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Engineering Model Of Electrical Energy Conservation System In Meeting Building Room Based On Iot

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ARTICLE INFORMATION

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A B S T R A C T

In general, electrical energy consumption has increased, in line with economic growth and lifestyle, the higher the economic growth of an area, the higher the use of electrical energy consumption in the area, in urban areas office buildings become one of the largest contributors to electrical energy consumption. In this case the conservation of electrical energy is needed. To handle the above problems, the author will design an electrical energy conservation and monitoring system in a room that will be used for teamwork meetings. With the method of calculating the size of the room and the number of people in the room to determine how many BTU / h is needed to cool the room, the use of lighting will also be regulated and can only turn on when needed, so that the use of electrical energy is not wasted. To calculate the number of people entering the room the author uses an infrared sensor, while to regulate the ignition of the lights the author uses a Passive InfraRed (PIR) motion detection sensor. This electric energy saving monitoring system can be monitored using an application on an android phone, the android application is connected to the room's electrical system using the Internet Of Things (IOT).

INTRODUCTION

INTRODUCTION

In general, energy consumption is increasing, in line with economic growth and lifestyle. The growth rate of energy consumption including biomass reached 4.1% per year, higher than the world consumption growth rate of 2.6%. Energy consumption growth occurs in all sectors, including industrial, household, commercial, transportation, and other sectors. There are three main sectors as the largest energy consumption, namely the industrial sector which reached 33%, followed by the household sector at 27% and the transportation sector at 27%. The higher the economic growth of a region, the higher the use of energy consumption in the region. This is because every activity of the community requires energy, while on the other hand energy sources are dwindling, as is the energy used every day. The diminishing energy sources will cause an energy crisis throughout Indonesia. This condition occurs because the demand for energy is increasing, while the availability of the amount of energy is getting less. This causes the value of energy to get higher every day so that effective and efficient use of energy is needed [1].

An office building is one that has a high dependence on electrical energy needs, especially to meet its operational needs, from the use of air conditioners, lighting, elevators, and the use of other office equipment. Every use of electrical energy will be a burden on dwindling energy sources.

To implement effective and efficient energy use in office buildings, each room in the building is of particular concern in conserving electrical energy. Energy conservation is a systematic, planned, and integrated effort to conserve domestic energy resources and improve the efficiency of their utilization.

Conservation itself comes from the word Conservation which consists of the words con (together) and servare (keep/save) which has the meaning of efforts to maintain what we have, but wisely. This idea was proposed by Theodore Roosevelt (1902) who was the first American to come up with the concept of conservation. Conservation in its current sense is often translated as the wise use of natural resources.

Energy conservation is the act of reducing the amount of energy use. Energy conservation can be achieved by using energy efficiently where the same benefits are obtained by using less energy, or by using less energy.

by reducing consumption and energy-using activities. Energy conservation can lead to reduced costs, as well as increased environmental value, national security, personal security, and comfort.

METHODS

Most energy conservation carried out is to save energy that is wasted manually, giving a warning to turn off the lights after use or turn off the air conditioner if you are leaving the room, which is currently very inefficient. Therefore, the researcher made a study on Prototype Design of Electric Energy Conservation System in IOT-Based Work Meeting Room.

In this discussion, it will be explained how to design an electrical equipment control system as an energy saving that can be monitored via a smartphone with a Wifi connection. The design of this tool, consists of several stages, namely, block diagrams, how the circuit works, hardware design (hardware) and software design (software).

The formula for calculating the need for air conditioning according to the size of the room and the number of people.

AC demand formula in Btu.

W_{AC} = (P x T x I x L X E) / 60 + (Number of People x Factor 1)

Where:

P = Length of the room (in feet).

T = Room height (in feet).

I = 10 for an insulated room (crushed by another room or on the lower floor), 18 for an uninsulated room (room on the upper floor).

L = Room width (in feet or feet).

E = Value based on the facing direction of the longest wall.

16 = north facing

17 = east facing

18 = south facing

20 = west facing

Factor 1 = Adults = 600 Btu, children = 300 Btu

In order for a room to be well-lit, it also needs an optimal number of lights to illuminate the room. To calculate the need for lights used in one room, you can use the formula below:

N = E x L x W / Ø x LLF x CU x n

From the formula:

N = number of lamp points

E = lux value or lighting power

L = room length

W = room width

Ø = lumen value or lighting power of the lamp

LLF (Light Loss Factor) = light loss factor (the value is 0.7 to 0.8)

CU = Coefficient of Utilization

n = number of lights in one point

The following is a circuit block diagram, where the inputs of this design are infrared sensors, PIR sensors and smartphones, then the input data will be processed by the MCU Node as the microcontroller of this design, the results of data processing will be issued through the MCU Node I / O port which is connected to the relay module which will later regulate the lights and Air Conditioner (AC) in the room.

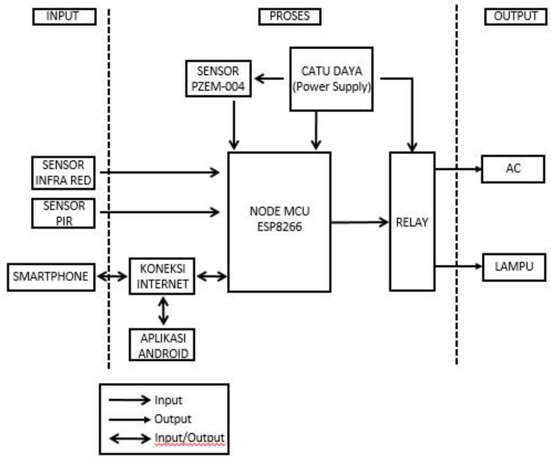

Figure 1. Block Diagram of the System

RESULTS AND DISCUSSION

The PZEM-004T sensor is an electronic module that functions to measure Voltage or Voltage, Current, Power, Frequency, Energy and Power Factor. This test is carried out by connecting the 5V pin of the sensor to the 5V pin of the NodeMCU voltage located on the acrylic board. Then the Rx pin of the sensor is connected to pin D7 on the NodeMCU. The Tx pin of the sensor is connected to pin D8 on the NodeMCU. The GND pin on the sensor is connected to the GND pin connected to the relay and NodeMCU. From this circuit, the data displayed is voltage, current, power and energy.

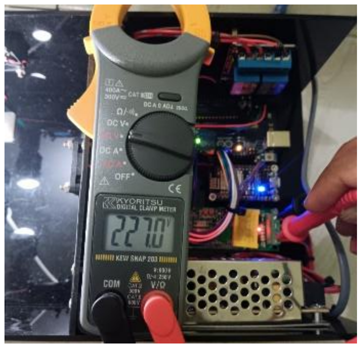

Figure 2. PZEM 004-T sensor testing

Table 1. PZEM 004-T sensor testing

No.	PZEM Sensor 004-T		Multimeter		Difference	
	Voltage (Volt)	Current (Amp)	Voltage (Volt)	Current (Amp)	Volt (%)	Ampere (%
1	226.3	0.1	227.0	0.09	0.3	10
2	226.4	0.1	227.1	0.08	0.35	20
3	226.3	0.1	226.9	0.09	0.26	10
4	226.1	0.11	226.9	0.09	0.35	20
5	226.2	0.11	226.9	0.09	0.3	20
6	226.3	0.1	227.0	0.08	0.3	20
7	226.2	0.11	226.9	0.09	0.3	20

Infrared sensor is an electronic device, which emits light from the LED and the light is received by the photodiode. This sensor can also detect heat and movement of objects. In this study, the infrared sensor is used to count the number of people entering the room, in the installation of the voltage used 3.3 V - 5V from NodeMCU and the sensor output is connected to pins D5 and D6 NodeMCU

Table 2. Infrared sensor testing

ENTER THE ROOM		OUT OF THE ROOM	
Testing	Results	Testing	Results
1	People in room 1	1	People in room 9
2	People in room 2	2	People in room 8
3	People in room 3	3	People in room 7
4	People in room 4	4	People in room 6
5	People in room 5	5	People in room 5
6	People in room 6	6	People in room 4
7	People in room 7	7	People in room 3
8	People in room 8	8	People in room 2
9	People in room 9	9	People in room 1
10	People in room 10	10	People in the room 0

PIR (Passive Infra Red) sensor is a sensor that is specifically designed to detect signals in the form of thermal radiation at infrared wavelengths, which are produced by every living thing. In this study, the Passive Infrared sensor is used to detect the presence of people in the room, in the installation of the voltage used 3.3 V - 5V from NodeMCU and the sensor output is connected to pins D1, D2, D3 and D4 NodeMCU

Table 3. Passive Infrared sensor testing

PIR SENSOR 01				
TESTING	**LAMP 1**	**LAMP 2**	**LAMP 3**	**LAMP 4**
1	No flame	No flame	No flame	No flame
2	Light up	No flame	Light up	No flame
3	Light up	No flame	No flame	No flame
4	Light up	No flame	Light up	No flame
5	Light up	No flame	No flame	No flame
6	Light up	No flame	No flame	No flame
7	Light up	No flame	No flame	No flame

System testing or process testing is carried out to test the entire system, namely reading sensor values, including current, voltage, power, energy, number of people in the room and the presence of those people.

Figure 3. System testing

Data on sensor readings can be shown in Table 4 below.

Table 4. Test Results

Status	Voltage (Volt)	Current (Ampere)	Cosφ	Amount Person	Savings (Watt)
0 Lights, 4 DC Fans & HP charger	228.2	0.1	0.42	7	10.6
1 Lamp, 5 DC Fan & HP charger	228.2	0.11	0.48	15	8.1
2 Lights, 6 DC Fans & HP charger	228.3	0.12	0.51	28	6.7
3 Lights, 7 DC Fans & HP charger	229	0.14	0.53	41	3.6
4 Lights, 8 DC Fans & HP charger	228.6	0.15	0.55	56	1

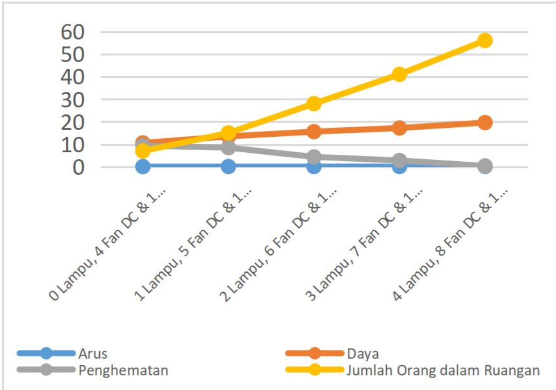

Figure 4. Comparison graph of the number of people with power savings

From the results of the system test, it can be seen that the savings obtained from the results of this electrical energy conservation test are 10.6 Watts when 0 lights and 4 DC fans are on, then the largest difference in savings from sensor readings with manual calculations is obtained when 1 light and 6 DC fans are on, which is 3.36% indicating that the accuracy of the sensor reading is good and there is no significant difference when compared to the results of manual calculations. In the actual room, IKE and PHE calculations were carried out, then it was found that the application of this Electrical Energy Conservation tool ran well with results efficiency at 9.4125 kWh / m² / Month.

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NOMENCLATURE

Cos φ = Phi
Ø = lumen value or amount of light intensity
LLF (Light Loss Factor) = light loss factor (value is 0.7 to 0.8)
CU = Coefficient of Utilization

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APPENDICES

USER GUIDE

This electrical energy conservation tool is a tool that can be used in a work meeting room in an office building, this tool functions to optimize the use of electrical energy. The method of this tool is to calculate the number of people in the room and detect the position where the person is located which will later be converted into Btu (British thermal unit) to determine how much air conditioning and lighting are on.

1. Turn on WiFi, so that the device can connect to the application on your smartphone.
2. Make sure the SSID and Pass in the NodeMCU ESP8266 program are the same as the WiFi username and password.
3. Open the Blynk application on your smartphone.
4. Turn on the electrical energy conservation tool, wait until the offline logo on the blynk application disappears.
   After the offline logo disappears, the device is connected to the application on the smartphone.
5. Click the Electrical Energy Conservation toolbar until the monitoring homepage appears.
6. The air conditioner and lighting can be turned on if 1 or more people have entered the room.
   a. When 1 to 7 people are in the room, 4 air conditioning units will be turned on.
   b. When 8 to 21 people are in the room, 5 air conditioning units will be turned on.
   c. When 22 to 36 people are in the room, 6 air conditioning units will be turned on.
   d. When 37 to 51 people are in the room, 7 air conditioning units will be on.
   e. When 52 to 60 people are in the room, 8 air conditioning units will be turned on.
   The number of times the air conditioner is turned on is based on the conversion of the number of people into Btu (British thermal units).
7. Infrared sensors are used to count the number of people entering and leaving the room.
8. Lighting is turned on using a Passive Infrared sensor that will detect the presence of people.
   a. If a person is in the area of lamp 1, only lamp 1 can be turned on.
   b. If a person is in the area of lamp 2, only lamp 2 can be turned on.
   c. If a person is in the area of lamp 3, only lamp 3 can be turned on.
   d. If a person is in the area of lamp 4, only lamp 4 can be turned on.
9. Voltage, Current, Power and Energy readings along with the amount of savings can be done in real time.
10. This Electrical Energy Conservation Tool can only be used if there is a Wifi internet network and a 220VAC single-phase electrical voltage.