Battery Charging and Discharging Control of a Hybrid Energy System Using Microcontroller

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Abstract— This study aims to control charging and discharging the battery for hybrid energy systems. The control system works by selecting the right energy source to supply voltage to the load. And also this control system can regulate charging and discharging the battery automatically. The voltage source consists of two energy, namely from the battery and DC source. The control system that has been designed has the ability to choose the right DC source when the battery capacity is less than 80%. This system also has a good ability to choose a battery source when the battery reaches 100% capacity and the DC source has a voltage drop of more than 20%. This control system is equipped with excessive electric current protection so that the security level is high.

Keywords: Battery Charging, Discharging Control, Hybrid Energy System, Microcontroller

I. INTRODUCTION

Renewable energy such as solar radiation as an energy source to reduce the energy crisis. Energy from photovoltaic panels can be used to charge the battery. The battery charge control regulates the flow of electricity from the photovoltaic panel to the battery or DC load. Battery energy storage systems (BESS) is the most common energy storage that can be integrated into grid connected PV system. Solar PV energy systems are used to convert the trapped solar light into electricity. The various power sources that are available may be invarious forms such as the utility grid, renewable power sources such as solar panel and DC energy storage units such as batteries. Multiple energy sources are integrated in the microgrid to have for a reliable energy supply. Batteries are everywhere, from power storage device in solar photovoltaic. Among them, lithium-ion (Li-ion) batteries have become the most promising technology for energy storage due to their high energy density and high efficiency. The energy management strategy should be determined among the renewables, energy storage and grid. Batteries are used as power storage device in solar photovoltaic (PV) systems. They supply power when there is no solar power generation in the absence of sunlight. The size of energy storage can be done using two types of batteries, namely Lead-acid Lithium-ion batteries and batteries. but it needs to be considered because there is a big difference between the minimum cost between a lead-acid battery and a Li-ion battery . Battery has the advantages of high energy density, but with low power density, short cycle life, slow charging and discharging speed, and many other shortcomings. Control of these hybrid batteries within the same system is more challenging compared to conventional battery management systems which mainly deal with the homogeneous battery system. A battery charger have to more intelligent and conscious of battery health and bring a positive impact on user satisfaction. There are many factors that affect SOC, such as battery voltage, temperature, current, battery history, battery chemistry and so on. Ambient temperature is a significant factor that influences the accuracy of SOC estimation

II. RESEARCH METHOD

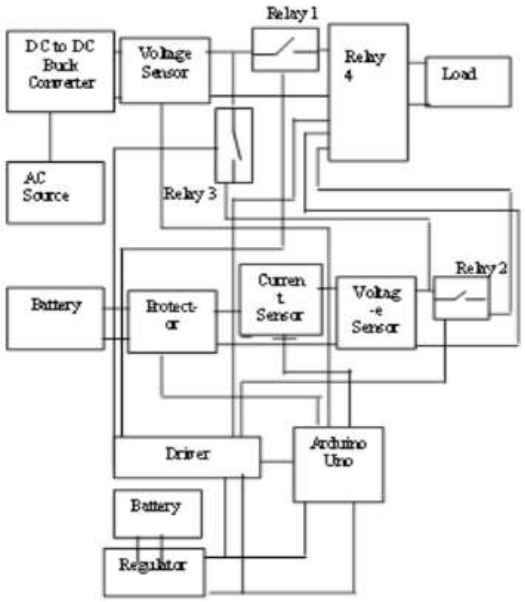

Fig. 1: Block Diagram of the battery charging for hybrid energy

Research method by designing hardware and software. The design of hardware and software will be explained in this section. The battery charging block diagram is shown in Figure 1.

A. System Design-Hardware

Control system for battery charging are designed based on the block diagram that is shown in Figure 1. Protector in this design consist of a fuse and diodes. The protection circuit is used to protect the system from overload condition. Beside that when the battery voltage is greater than the solar module it is likely that the battery will send its voltage back to the solar module. This is where the blocking diode functions to protect the battery.

B. System Design-Hardware

Software that has been created using the Arduino IDE 1.6.4 softwear. Designing software based on flowchat which has been designed based on Arduino Mega 2560. To be able to upload software, a connection must be made to the Arduino port. The following is an explanation of the flowchart in Figure 2.

1) The control system always prioritizes the DC source rather than the battery when the DC source reaches the voltage that has been set and when the DC source is

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below that which has been set then selects the battery and displays it on the LCD screen.

2) The control system selects all switches off to load if all voltage sources are below 80%
3) The control system charges when the battery capacity is below 80% and will stop charging when the battery capacity is 100% and displays this status on the LCD screen.
4) The control system disconnects if there is an overload and displays this status on the LCD screen.
5) The control system calculates the power load to the load and displays this status on the LCD screen.
6) The control system calculates and estimates the remaining battery time and displays this status on the LCD screen.

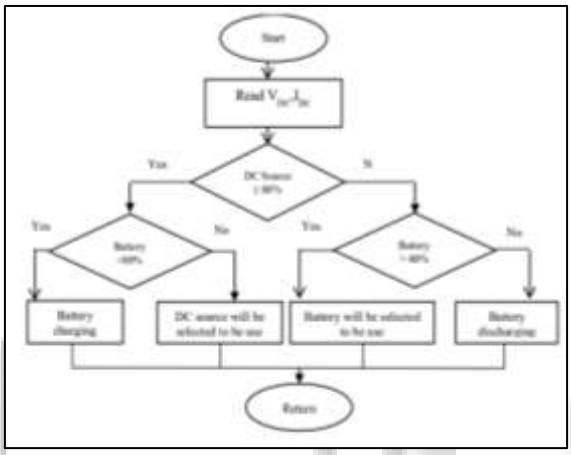

Fig. 2: The flow chart for the battery charging control program

III. RESULT AND ANALYSIS

In this section, there are 3 parts of the design result, hardware, software, and test result.

A. Minimum Battery Capacity Test

Testing aims to get system performance. Minimum battery capacity the allowable for supply of loads is 80%. The test results show the system can work automatically disconnecting the battery to the load when the capacity is below 80%. In Figure 4 shows relationship between percent of battery capacity and battery voltage. and for more detailed data can be seen in Table 2. In Table 2 the position of the switch NC or normally close means that the battery is connected to the load. While on the position switch NO or normally open means that the battery is not connected to the load.

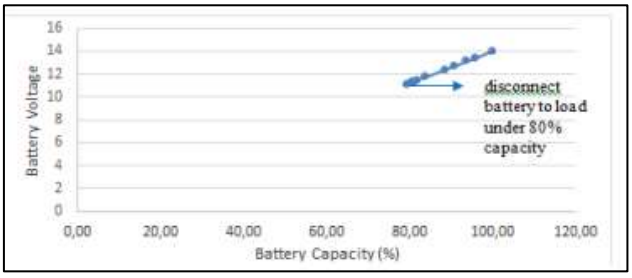

Fig. 3: Relationship between percent of battery capacity and battery voltage

B. Duration Time of the Battery

The remaining time is the duration of time the battery will run out of energy. In this study using battery with 14 V 5Ah. If the average electric current used is 5 A, the battery usage time is 1 hour. In Figure 6 shows that the more electric current the battery uses, the battery energy will also run out faster.

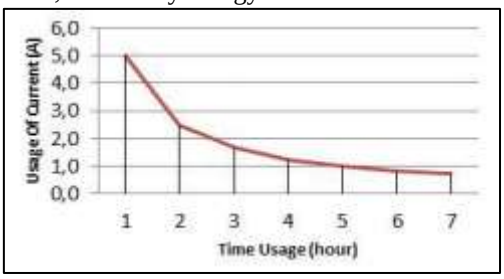

Fig. 4: Relationship between usage current and time duration battery

In following table is the estimation of the duration of time based on the use of electric current batteries usage. A battery with 5 Ah means that the average current used in 1 hour is 5 amperes. If use an average electric current of 0.7 amperes, the duration of the battery reaches 7 hours. For more details are presented in following table.

Time Remaining on the Battery

No	% Battery Capacity	Battery Ah Value	Usage of Current (Ampere)	Duration Time (hour)
1	100	5	5.0	1
2	100	5	2.5	2
3	100	5	1.7	3
4	100	5	1.3	4
5	100	5	1.0	5
6	100	5	0.8	6
7	100	5	0.7	7

C. Protection of Overload

In this research an over current protection system performance test was also carried out. The purpose of this protection system is to protect the panel and load due to over current from the battery and DC source. Testing on short circuit safety uses detection from current sensor 1. When the current sensor reads the current value of more than 5 amperes, the system will disconnect the current from the DC source and the battery source. The test results are shown in following Table.

Protection of Overload

No	Current Sensor 1	Position Of Relay 1	Position Of Relay 2	LCD Screen Status
1	1,1 A	NC	NO	Select DC Source
2	1,3 A	NC	NO	Select DC Source
3	2,8 A	NO	NC	Select Battery
4	3,2 A	NO	NC	Select Battery
5	5,1 A	NO	NO	Overload

IV. PROBLEM FORMULATION

– The hybrid energy sources are being depleted and causing severe negative impacts to the ecosystem thus exploiting the future needs.
– Renewable energy plays a vital role in sustaining these conventional sources. The renewable energy is

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abundantly available in the nature but without proper control and incorporation these resources cannot be used for power generation.

- Main drawback on depending on a single source of energy is the unstable operation caused due to inaccessibility and climatic variations.

V. CONCLUSION

Based on the results of testing and analysis that has been carried out the charge controller battery can work well even with low cost materials. The battery charge controller can choose the right energy form DC source when the voltage more than 12 V and the battery voltage less than 12.60 volts. And also when the DC source is less than 12 V and the battery voltage is 12.60 volts, the system selects the battery source. The control system can also work well when the battery voltage < 11.1 volts than relay 2 will cut the electric current to the load. The DC source cannot charge the battery if the voltage is less than 80%. In order for a DC source to charge the battery it needs more than 80% voltage. This BCR protection system also works well. When the sensor reads a current value of more than 5 amperes, the system will disconnect the current from the DC source and battery source

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