MONITORING SYSTEM AND AUTO SWITCH POWER SUPPLY USING SOLAR CELL POWERBANK ON SERVER

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ABSTRACT

Power generated by PLN (Pembangkit Listrik Negara) or National Power Plant are not always up and running as expected. There are many unpredictable technical problems caused by transmision or distribution factors. Backup power selection could raise a new problem such as increase operational cost by using certain backup power system.

The problems previously described could be anticipated by reviewing backup power plan to minimize costs. Besides, it needs automatic control system design to handle switching problems automaticaly. PLTS (Pembangkit Listrik Tenaga Surya) or Solar Power Plant is one of popular power resource in Industry. The abundant of solar energy from the sun is a great advantages of solar power plant. The operational costs is also relatively minimal compared with other resources. Solar power could also be integrated with ATS (Automatic Transfer Switch). ATS is power inverter switch control to connecting power inverter with power load. It can automaticaly switch power resources from PLN when the power is up and down. The utilization of ATS could be answered the problems previously described. Based on this research, integration of ATS could simplify server operator tasks on monitoring current and power resources switching. Solar system could make a profit by Rp 4.200,- per month if using 20W solar panels. Further research on utilization better sensor to increase accuracy probloem, saver hardware component, cable simplification and longer power backup capability are needed.

***Key words** : ATS, PLTS,Power Inverter, control system*

1. INTRODUCTION

Server are the main computer used to provide resources either in the form of data or other resources. Due to such server functionality, the server is required to work at any time in order for the requested resource requests of the client to be provided by the server. To assist server performance in order to work at any time, a backup power source is required that can backup server current consumption.

PLTS (Pembangkit Listrik Tenaga Surya) or Solar Power Plant is is one of the most widely used reserve resources both individually and corporate. PLTS development in tropical areas is very strategic, where Indonesia is a country that has a tropical climate, so that PLTS in Indonesia can run with a maximum. PLTS has been realized with the development of PLTS with a large scale such as examples of PLTS in Bali with power 1 Mega watt peak. [1]

Along with the development of technology, everything has been connected to the internet, and everything can be done with internet connection, this technology more often called the Internet Of Things (IOT), as well as PLTS is possible combined with IOT technology, with the aim we can monitor the system PLTS us everywhere without being blocked by distance. IoT makes it easier for consumers to monitor their power source.

1.1. IOT Tools

In building the IOT system, a microcontroller is needed as the brain that will run the IOT system. Microcontroller system can also be combined with sensor supporting sensors that will assist the microprocessor in managing the data. Some of the supporting sensors that can be used in building an electrical power resource monitoring system are as follows

1.1.1. *ACS 712 electric current sensor*

ACS 712 Current Sensor is an AC current measuring sensor capable of measuring the current rating through the sensor, because there is a linear Hall low-offset circuit with a single track made of copper. The workings of this sensor is the current that is read flowing through the copper wire contained therein which produces a magnetic field captured by integrated Hall IC and converted to a proportional voltage. The accuracy in sensory readings is optimized by means of mounting the components present therein between the conductor which generates a magnetic field degan hall transducer adjacent. [9]

In this research ACS712 current sensors are used to measure the current on the main power source

of PLN, so that automatic decision can be made to move the switch to a power backup source.

1.1.2. *DC Voltage Sensor*

The sensor works to calculate the DC voltage, for this sensor can calculate 0-25V DC. The output of this sensor is 0-5V voltage. So 5x5 = 25V, so if the calculated voltage is 5V then the output is 1V. If the calculated 12V, then the output is 2.4V.

1.1.3. *AC Voltage Sensor*

AC voltage sensor serves as an AC current voltage meter, where Zmpt101b sensor is capable of measuring AC voltage from 110 to 250 VAC.

1.1.4. *ESP8266*

ESP8266 Module is one module that can connect our micro controller with local network connection (LAN) or internet network using wifi media to transfer data via local network or internet network.

In this research ESP8266 serves as a tool for sending data from microcontroller into firebase database.

The default firmware used by this device uses AT Command, in addition there are several Firmware SDKs used by this opensource-based device which are as follows:

- ***NodeMCU** by using lua basic programming and also can using C programming language.*
- ***MicroPython** use python basic programming*
- ***AT Command** using AT command*

For its own programming we can use ESPlorer for NodeMCU-based Firmware and use putty as the control terminal for AT Command.

1.1.5. *Sensor DHT11*

DHT 11 sensor is a digital sensor that can measure the temperature and humidity of the surrounding air. This sensor is very easy to use along with Arduino. It has excellent level of stability and highly accurate calibration features. The calibration coefficients are stored in the memory of the OTP program, So when the internal sensor detects something, then this module includes the coefficient in its calculation. [6]

DHT 11 sensor is used to measure the temperature and humidity in the Server room, where the temperature of the room should be at the operating temperature either from the hard drive that is between 18 ℃ -27 ℃ with humidity 40RH-60Rh. [1]

1.2. Firebase Database

Firebase Realtime Database is a cloud-based database. Data is stored in JSON type and synchronized in real time to each connected client. When you build cross-platform apps with iOS, Android, and JavaScript SDKs, all your clients share one instance of Realtime Database and automatically receive updates with the latest data.

Advantages Database Firebase can be seen in the following table

Table 1 Advantages of Firebase Database

Excellence	***Information***
Realtime	*Instead of a regular HTTP request, Firebase Realtime Database uses data synchronization, each time the data changes, each connected device receives the update in milliseconds. Provide a collaborative and in-depth experience without thinking about network code.*
Offline	*Firebase applications remain responsive even when offline because the SDK Firebase Realtime Database retains data to disk. Once connectivity is retrieved, the client device will accept a missed change, syncing it with the current Server status.*
Can access form any android device	*Firebase Realtime Database can be accessed directly from mobile device or web browser; No more Server application required. Data security and validation are available through Firebase Realtime Database Security Rules, an expression-based rule that is executed when data is read or written.*

2. CONTENT OF THE RESEARCH

1.3. System Design

The design of the system is done by several stages, namely designing block diagram, designing the database, encoding the microcontroller so that sensors can be read and processed so as to produce the output and successfully thrust into the database.

1.3.1. Block Diagram

The block diagram of the monitoring system is shown in the figure below

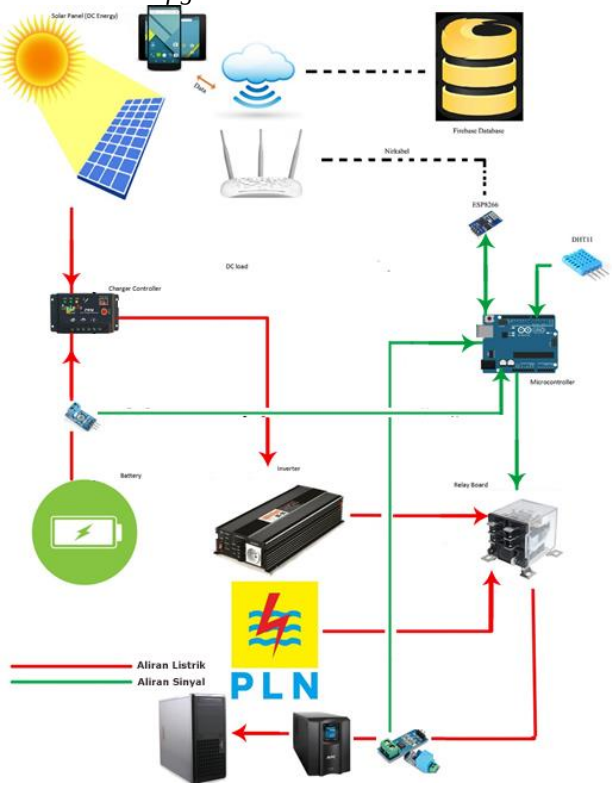


Figure 1 Block diagram

1.3.2. Database Design

To fulfill the needs of the monitoring system resources, Required a database to store data that will be easier for users in monitoring the power source. The design of this database using firebase database where this database can perform synchronization in realtime. The scheme of data design based on the sensors used are as follows

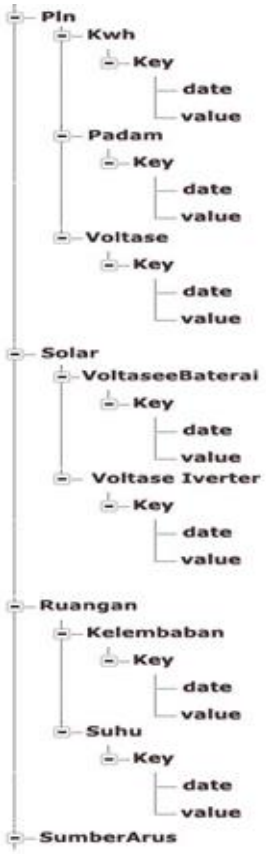


Figure 2 skema database

1.3.3. *Arduino Software Design*

This design is aims to know the workflow of arduino to do sensor readings, controlling the relay and send data to NodeMCU

The workflow can be described in the following flowchart

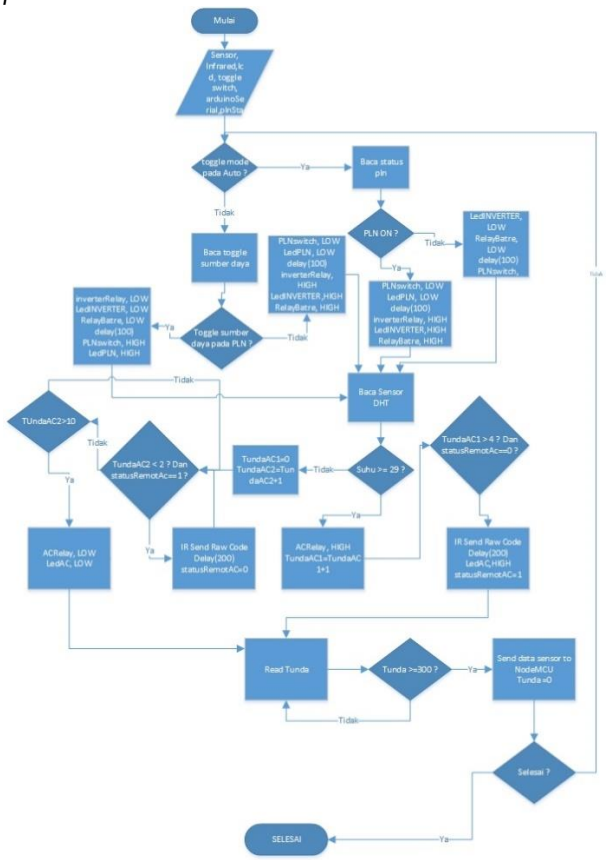


Figure 3 Arduino Flowchart logic

1.3.4. *NodeMCU Software Design*

This design is done to know the workflow from NodeMCU to send data to the database. The workflow can be described in the following flowchart

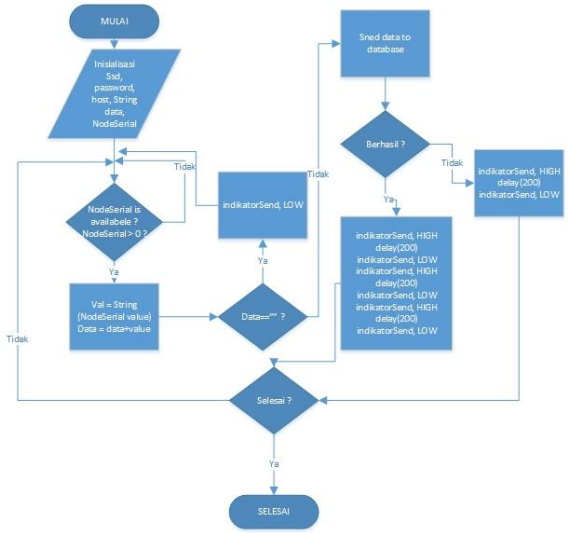


Figure 4 NodeMCU Flowchart logic

1.4. Results and Analysis

1.4.1. *Testing Sensor data readings*

This test is done by operating the monitoring tool without updating the data to the database. This test is done within 5 hours in which every reading of all sensors is done within 2 seconds.

The results of this test obtained data sensor readings of 9000 sensor data, with the success of data obtained is 8999 times with data readout failure on AC voltage and current sensor as much as 1 times, so it can be concluded that the experiment of reading sensor data succeed with 99.9999% success percentage.

1.4.2. *Testing calibration of AC voltage sensor*

Measurement of AC voltage calibration is done by measuring the source voltage is measured 10 times, where in determining the suitability of voltage source reading used energy meter tool as an accurate data reference, while the data that has been obtained is as follows :

Table 2 Calibration measurement of AC voltage sensor

Trial Data	*Pembacaan dengan sensor (v1) (Volt)*	*Pembacaan dengan energy meter(v2) (Volt)*	*Persentase kesalahan abs(v1-v2)/v2 * 100%*
1	*0*	*0*	*0%*
2	*224*	*223*	*0.00493%*
3	*202*	*203*	*0.00495%*
4	*201*	*202*	*0.000205%*
5	*202*	*202*	*0%*
6	*203*	*203*	*0%*
7	*224*	*223*	*0.00448%*
8	*223*	*223*	*0%*
9	*225*	*224*	*0.00446%*
10	*224*	*224*	*0%*
Persentase kesalahan			*0.00233%*

From the data above can be assumed a relative error between sensor calculation data to energy meter reading data is 0,00233% so that sensor readout data can be said to be accurate and can be used as variable calculation of power usage.

1.4.3. *Calibration Testing of DC voltage sensor*

Measurement of DC voltage calibration is done by measuring the DC voltage of the battery, where the test is carried out 10 times, for the data comparison of the reference value of truth using the solar charger controller tool that has been declared in accordance standard voltage measurement. The test data results are as follows :

Table 3 accu voltage measurement calibration

Trial Data	*Read by sensor (Volt)*	*Read by solar charger controller (Volt)*
1	*12.50*	*12.5*
2	*12.33*	*12.3*
3	*12.52*	*12.5*
4	*12.62*	*12.6*
5	*12.74*	*12.7*
6	*12.81*	*12.8*
7	*12.57*	*12.6*
8	*12.52*	*12.5*
9	*12.71*	*12.7*
10	*12.86*	*12.8*

From this test data can be seen that the battery voltage data can be measured well adjusted to the solar charger controller as a reference battery voltage is correct, so it can be used as real battery voltage variable to calculate 20WP solar panel can generate current in per day.

1.4.4. *Calibration Testing of electric current sensor*

Sensors calibration test Flow is done by measuring the reading of power consumption of a load, where the data will be comparable with the calculation of power consumption using the formula. It is known that the load used is a 13 watt vortex monitor, measured every 1 hour once 10 times. The results of test data are as follows

Table 4 Calibration Testing of electric current sensor

Time (IWST)	*Read by sensor (k1) (Kwh)*	*Calculation by formula P=V*I*T (k2) (Kwh)*	*percentage of error abs(k1-k2)/k2 * 100%*
11.00	*0.00*	*0.00*	*0%*
12.00	*0.12*	*0.13*	*0.07692%*
13.00	*0.25*	*0.26*	*0.03846%*
14.00	*0.37*	*0.39*	*0.05128%*
15.00	*0.50*	*0.52*	*0.03846%*
16.00	*0.61*	*0.65*	*0.06154%*
17.00	*0.74*	*0.78*	*0.05128%*
18.00	*0.87*	*0.91*	*0.04396%*
19.00	*0.98*	*1.04*	*0.05769%*
20.00	*1.11*	*1.17*	*0.05128%*
Percentage of errors			*0.04709%*

From the above test data can be assumed that the percentage of error between the calculation of the sensor data to the measurement data using the formula is 0.04709% so that the sensor readout data can be said to be accurate.

1.4.5. Pengujian Kalibrasi Pembacaan status pln

After testing checked the status of PLN by doing the measurement 10 times.

Table 5 Calibration reading PLN status

Trial Data	*Action*	*The Value read by Arduino*	*The value that should be generated*
1	*Unplug the appliance plug from PLN*	*0*	*0*
2	*Reconnecting device plug to PLN source*	*1*	*1*
3	*Unplug the appliance plug from PLN*	*0*	*0*
4	*Reconnecting device plug to PLN source*	*1*	*1*
5	*Unplug the appliance plug from PLN*	*0*	*0*
6	*Reconnecting device plug to PLN source*	*1*	*1*
7	*Unplug the appliance plug from PLN*	*0*	*0*
8	*Reconnecting device plug to PLN source*	*1*	*1*
9	*Unplug the appliance plug from PLN*	*0*	*0*
10	*Reconnecting device plug to PLN source*	*1*	*1*

1.4.6. Manual Mode Testing

Testing is done by operating the monitoring system tool in manual mode by switching toggle button to manual mode. After the observation, there are two observations:

1. *Manual Mode with PLN options*
   Based on observation, PLN relay is active within ± 1 second. This can be observed from the LED indicator's flame on the PLN relay and the load on the lit monitor.

2. *Manual Mode with Accu options*
   Based on observation, Accu relay is active within ± 1 second. It can be observed from the LED indicator light on the accu relays, the power inverter is on and the load on the monitor is on.

1.4.7. Auto Mode Testing

Testing is done by operating system monitoring tool in auto mode by switching toggle button to auto mode. After the observation, there are two observations:

1. *Auto PLN Mode is on*
   Testing is done when the condition of PLN under normal circumstances. This test was conducted 4 times experiment by connecting the plug to PLN current source.
   Based on observation, PLN relay is active within ± 1 second. This can be observed from the LED indicator's flame on the PLN relay and the load on the lit monitor. In the experiment 4 times, obtained the result of failure as much as 0 times, and succeeded 4 times so concluded in auto mode is running normally.
2. *Auto PLN mode is off*
   Testing is done when the voltage and frequency condition of PLN in the state is not lit. At the time of testing the voltage read on the LCD of 0 VAC, and this test is done 4 times by removing the plug from the PLN current source.
   Based on observation, Accu relay is active within ± 1 second. It can be observed from the LED indicator light on the accu relays, the power inverter is on and the load on the monitor is on. In the experiment 4 times, obtained the result of failure as much as 0 times, and succeeded 4 times so concluded in this auto mode the transfer of resources running normally.

1.4.8. Testing On Off Air Conditioner

The test is done by heating the condition of the room, so that temperature sensors read the room temperature is at a temperature of more than or equal to 29 ℃. And after the temperature is within the specified limits, whether the air conditioner will turn on or not, if the temperature below than 29 ℃ is expected the air conditioner is off.

After testing with experiment 4 times where heating and cooling the room once every 1 hour, and got result 4 times succeed, so can be concluded functional to do on / off AC running well where percentage of success is 100%.

1.4.9. Accu Filling Testing

Testing is an accu charging test using 20WP solar panel and accu 60AH. Data test results can be seen in the graph below.

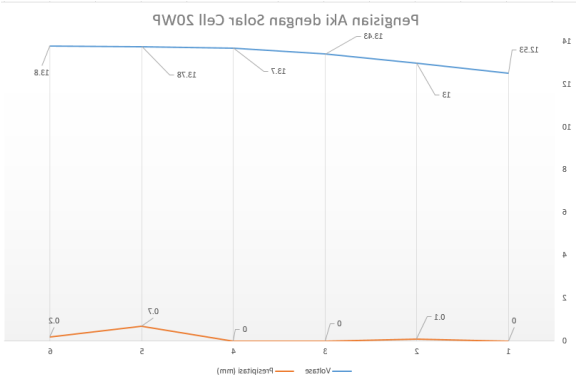


Figure 5 Charging chart of 60 AH batteries with 20 WP solar panels

1.4.10. Testing Usage of Accu

Testing is usage of accu 60AH with incandescent LED 10W 220V and 12VW 12V to AC 230V 12V AC inverter where converting DC current into AC requires 12W power, so total load is 22W, where the initial condition before accu is connected to load at 13:57 IWST accu 60AH is at a voltage of 13.71 VDC and the final conditions at 16:58 IWST after the batteries are not connected to the load to 13.3 VDC. The usage graph of batteries when connected with load is as follows.



Gambar 6 Graph of 60 AH battery usage with 22 W load

1.4.11. *Testing data transmission to the database*

Testing data delivery done as much as 15 times, where data successfully sent with delivery time every 2 minutes.

Table 6 Testing data to the database

Trial Data	*Voltage PLN*	*Voltage Inverter*	*Volt Battery*	*Temperature (Celsius)*	*Humidity (RH)*
1	*212*	*0*	*13.93*	*25*	*65*
2	*220*	*0*	*13.93*	*25*	*65*
3	*212*	*0*	*13.93*	*25*	*65*
4	*214.9*	*0*	*13.95*	*25*	*65*
5	*218.3*	*0*	*13.93*	*25*	*65*
6	*218.9*	*0*	*13.93*	*25*	*65*
7	*212*	*0*	*13.93*	*25*	*65*
8	*217.7*	*0*	*13.95*	*25*	*66*
9	*208.6*	*0*	*13.95*	*25*	*66*
10	*216.6*	*0*	*13.98*	*25*	*66*
11	*218.9*	*0*	*13.95*	*25*	*66*
12	*217.7*	*0*	*13.98*	*25*	*66*
13	*224.6*	*0*	*13.98*	*25*	*65*
14	*211.4*	*0*	*13.98*	*25*	*66*
15	*208*	*0*	*13.98*	*25*	*66*

3. CONCLUSION

This study resulted in a monitoring system and Automatic Transfer Switch (ATS) can automatically switch resources to the backup power source when the main current source voltage goes off and the system is able to transfer the current source to the primary source again when the primary source comes back. The system can make changes manually in accordance with the toggle switch position. The system can also facilitate server operators in monitoring the flow on the server and make the transfer of resources and solar system is able to fully charge 60 AH batteries for 6 days if using solar panels with a maximum power of 20W with the ability of batteries that each 0.4 Volt can do a load backup of 22W For 3 hours.

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