

Prototype Monitoring Electricity System 220v of Wind Power Plant (PLTB) based on the Internet of Things

By Yuli Hermanto

Article

Prototype Monitoring Electricity System 220v of Wind Power Plant (PLTB) based on the Internet of Things

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Abstract: Electrical energy is a daily human need that cannot be separated; even the demand for electrical energy has increased every year. This is evident from the construction of renewable energy plants in areas with potential. In this thesis, a control and monitoring system for a vertical turbine wind power plant prototype will be made using the internet based on IoT (Internet of Things) technology. Where the IoT technology here, the author uses the Thingspeak and Blynk applications which are used to monitor the electrical energy output from the wind power plant (PLTB) and the output from the 220V inverter. The purpose of using IOT technology is to make it easier to monitor and control the voltage, current, and output power of wind power plants from anywhere and anytime via the internet. This tool's manufacture needs a voltage sensor, current sensor, relay, LCD, and NodeMCU. The voltage sensor uses PZEM 004T, which functions to read the value of voltage, current, cos phi, and frequency, relay1 serves to limit the output voltage from the dynamo generator and relay2 to limit the output voltage to 220V in case of equipment problems. Moreover, NodeMCU functions to process data read from the sensor. This NodeMCU is already equipped with a WIFI module that sends data to an internet server to be controlled and monitored anywhere and anytime. The results of the tests carried out measurements for 2 hours on the load of the iron, fan, television, 1 phase AC motor, soldering iron, dispenser, laptop charger, incandescent lamp, and refrigerator using the 004T PZEM sensor resulted in an error of 0.28% - 0.3%.

Keywords: PLTB, IoT, Thingspeak, Blynk, NodeMCU, PZEM 004T



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1. Introduction

Indonesia is a country located on the equator with various natural potentials. The natural resources in question are sunlight, water flow, wind gusts, and other natural resources that have the potential to be used as alternative sources of electrical energy. Alternative sources of electrical energy are supporting the sustainability of electrical energy in the future. The longer the availability of coal will be depleted, so it must be balanced with the utilization of alternative electrical energy sources. Some examples of alternative sources of electrical energy that have been established in several regions in Indonesia are Solar Power Plants (PLTS), Hydro Power Plants (PLTA), Wind Power Plants (PLTB), and there are several other types of power plants. PLTB is one type of power plant that utilizes natural conditions. Therefore, the energy produced by PLTB is also very dependent on natural conditions, namely the stability of wind gusts. The way to know the performance of a PLTB is by monitoring the current, voltage, and frequency at the generator so that the performance of a generator can run as it should.

At this time, the Wind Power Plant (PLTB) how to monitor the condition of the generator, an officer every hour must visit the PLTB area. However, the current monitoring uses the manual method, namely measuring using measuring instruments and recording directly. Therefore, it takes a lot of time and the data obtained is also limited. It will be more efficient and effective when monitoring is carried out routinely and automatically.

Based on the above, the authors make an online monitoring prototype consisting of hardware and software that are connected to each other so that the information presented can be directly accessed at that time. Hardware cannot work effectively if the software is not designed properly. This device is designed to replace manual and conventional electrical energy measurement systems. Therefore, the design of a tool for the control system and monitoring of electrical power based on IoT (internet of thing) was made. For control using Blynk and monitoring display on the internet using Thingspeak, the data displayed by Thingspeak is in the form of tables and graphs.

2. Literature Review

The Internet of Things is a dynamic global infrastructure network with configuration capabilities based on communication protocol standards by having an identity system, physical attributes, strong characters, and intelligent interfaces connected and integrated into an information network. Simply put, IoT can unite the virtual world of information technology with real objects in the real world. IoT can work by taking data from sensor readings placed on objects in the real world and then sent to the server.

As for how this monitoring system works so that it can be monitored remotely, first, set the internet network that will be used; currently, the author is setting up a monitoring system connected to Telkomsel's wifi. Second, the monitoring system's turned on and directly connected to the internet network. Third, the monitoring system is directly connected to the load. Then, the monitoring system will read the data on the load. The results of these readings will be sent to the server for viewing. Fourth, login to the Thingspeak server through the available account, and in it, you can see the results of sending data from the monitoring system.

Wind turbines are part of the PLTB system that converts wind energy into mechanical energy. This energy change occurs because the shape of the wind turbine is like a propeller. This wind turbine can rotate when the wind sweeps the turbine area as the propeller propulsion energy. The propeller's rotation is used to rotate the rotor on the generator.

An electric generator is a device that converts mechanical energy into electrical energy using an electromagnetic induction process. This process is usually called the electricity generation process. Electric generators and electric motors use the same electromagnetic induction process; the difference is that electric motors convert electrical energy into mechanical energy/motion energy, while electric generators convert mechanical energy/motion energy into electrical energy. Generators can generate electricity by rotating a coil that is in a magnetic field so that an emf is generated [8].

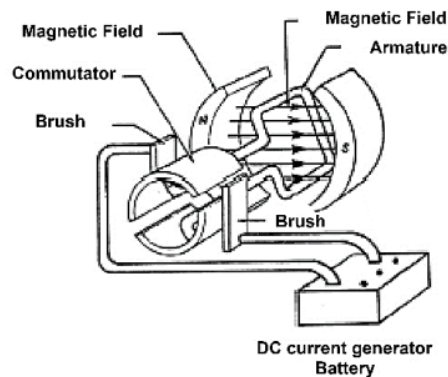


Figure 1. a Simple DC Generator or Motor

The Source from Figure 1 from Nur Fauziyah, Ten November Institute of Technology Surabaya 2017) [9]. Furthermore, A battery is an electrochemical cell consisting of a pair of electrodes (cathode-anode) and an electrolyte. This cell functions as a source of electrical energy obtained from chemical energy conversion through redox reactions (reduction and oxidation). The reduction reaction occurs at the cathode, and the oxidation reaction occurs at the anode [4].

As an energy storage medium and as backup energy when the main source is interrupted or disconnected, the battery used is an accumulator battery with a capacity of 12V 20Ah/20HR (ampere hours), which means it has a nominal total cell voltage of 12V and a real capacity of 20Ah if the continuous amperage used is 20Ah / 20Hr = 1 Ampere. The battery is operated in floating and inverter mode to keep the voltage source stable. An example of a battery is shown in Figure 2 [3].



Figure 2. Battery (Source: Personal data)

Furthermore, an Inverter circuit is a circuit that converts DC voltage levels into AC voltage levels. Usually, the DC voltage that is converted is a 12V DC voltage that comes from the accumulator or battery. This 12 V voltage will be converted into AC voltage. Then the voltage will be increased by a step-up transformer to 220VAC, which meets the specifications for powering electronic devices. The schematic can be seen in Figure 3.

The inverter is an electrical converter that converts DC voltage into AC voltage with a frequency value that can be changed. The inverter accepts a DC voltage source as an input voltage that can be obtained from the accumulator (battery). With the switching process of the semiconductor components in the inverter circuit. [5]

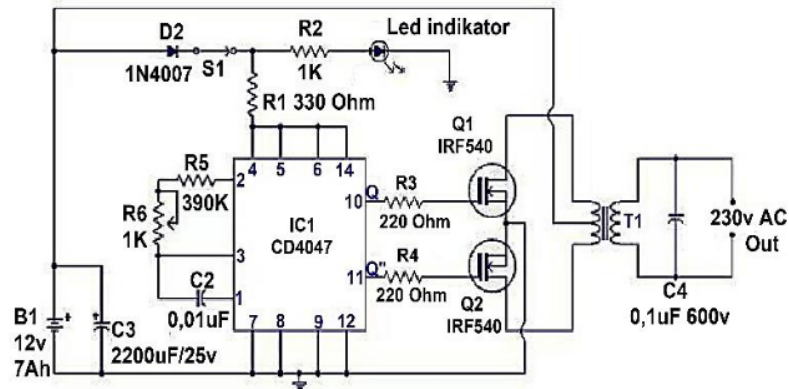


Figure 3. Schematic of inverter and step-up transformer 220 VAC (Source: Personal Data)

One of the efforts to overcome the energy crisis is to reduce dependence on fossil energy sources by utilizing alternative energy sources. One alternative energy that can be used is wind energy (Bayu). Wind energy can be utilized in wind power plants. Wind power generation is a method for generating electrical energy by rotating wind turbines, which will then be converted to electrical energy.

3. Methods

The next stage is to create an algorithm for system settings on the tools that have been made. Then the algorithm is written in a programming language, the programming language used is C language. The program will be uploaded to the NodeMCU. The user interface design (user interface) aims to make it easier for users to control the microcontroller anywhere and anytime. This interface is designed according to the working principle of the internet of things, namely thingspeak and blynk with smartphones using NodeMCU.

Arduino here functions as a publisher with Thingspeak as a broker and datalog server. As a subscriber using a laptop. Here the laptop will be used to monitor data in graphic charts sent by the Arduino client to view the sensor data graph, and logging can be anywhere and anytime, as long as the laptop is connected to the internet. In the picture below, an illustration of the use of Thingspeak in the IoT system "monitoring the amount of 220V electricity on a prototype wind power plant (PLTB) based on the internet of things." will be made.

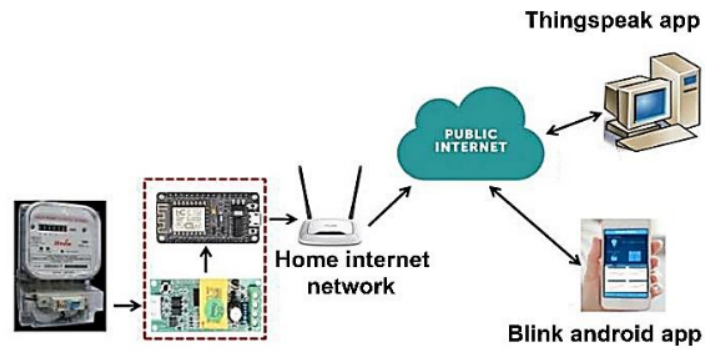


Figure 4. Thingspeak on IoT systems

Figure 4 is a Thingspeak on IoT systems, Source of Figure 4 is from Hartono Budi Santoso, Bandung State Polytechnic) [10], Furthermore, The following is a flowchart display that represents the system's working principle to be designed, which is shown in Figure 5.

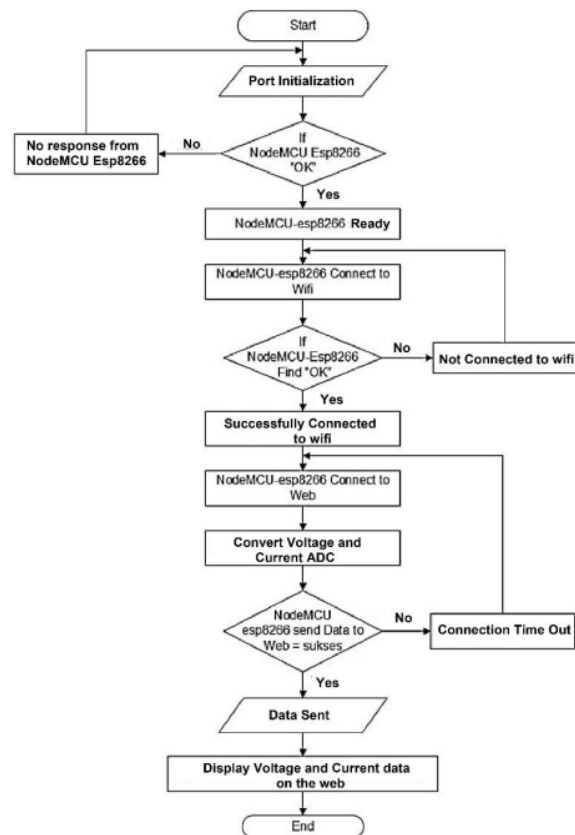


Figure 5. System flow diagram

As for how this monitoring system works so that it can be monitored remotely. First, set the internet network that will be used. Currently, the author is setting up a monitoring system connected to Telkom's wifi. Second, the monitoring system is turned on and directly connected to the internet network. Third, the monitoring system is directly connected to the load. Then, the monitoring system will read the data on the load. The results of these readings will be sent to the server for viewing. Fourth, login to the Thingspeak server through the available account and see the results of sending data from the monitoring system.

Wind energy moves from high pressure to low pressure or vice versa, namely from low air temperature to higher air temperature. Wind energy is a new and renewable energy source that the community can utilize to meet energy needs. One of the potential uses of wind energy is to drive turbines, as in Figures 6 and 7.

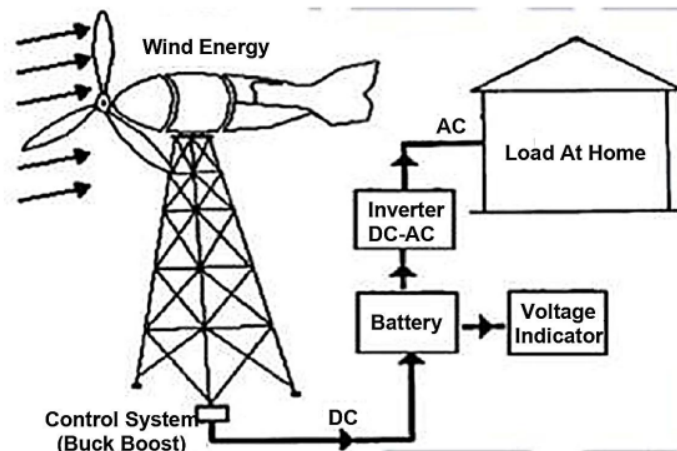


Figure 6. Wind energy conversion

Figure 6 is a Picture of Wind energy conversion, Figure 6 Source from Dimas Priyambodo, Achmad Imam Agung, Surabaya State University) [11].



Figure 7. PLTB prototype propeller (Source: Personal data)

The propeller has a diameter of about 40 cm with 4 blades. Then the gear from the propeller is coupled with the gear from the generator. The gear size of the propeller and generator is approximately 2:1 because the rotation of the generator can be doubled compared to the rotation of the propeller, as in picture 8, and for the gear size in picture 9.



Figure 8. Coupling between a wind turbine and generator (Source: Personal data)

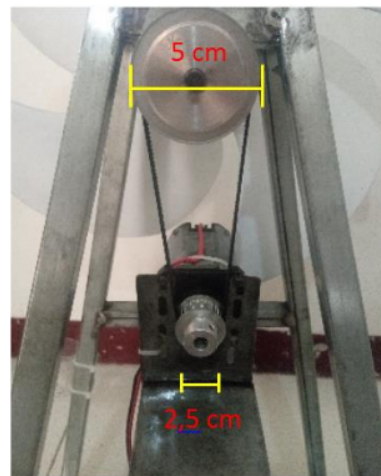


Figure 9. Coupling size of a PLTB turbine (Source: Personal data)

One monitoring box consists of a NodeMCU microcontroller as a data processor from the unit, then a ZEM 004T sensor as a voltage, current, frequency, and power reader sensor, then relay1 (5v) as an output voltage switch from the generator, relay2 as an inverter voltage breaker and then a dc voltage regulator 12v to 5v as a voltage supply in the microcontroller in the monitoring unit. It can be seen in Figure 10.



Figure 10. Monitoring unit circuit (Source: Personal data)

Monitoring tools need a place that can accommodate the circuits to function properly. Therefore, it takes a sufficient box to accommodate all monitoring devices such as microcontrollers, relays, voltage regulators, LCDs, a series of sensors. In this final project, the box used is acrylic with a thickness of 2mm. The box is designed from easily available materials and is a good insulator. The box design drawing is designed using SketchUp 2019 in figure 11.

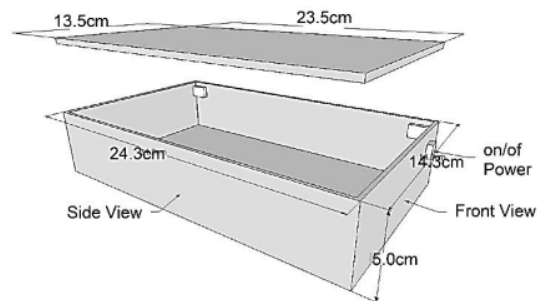


Figure 11. Monitoring unit box size

4. Result and Discussion

The list of voltage measurements produced by the PLTB prototype can be seen in table 1. This is the condition when the PLTB is no-load (not yet included auto buck-boost) and the graph in Figure 12.

Table 1. PLTB voltage measurement

Wind velocity	Voltage
2 m/s	8,45 V
4m/s	9,01 V
5m/s	10,13 V
6m/s	13,12 V
7m/s	15,85 V
9m/s	17,45 V
11m/s	20,01 V

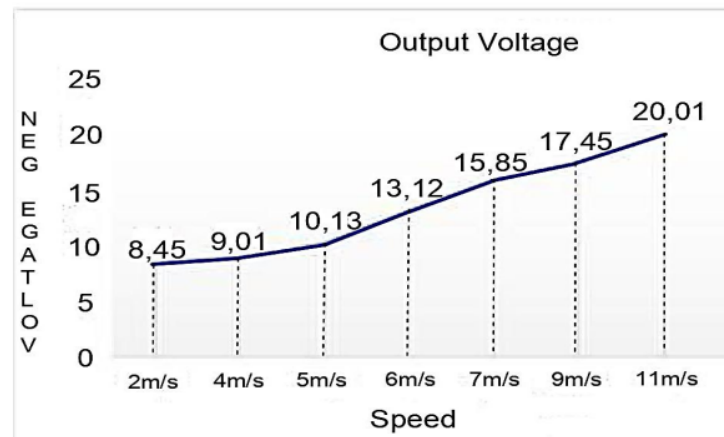


Figure 12. PLTB measurement graph (Source: Personal test Data)

In table 1 and Figure 12, it can be seen that the value of the output voltage is directly proportional to the speed of the wind as the generator's propeller. The stronger the wind blows, the greater the voltage generated.

This test is done by providing the input voltage from the PLN source. In this test, the data obtained are shown in Table 2.

Table2. PZEM 004T sensor testing

Load	Voltage		Error (%)
	Pzem 004t	Voltmeter	
Refrigerator	220 V	220 V	0
Iron	219 V	220V	0,45
Single phase AC motor	219 V	219 V	0
Laptop Case	219 V	220 V	0,45
Solder	219 V	220 V	0,45
Dispenser	220 V	220 V	0
Television	220 V	220 V	0
Incandescent lamps	215 V	217 V	0,9
Fan	218 V	219 V	0,45
<i>Average error</i>			0,3

Based on table 2, it can be seen that the variation between the PZEM 004T sensor and the voltmeter is not too far away; this indicates the PZEM 004T sensor is working normally. And it is still feasible to be installed as an AC voltage sensor on a monitoring device. The results of monitoring the amount of electricity on Thingspeak tested with a load are shown in the graphic display in Figure 13.



16
(a) Voltage



(b) Current



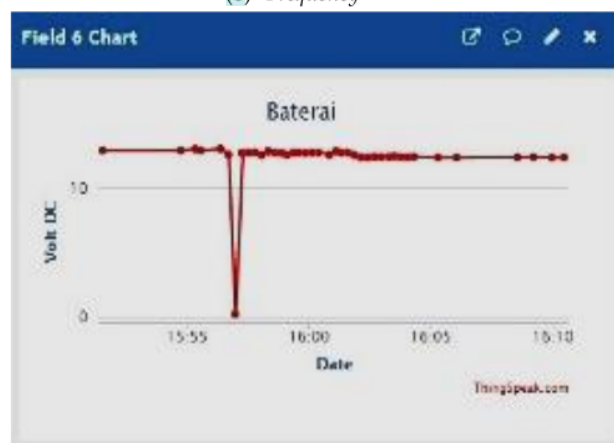
(c) Power



(d) Energy



(e) Frequency



(f) Battery

Figure 13. a, b, c, d, e, f Graph of electricity monitoring results on Thingspeak (Source: Personal test Data)

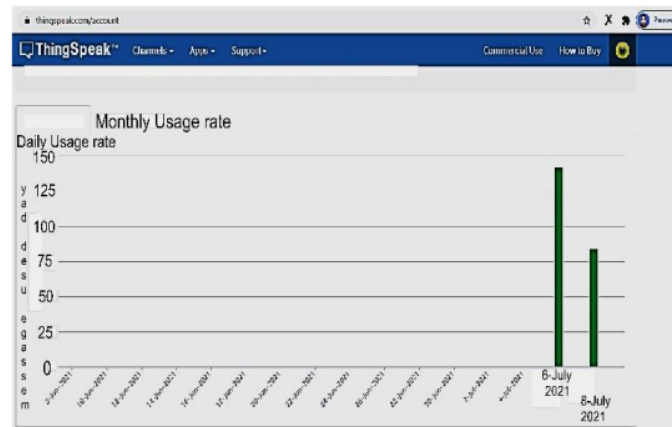


Figure 14. Graph of test results per day on 6 July and 8 July 2021 (Source: Personal test Data)

5. Conclusions

After measuring and testing the tools made, the following conclusions were obtained: Based on the results of measurements and tests on the inverter. The inverter input voltage uses a voltage of 12 volts. Can be step up to 223 volts without a load, and after being given a load at the output, the power capacity becomes 220 V. The results of the tests carried out by measuring for 2 hours on the load of the iron, fan, television, 1 phase AC motor, soldering iron, dispenser, laptop charger, incandescent lamp, and refrigerator using the PZEM 004T sensor resulted in an error of 0.28 in succession % - 0.3%. And Sending readings from this monitoring tool to the server takes about 10-15 seconds.

Author Contributions: Conceptualization; Yuli Hermanto (YH), Agus Kiswanto (AK), methodology; YH, AK, software; YH, AK, validation; YH, AK, formal analysis; YH, AK, investigation; YH, AK, data curation; YH, AK; writing—original draft preparation; YH, AK, writing—review and editing; YH, AK, visualization; YH, A, supervision; YH, AK, project administration; YH, AK, funding acquisition; YH, AK, have read and agreed to the published version of the manuscript.

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Conflicts of Interest : The authors declare no conflict of interest.

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