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The Automatic Monitoring System for WPP, SPP, and PLN based on The Internet of Things (IoT) Using Sonoff Pow R2

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ABSTRACT

The usefulness of monitoring systems in the electric power system supports the importance of people's work today. One of which is the monitoring system at the generator. The monitoring system for Wind Power Plant (WPP), Solar Power Plant (SPP), and electricity from State Electricity Company (PLN) use IoT (Internet of Things) in the form of Sonoff Pow R2. With the monitoring system on this tool, the parameter values for WPP, SPP, and PLN can be seen and monitored online via a smartphone. The purpose of this research is to design a monitoring system for WPP, SPP, and PLN based on the Internet of Things (IoT) to determine the value of the output power. In addition, this system can distinguish load parameter values when WPP, SPP, and PLN are supplied directly (real time) and monitored online using the Sonoff Pow R2 app and the Ewelink App. This study uses the methodology that started the process of designing and manufacturing systems and designing the wiring that has been formed from the process of making tools and testing results. The results obtained from the experiment show that the current values in WPP, SPP, and PLN that appear on the monitoring screen are stable. The stable condition values are measured and tested when power is used when loading through sonoff. For the power value, the power value in PLN is stable, whereas in WPP and SPP has increased. For the voltage, the voltage value from PLN does not reach 220 V, whereas the voltage value from WPP and SPP reaches a value of 220 V.

Keywords*:* eWeLink, IoT, Monitoring System, WPP, PLN, SPP, Sonoff

INTRODUCTION

The sunlight energy can be utilized into electrical energy by solar panels, and wind kinetic energy can be converted into electrical energy by wind generators or wind turbines [1]. A hybrid power generation system is an alternative energy that uses a system that combines several conventional energy sources and renewable energy [2], [3]. Generators with hybrid systems can streamline the power generation system by backing up each other to meet the shortcomings of each power plant.

The hybrid power monitoring implementation is still mostly done manually by taking measurements using measuring instruments and recording straightly so that the data obtained is also limited. It will be more efficient and effective when the monitoring is routinely and automatically performed. One information and communication technology in monitoring is the Internet of Things (IoT). According to [4], IoT is a term used generally for conventional objects or tools that are connected to the internet in use. With this IoT concept, it is easier for us to monitor electrical power consumption to get data related to electrical parameters, namely current, voltage, and real-time power, we can control electrical equipment remotely, anytime, wherever we are. Based on the above background, the researchers designed a Monitoring & Analysis system for output power consumption at WPP, SPP, and PLN based on the Internet of Things (IoT) [4], [5], [6].

The more diverse human activities result in the increasingly diverse electronic equipment used to facilitate human activities. The demand for sustainable energy supply has resulted in the emergence of various uses of new renewable energy combined with previous primary energy sources [7]. In order for the performance of the electrical system that uses various sources to be optimal, a monitoring system is needed that can not only monitor technical matters, such as voltage and current, but also monitor environmental factors that also affect system performance, such as humidity, weather and temperature. This is in line with the increasing need for a wireless-based monitoring system in almost all research institutions, industry and even for household use that allows remote access [8], [9], [10].

Wind and solar energy is one type of renewable energy hybrid that is quite economical in terms of availability because these two types of energy are freely available in nature and quite economical [7], [8]. Because in nature solar and wind power is periodic and difficult to predict, the biggest challenge is to integrate these two energies into the existing electric power system (PLN). To answer these challenges, it is necessary to create advanced techniques, especially in weak grids systems or stand-alone systems without proper and enough storage capacity [11], [12], [13], [14], [15].

There are several studies related to monitoring systems in wind and solar power systems, namely [16], in this study, ESP 32 is used as a microcontroller and voltage-current sensor, as well as an IoT system with a Blynk display, which can also monitor and control input and output. this alternative electric power system so that any differences can be immediately seen in this IoT system. The results showed that the ESP 32 as a microcontroller and current-voltage sensor on the module can read electrical quantities. In addition, the Blynk software can display monitoring results on smartphones. Sequent research related to controlling the solar power system is [17], in this study a constraint system was designed that was able to move the solar panels following the direction of the sun's rays. The system in question uses an ATMEGA 8535 microcontroller with one temperature sensor to detect the high solar heat temperature received by the solar panel and four photodiode sensors to detect the reflected light received. The tool is designed to detect the presence of sunlight to get the focal point received by the solar panel and stored in the battery, converted using an inverter to produce power as lighting lamps.

In this study, the challenges in designing a hybrid system topology design are reviewed from the three types of power, namely wind, solar, and electrical energy sourced from PLN. The main review of this research is the monitoring directly and online of the power output value of the hybrid system through the IoT platform. Monitoring of characteristics differences in load parameter values when current from PLN is also observed using by Sonoff Pow R2 and Ewelink Applications.

METHODS

This research started from designing and making wiring diagrams on the tools to be made. The initial step is designing a monitoring system for WPP, SPP, and PLN so that the work procedures can run well. The design begins with collecting data. Then, it can be seen which modules are suitable for monitoring WPP, SPP, and PLN, and design a monitoring system for WPP, SPP, and PLN using a microcontroller module and a series of wiring monitoring systems for WPP, SPP, and PLN. This monitoring can determine the consumption of electrical power used from electrical equipment and also control the electrical equipment remotely from either the WPP, SPP, or PLN sources.

A. Flowchart Diagrams

The working system will be explained in the form of a workflow flowchart diagram in Figure 1.

Starting is the first stage. There are three sources, namely WPP, SPP, and PLN, where SPP is the main source of priority for the use of electrical energy. WPP and PLN as a backup if the SPP battery runs out. From SPP, enter into SCC or Solar Charger Controller. Continued from SCC, the output from SCC will enter into the battery to store electrical energy used. After being stored in the battery, the electrical energy will enter the inverter. In the inverter, the electrical energy source from the battery is DC electricity which will be converted into AC electricity.

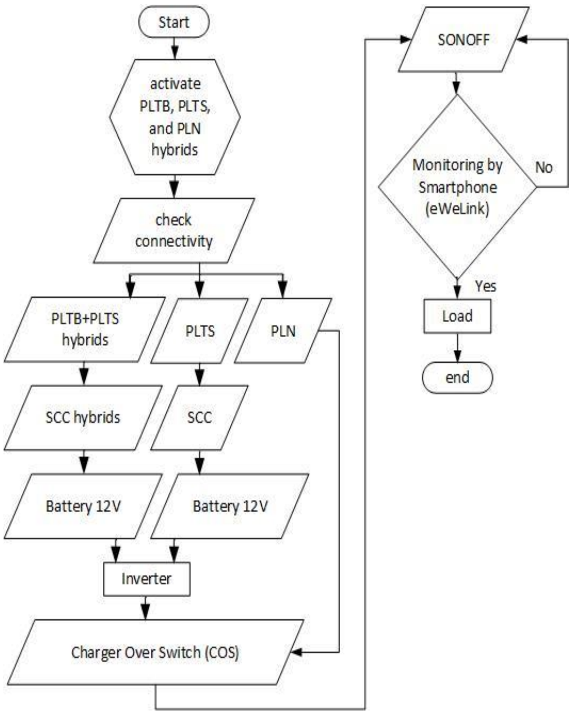


Figure 1. Tool work system flowchart

After becoming AC electricity, the electricity will be directed to a change-over switch which is used to choosing which generator and directly to Sonoff. Once connected, Sonoff will be working and be ready to monitor the load used via the Smartphone and eWeLink application.

B. Wiring Design

Figure 2, there are two wiring in the monitoring system. First, wiring for power sources. And secondly, wiring for Sonoff. On the first wiring, there are three sources of electricity, namely WPP, SPP, and PLN, whose work system is to back up each other. If one of the sources is disconnected, another power source will replace the main role as the priority source of the Hybrid Generator. On the seccond wiring, there is a Sonoff, is a module that functions to monitor load parameter values that are connected straightly to Sonoff. Sonoff system is based on IoT. Sonoff will be connected to the internet network and smartphones through the eWeLink application to monitor the load parameter values remotely.

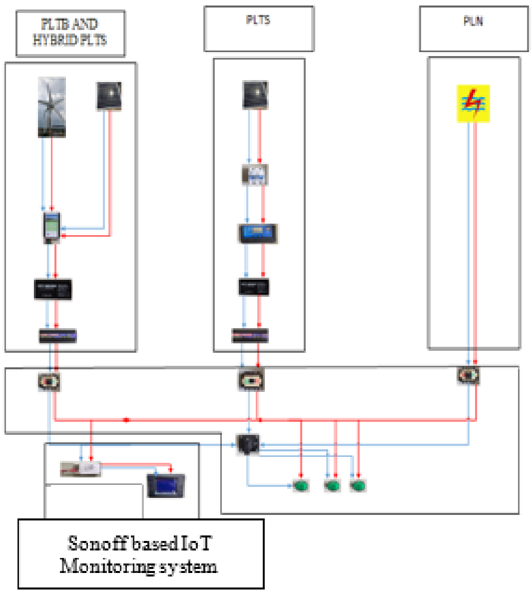


Figure 2. The Wiring Monitoring Diagram of WPP, SPP, and PLN

C. System Design

Sonoff's working mechanism will monitor the output power of the use of WPP, SPP, and PLN made with the Fiesto Fluidsim-p application.

When there is a transfer of the power source, the sonoff will remain on but the parameter values that appear on the smartphone will return to zero because the load will temporarily turn off.

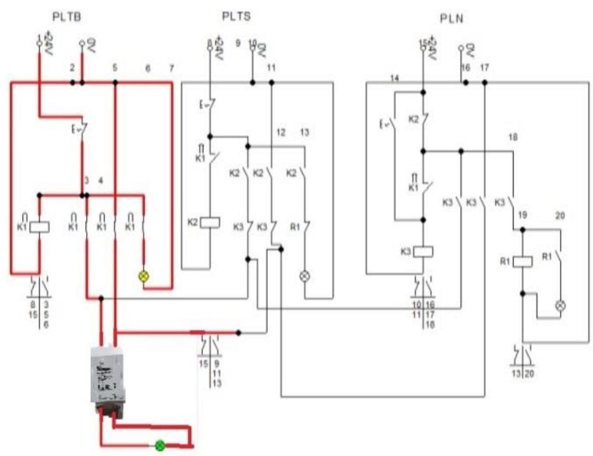


Figure 3. Conditions When WPP Becomes a Power Source

The Wind Power Plant or WPP, in Figure 3, is a source of electricity. In this condition the solar power plant and PLN do not work. If the Wind Power Plant does not work / the battery is empty, the Solar Power Plant will automatically work. And sonoff is connected to the load to monitor the parameter values that come out at the load.

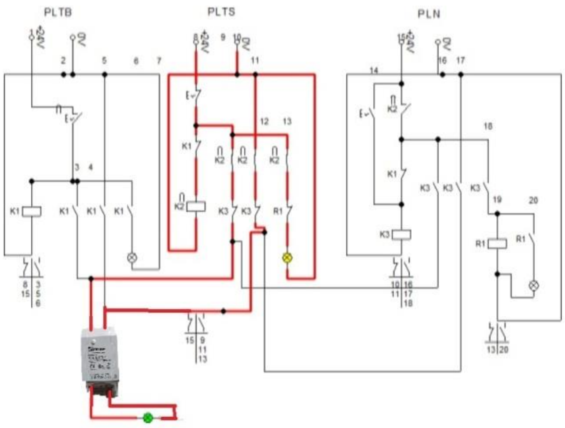


Figure 4. Conditions When SPP Becomes a Power Source

The Solar power plants or SPP (Figure 4) become a source of electricity. In this condition the wind power plant and PLN do not work. If the solar power plant does not work / the battery is empty then PLN will automatically work. When there is a transfer of the power source, the sonoff will remain on but the parameter values that appear on the smartphone will return to zero because the load will temporarily turn off.

PLN, in Figure 5, is a source of electricity. In this condition the wind power plant and solar power plant do not work. If PLN does not work / the battery is empty then one of the generators that are ready / the battery is in full condition will automatically work. When PLN becomes a power source, Sonoff will also be directly active or connected.

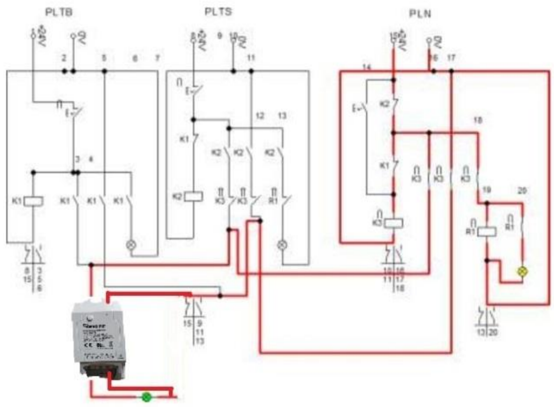


Figure 5. Conditions When PLN Becomes a Power Source

RESULT AND DISCUSSION

A clear presentation of experimental results, highlighting any trends or points of interest. The results should not be repeated in both tables and figures. The discussion should relate to the significance of the observations. If the content contains sub-chapters, it must be arranged in the following format.

A. The Resulting Research Technology

At this stage, the tool is tested by providing different sources, namely from WPP, SPP, and PLN. From these 3 sources will be monitored by the Sonoff POW R2 module which will be monitored via the eWeLink application on the Smartphone (Figure 6).

Figure 6. WPP, SPP, PLN panel network

B. Sonoff Pow R2 Testing

Testing to activate Sonoff Pow R2 by connecting this module with internet network connectivity or wifi network. to be able to monitor the load to see the parameter values.

We can also find out whether the Sonoff Pow R2 is connected or not through the display on the eWeLink application on the Smartphone. At the beginning of the connection, Sonoff requires a stable internet network and a stable internet.

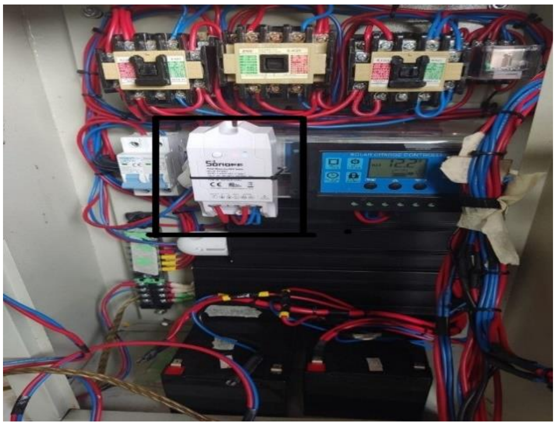


Figure 7. Sonoff Pow R2 Internet Connected

Figure 7., the Sonoff Pow R2 will light up if it is connected to the internet and is marked with an indicator light that keeps on. Meanwhile, if the indicator light is on but flashing, then Sonoff Pow R2 is not connected to the internet. We can also find out whether the Sonoff Pow R2 is connected or not through the display on the eWeLink application on the Smartphone. At the beginning of the connection Sonoff requires a strong internet network and must be close to the Sonoff Pow R2.

C. eWeLink display

Figure 8, sonoff is not connected to the internet and Figure 9 when sonoff is connected to the internet.

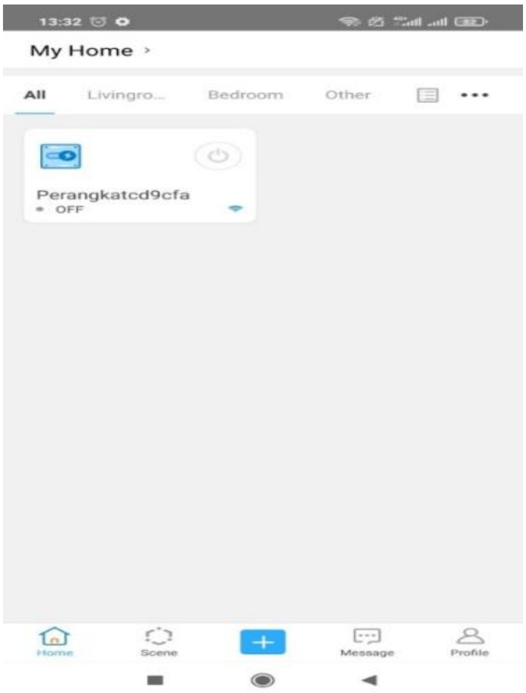


Figure 8. eWeLink display when sonoff is not connected to the internet

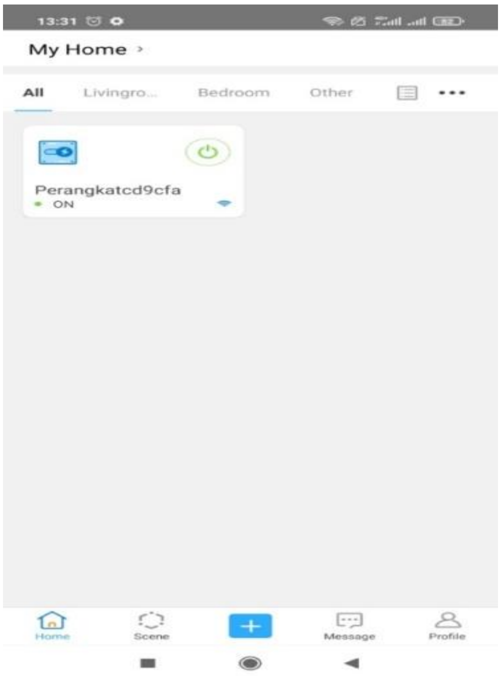


Figure 9. eWeLink display when sonoff is connected to the internet

Figure 10, is a Sonoff display on the eWeLink application is without a load, and only the value of the voltage parameter is visible while the picture beside it is the Sonoff display on the eWeLink application that is already connected to the load.

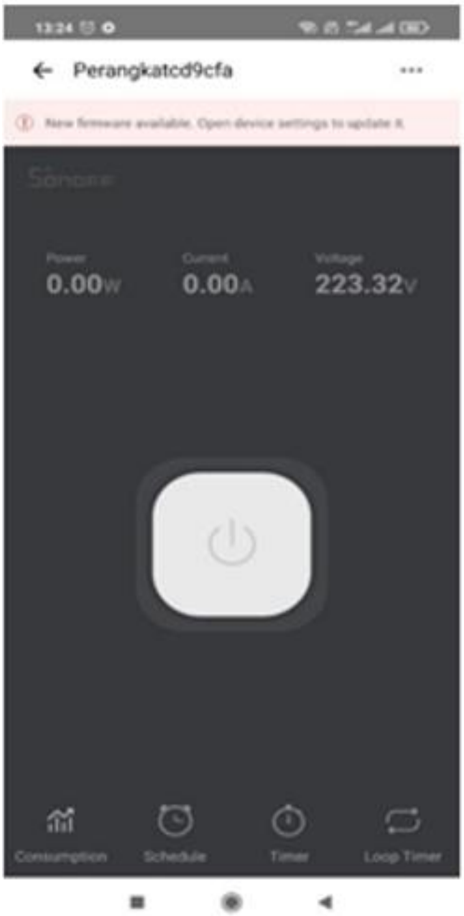


Figure 10. Display of eWeLink When Sonoff is no-load

Figure 11 is a Sonoff display on the eWeLink application that is already connected to the load. When connected to a load, the parameter values to be analyzed will appear, namely current, power, and voltage. However, the parameter values in the eWelink application will not appear immediately, there is a time delay of 3-5 seconds to display the values for these parameters and it depends on the network around the location.

D. Load Result Data

Measurements and tests performed on the tool aim to get real-time values on the parameters of Current, Power, and Voltage in WPP, SPP, and PLN. This experiment was performed at a predetermined load and in 10 minutes per load. The loads used are 50 Watt LED light, 40 Watt Incandescent Lamp, 45 Watt Fan, 70 Watt LED Television, and 300 Watt Iron. The measurement data shows in the following table:

Figure 11. eWeLink display when Sonoff is connected load

Table 1. Loads with WPP Supply

No.	Loads	Time	Sonoff Pow R2		
			I	W	V
1.	50 Watt LED Light	11:43	0,44	45.24	224.48
		11:48	0,43	44,22	225,14
		11:53	0,42	43.63	224,75
2.	40 Watt Incan-descent Lamp	11:55	0,27	58,58	225,14
		12:00	0,27	58,07	223,82
		12:05	0,27	58,27	225,14
3.	45 Watt Fan	12:08	0,21	43,34	225,88
		12:13	0,20	42,53	224,88
		12:18	0,20	42,42	224,51
4	70 Watt LED TV	13:05	0,40	46,28	225,14
		13:11	0,37	42,04	225,61
		13:15	0,44	44,34	192,49
5	300 Watt Iron	22:31	1,29	283,50	220,95
		22:36	1,28	279.00	225,61
		22:41	0,08	272,55	224,92

*Where I is Current, W is Power and V is Voltage.

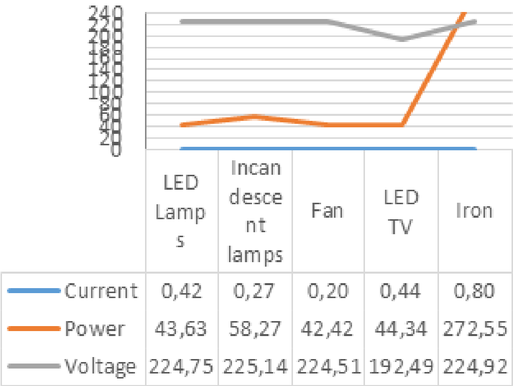


Figure 12. Graphic of Loads with WPP Supply

Table 1 and Figure 12 is obtained from the load supplied by the WPP, where the current and power values are in a stable condition which was carried out for an experiment for 10 minutes. Meanwhile, the value is displayed by Sonoff Pow R2 with the eWeLink application on a smartphone. The voltage reaches 220V, but at the load of the LED TV, the voltage does not reach 220V. With Sonoff Pow R2 and the eWelink application, it can be seen that a 40 Watt incandescent lamp load produces a power value that is different from the specifications of the incandescent lamp.

Table 2. Loads with SPP Supply

No.	Loads	Time	Sonoff Pow R2		
			I	W	V
1.	50 Watt LED Lamp	23:03	0,42	45,50	223,03
		23:08	0,41	44,16	223,58
		23:13	0,40	43,53	223,82
2.	40 Watt Incan-descent Lamp	23:16	0,28	59,07	224,08
		23:21	0,28	59,31	224,08
		23:26	0,28	59,38	224,08
3.	45 Watt Fan	12:00	0,20	42,17	224,08
		12:0	0,20	41,82	223,16
		12:10	0,20	41.82	223,16
4	70 Watt LED TV	12:48	0,39	44,76	223,55
		12:53	0,39	45,62	224,61
		12:58	0,40	44,86	223,55
5	300 Watt Iron	13:00	0,9	282,97	224,68
		13:05	0,8	279,65	223,71
		13:10	1,08	270,43	224,36

Table 2 and Figure 13 is obtained from the load supplied by the SPP, where the current and power values are in a stable condition which was carried out for an experiment for 10 minutes. Meanwhile, the value is displayed by Sonoff Pow R2 with the eWeLink application on a smartphone. The greater the power generated, the greater the current.

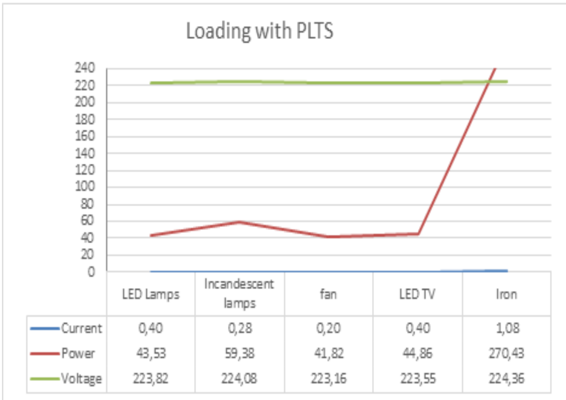
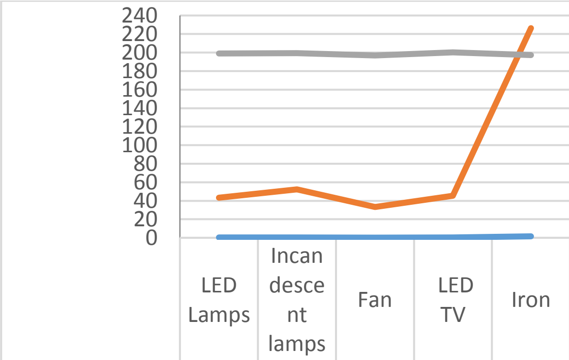


Figure 13 Graphic of loads with SPP supply

Table 3 Loads with PLN Supply

No.	Loads	Time	Sonoff Pow R2		
			I	W	V
1.	50 Watt LED Lamp	21:43	0,36	44.81	198,95
		21:48	0,35	43,83	198,95
		21:53	0,35	43.23	198,95
2.	40 Watt Incan-descent Lamp	21.55	0,27	51,56	198,53
		22:00	0,27	51,64	200,58
		22:05	0,27	52.18	199,36
3.	45 Watt Fan	22:07	0,19	35,23	201,48
		22:12	0,18	32,68	194,26
		22:17	0,18	33,25	196,88
4	70 Watt LED TV	13:20	0,32	39,28	197,09
		13:25	0,36	45,28	199,36
		13:30	0,36	45,39	200,21
5	300 Watt Iron	22:44	0,8	226,24	199,87
		22:49	0,9	233,54	204,87
		22:54	1,6	226,35	197,40



	LED Lamps	Incandescent lamps	Fan	LED TV	Iron
Current	0,35	0,27	0,18	0,36	1,60
Power	43,23	52,18	33,25	45,39	226,35
Voltage	198,95	199,36	196,88	200,21	197,40

Figure 14. Graphic of Loads with PLN Supply

Table 3 and Figure 14 shows that when the load is supplied by PLN, the current and power values for the 10-minute experiment displayed by Sonoff Pow R2 with the eWeLink application on the smartphone are unstable or up and down, and the voltage does not reach 220V. The factor that affects the PLN voltage does not reach 220V is the location where the experiment is in a densely populated environment and far from distribution transformers so that it affects the PLN voltage.

CONCLUSION

A monitoring system using IoT Sonnof will certainly make it easier for us to monitor and analyze the load. Because it can be done automatically via Smartphone so that it can save time and human effort. From the results of the study, it was found that the current value at PLTB, PLTS, and PLN which appeared on the monitoring screen was stable. While the power value at PLN is stable, in PLTB and PLTS the power value has increased. And for the value of the voltage from PLTB and PLTS it reaches a value of 220 V.

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