circuit.
3. PZEM-004T sensor.
4. DC Power Supply.
5. A set of USB Data Cable.
6. Arduino IDE Software.

The preparations made are:

1. Type a test program using the Arduino IDE software.
2. Uploading programs and Running programs.

The steps taken in testing:

1. Click Start à All Programs àArduinoàArdunio IDE
   Next will appear the initial display "sketch_xxxxxx" automatically. On this page begins writing the program to test the PZEM-004T sensor circuit.

***Figure 8**. Page for Starting Program Writing*

2. Type the program listing according to Figure 9.

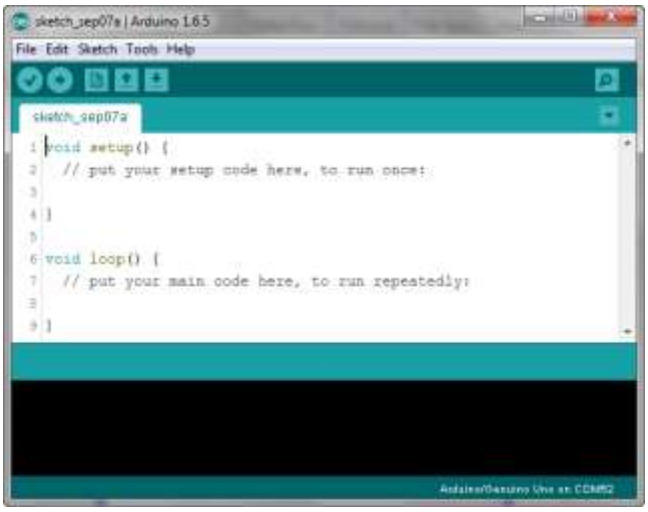

***Figure 9**. Listing of Sensor Testing Programs PZEM-004T*

1. Then click Sketch à Verify. Save with the file name Testing SENSOR.ino.
2. When the Compiling process is complete, it will appear at the bottom of the Arduino IDE program as shown in Figure 10.

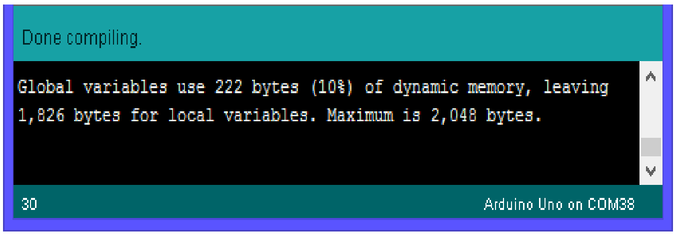

***Figure 10.** Compile Program*

5. If there are no errors, then click File à Upload or Ctrl + U

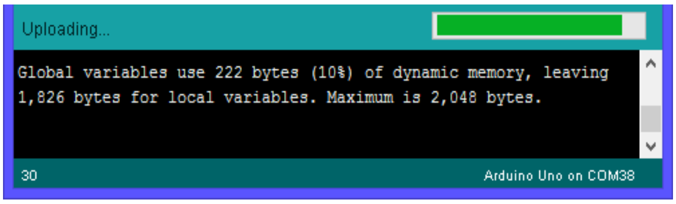

***Figure 11**. Upload Program*

4.3 PZEM-004T Sensor Loading Test with LCD

In the PZEM-004T test used here, the LCD 20x4 serves to display current and voltage information that has not been loaded yet. The test results are shown in Figure 13.

***Figure 12.** Display of PZEM-004T Sensor Testing Without Load Passing*

The results of reading the sensor data on the LCD display above are digital data that have values between 0-1023. In this experiment, sensor data when there is no load is small and when the sensor is given a higher load value.

Figure 13. *PZEM-004T LCD Display with 60 Watt Adapter Load*

When the sensor is loaded, the sensor data value gets bigger. The data displayed on the LCD above is already in digital form. To get the value in units of kwh, a formula is added to match the load that passes through the current sensor.

4.4 Testing LED and Buzzer

In this LED and buzzer test, the aim is to give a warning to the occupants that the electricity consumption has exceeded the usage limit that was previously determined.

Equipment needed to carry out this test are:

1. Arduino uno.
2. Arduino Uno data cable.
3. PZEM-004T sensor.
4. LCD circuit.
5. Buzzer and LED circuit.

In figure 15. it is seen that electricity usage is more than Rp. 1,000 where the red LED is active and the green LED is on, when the red LED is active the buzzer will issue a warning in the form of a "beep beep beep" sound until the payment process is complete and conduct research.

Figure 14*. Red LED and Buzzer Testing*

4.5 Overall Flow Testing with Benan Incandescent Bulbs

a. Power Testing Using Incandescent Bulbs

Tests using incandescent lamp prototypes are carried out to determine the function and performance of the whole tool. The testing program is implemented in an appropriate system. This testing is carried out to determine the performance of the tool and to find out whether it is in accordance with planning or not. Testing is first done separately , and then carried out into an integrated system. Testing uses one lamp. On the first test uses one 100 watt incandescent lamp, one series switch and one plug.

Figure 15. *Power Testing Using One 100 Watt Lamp*

Figure 16*. LCD Display Using One 100 Watt Lamp*

b. Testing using two incandescent lamps

In the second test using two 100 watt incandescent lamps, one series switch and one plug.

Figure 17*. Power Testing Using Two 100 Watt Lights*

Figure 18*. LCD Display Using Two 100 Watt Lights*

c. Testing using three incandescent lamps

In the third test using two 100 watt incandescent bulbs, one 60 watt incandescent bulb, serial switch and one plug.

Figure 19. *Power Testing Using Three 100 Watt Lights*

4.6 Testing using Angina Fans, Lamps and Rice Cookers

Tests using angina fans, lamps and rice cookers were carried out to determine the function and performance of the entire device.

***Figure 20**. Measurement Results Using a Fan and Lamp*

Table 1. Measurement Results with Fans and Lights

No.	Load	Power	Time	KWH	Invoice
1	Fan	55 W	1 hours		
2	Lamp	26 W	1 hours		
		TOTAL		0,081	Rp.81

Fan P = 40 Watt
LampP = 26 Watt
Hours t = 1 Jam
Answer :
= 40W+26W
= 81 x 1 hours
= 81 Watt
= 81 : 1000
= 0.81 Kwh
= 0.81 x 1000 Rp = 81

The cause of testing and the calculated results are different due to the voltage from the PLN which changes every time. Measurement Analysis Using a Fan, Rice Cooker and 26 watt lamps.

***Figure 21**. Measurement Results Using a Fan, Lamp and Rice Cooker*

Table 2. Measurement Results with Fans, Lights and Rice Cookers

No.	Load	Power	Time	KWH	Invoice
1	Fan	55 W	1 Hours		
2	*Rice cooker*	50 W	1 Hours		
3	Lamp	26 W	1 Hours		
		TOTAL		0,131	Rp.131

Fan P = 55 Watt
Rice cooker P = 50 Watt
Lamp P = 26 Watt
Hours t = 1 hours
Answer :

= 55W+50W+26W
= 131W x 1 hours
= 131 Watt
= 131 : 1000
= 0.131 Kwh
= 0.131 x 1000 Rp = 131

From this test and measurement the difference in value is 11 watts.

4.7 Measurement Analysis Using a Fan, Rice Cooker, 26 Watt Lamp and Iron.

Figure 22. *Using a Fan, Rice Cooker, Lamp and Iron*

Table 3. Testing Using Fans, Rice Cookers, Lights And Irons

No.	Load	Power	Time	KWH	Invoice
1	Fan	55 W	hours		
2	*Rice cooker*	50 W	hours		
3	Iron	300 W	hours		
4	Lamp	26 W	hours		
		TOTAL		0,431	p.431

Fan = 55 Watt
Rice cooker = 50 Watt
Iron = 300 Watt
Lamp = 26 Watt
Answer:

= 55W + 50W + 300W + 26W
= 431W x 1 Hour
= 431 Watt
= 431: 1000
= 0.431 kwh
= 0.431 x 1000 Rp = 431

From the results of testing with 24 hours the results obtained are close to the results of calculations in determining the cost of electricity consumption in the room.

Table 4. Calculation Result for 30 Days

No.	Load	Power	Time	KWH	Invoice Rp.
1	Fan	55 W	12X 30	19.800	
2	Lamp_1	5 W	12 X 30	1.800	
3	Lamp_2	25 W	12X 30	9.000	
4	*Rice cooker*	50 W	17X 30	25.500	
5	Refrigerator	74 W	24X 30	53.280	
Total 1 Month				109.308	159.903

From the calculation results for 30 days, we got 109,308 kwh with a nominal payment of Rp 159,903.

V. Conclusion

In using this electrical measuring instrument can determine the cost of use in households, then testing is done to make this tool needed Arduino, PZEM-004T sensor, LED buzzer, RFID and LCD, on the Arduino Circuit connected to the PZEM-004T sensor using cables as processed inputs by Arduino Uno. While for researching the kwh value, RFID is used to connect the MOSI, MISO, SCK, VCC GND research, has a function for kwh andbuzzer research sounds for 2000 ms, indicating that the research process has been completed and the tool will perform calculations from the beginning. Then the calculation results for 30 days obtained the number of kwh 109,308 with a nominal payment of Rp. 159,903.

References

Rimbawati, “No Title,” Semin. Nas. Tek. UISU.

R..Indarti. (2019) “Visualisasi Monitoring Performance Pada Motor Listrik Ac 1 Fasa Berbasis Visual Augmented Reality Visualisasi Monitoring Performance Pada Motor Listrik Ac 1 Fasa Berbasis Visual Augmented Reality.

F.I.Pasaribu and S. Yogen. (2019) “Perancangan Prototype Troli Pengangkut Barang Otomatis Mengikuti Pergerakan Manusia,” RELE, vol. 1, no. 2, pp. 82–92, 2019.

P. Harahap, “Implementasi Karakteristik Arus Dan Tegangan Plts Terhadap Peralatan Trainer Energi Baru Terbarukan,” Semin. Nas. Tek. UISU, vol. 2, no. 1, pp. 152–157.

Y.I.Indra, B. L. Pahlanop, and I. Sanubary. (2018)“Rancang Bangun Alat Kontrol Pemakaian Energi Listrik Berbasis Mikrokontroler Atmega 328P pada Rumah Indekos,” Prism. Fis. Vol. 6, No. 3 Hal. 220 - 227, vol. 6, no. 3, pp. 220–227, 2018.

U. K. Usman, “Dasar Teori Trafik,” Dasar Teor. Trafik, no. 1, pp. 4–22, 2013.

A.Fallis. (2013). “Tinjauan Pustaka,” J. Chem. Inf. Model., vol. 53, no. 9, pp. 1689–1699.

P. A. Ibrahim Dincer, Marc A. Rosen, “Kajian Teori,” J. Chem. Inf. Model., vol. 53, no. 9, pp. 1689–1699, 2019.

A.Sulistiyo, Agus. Prasetio, Dedi Ary. Supardi. (2011). “Kwh Meter Digital Terkoneksi Personal Computer (Pc) Berbasis Mikrokontroler Atmega16,” Emit. Univ. Muhammadiyah Surakarta, vol. 12, no. 01, pp. 1–7.

T.Elektro and T. Elektro. (2017)“Jurnal Teknologi Elektro , Universitas Mercu Buana Perancangan Pemodelan Kontrol Sistem Keamanan Perumahan Melalui Jaringan Gsm Issn : 2086 - 9479,” Vol. 8, No. 2, Pp. 156–163.

R..Chen, W. Zhai, and Y. Qi. (1996) “Rancang Bangun Prototipe Elevator Menggunakan Microcontroller Arduino Atmega 328p,” Mocaxue Xuebao/Tribology, Vol. 16, No. 3, Pp. 235–238.

J.Oliver. (2019.) “Rancang Bangun Sistem Pendeteksi Kebakaran Pada Ruangan Menggunakan Sensor Api Berbasis Mikrokontroler Atmega 328,” Hilos Tensados, vol. 1, no., pp. 1–476.