Technical Assessment of DC Supply Burglar Alarm System in Sta Barbara Elementary School

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Abstract- This research is focused on upgrading the operated anti-theft device/ burglar alarm system in Sta. Barbara Elementary School in Bacolor, Pampanga. Formerly, the installed burglar alarm system uses a 12VDC lead acid battery with 100 W solar panel. The solar panel comes from different sizes and types according to the accessibility of the panel. It will also be based on the components of the battery provided. The life span of the Lead acid battery is shorter, has low energy density and it can be charged slowly. This was the problem of the system's power supply that leads the system to not work as intended. Hence, the researchers stipulated and assessed the burglar alarm system's power source by means of conducting technical assessment, installing an efficient battery and evaluated the output of the solar powered burglar alarm system to know if it is efficient and durable. The researchers used a 12V, 100Ah Lithium-ion battery, which is design specifically for solar powered system industry. They assessed that the lithium-ion battery's specifications are impressive and effective. This battery is a fast charging and competent battery than the lead acid battery. It can also supply the given load within 24 hours without the help of the solar panel.

Indexed Terms- Technical Assessment, Burglar alarm system, Solar panel, Lithium-ion Battery

I. INTRODUCTION

Technological advancements have worked to improve the security and safety of every place in the world, particularly schools, offices, streets, establishments and many more. One of the examples that uses technology for security is the burglar alarm. A major benefit of installing a burglar alarm to your property is that it can deter a break-in before it happens.

Burglar alarms can be powered by solar panels. The advantage of solar panel is it can provide the continuous (rechargeable battery for backup) power supply for alarm device, and because it requires sunlight, it must work outside, recently many companies are providing solar panel powered perimeter alarm systems (Tom Harris, 2001).

Because of the increasing cases of theft in schools, a project was conducted by the professionals from Don Honorio Ventura State University that focused on the installation of 12VDC burglar alarm system with 100W solar panel in Sta. Barbara Elementary School at Bacolor, Pampanga. The said power source was chosen to provide a low cost, effective, and simple security system.

However, after a few months since its installation, it has been found out that the alarm system is no longer working as intended. Correspondingly, Sta. Barbara Elementary School was newly renovated and the area where the alarm system is installed was said to be altered.

Through that, the students from the Department of Electrical Engineering of Don Honorio Ventura State University (DHVSU) will stipulate and assess the burglar alarm system's power source by means of providing efficient type of battery and analyzing the solar panel of the said power supply.

For this study, the researchers enumerated the following questions:

1. What are the components to be considered to improve the alarm system's battery and power supply?
2. What type of battery should be used to prolong the life span of the alarm system?

The following are the specific objectives of the research study:

- To improve the components (Battery and Inverter) by choosing the appropriate specifications for the alarm system.
- To evaluate the output of the Solar Powered Burglar Alarm System after providing more efficient battery and checking the condition of the solar panel.

In line with the objectives, this study is performed to manage and improve the utilized anti-theft device/system in Sta. Barbara Elementary School. Through the conduct of technical assessment, the proponents will provide efficient battery and evaluate the output of the solar powered burglar alarm system for more effective and longer service. Likewise, this research would give a deep understanding and clear insights about the specifications and components of the power supply to be used to make the burglar alarm last longer.

The central point of the paper will only be on the technical assessment of a DC Supply Burglar Alarm System in Sta Barbara Elementary School. This study will only focus on the power supply of the system. It will emphasize about the provided components installed and illustrate its improvement and efficiency. Also, graphs and tables will be used to interpret the consume capacity, charging period, and quantity discharge of the battery.

II. METHODOLOGY

- Conceptual Framework

Figure 1 presented the conceptual framework of the study. It illustrates how the power supply will work together to make a burglar/anti-theft alarm system. Starting with the 100-watts solar panel, it will serve as the source of power supply connected on the 30-Ampere Charge Controller that will distribute and maintain the balance of the attached battery to avoid overcharging. The battery will serve as the storage of the supply and, can be the power source when having a low level of sunlight/power interruption in the solar panel. It will supply the power needed to make the burglar alarm system function well. The inverter connected will convert DC to AC supply for the bell.

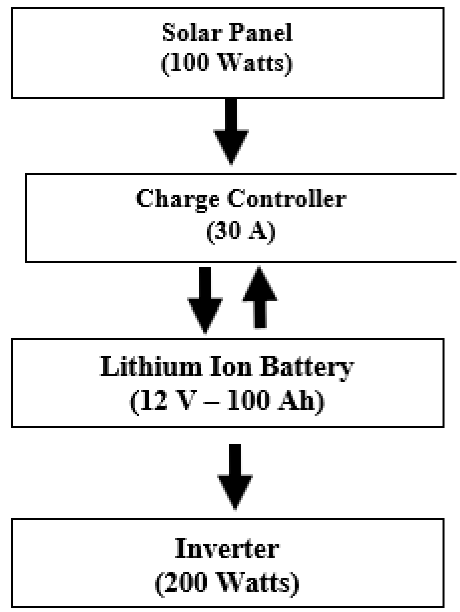

Figure 1. Conceptual framework of the study

- Research Framework

The succeeding procedures will be employed in providing efficient power supply and assessing the solar powered burglar alarm system. The IPO model was implemented to recognize the inputs, outputs, and required processing tasks essential to convert inputs into outputs. That asserts that a system's general construction is just as substantial as its individual apparatuses in deciding how well it will execute.

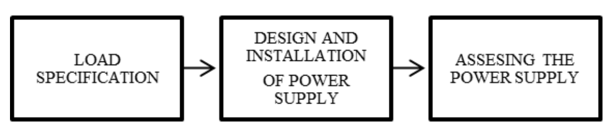

Figure 2. Research framework of the study

- Load Specification

In determining the specification of components (battery and inverter) to be used, prior materials and components were considered. Loads were recognized in accordance with the power consumption of each component that will be used in the system that is shown in Table 1 and 2.

Table 1. Total Power Rating and Watt-Hour of Components

Component	Power Rating (Watts)	Hours	Watt-Hour/day
Electric Bell	7	0.5	3.50
2 Flood Lights	50	12	600
2 Motion Sensor	0.2	12	2.44
Magnetic Switch	0.1	12	1.20
Arduino Uno	0.2	12	2.4
200 W Inverter (No load)	5	12	60
TOTAL	62.5 Watts		669.54 Watt-Hour

Note:
Operates at 6 pm to 6 am daily; Operates only if there is an Intruder; Operates as Outdoor lighting of the school.

Table 2. AC and DC Loads

Component	Watts	Volts	Ampere	Size of wire	Size of conduit
AC Loads					
Electric Bell	7	220	0.03	2 sq.mm THW Wire	20mm dia. PVC
DC Loads					
2x Flood Lights (25W)	50	12	4.17	2 sq.mm THW Wire	20mm dia. PVC
2x Motion Sensor	0.2	12	0.02	2 sq.mm THW Wire	20mm dia. PVC
1x Magnetic Switch	0.1	12	0.01	2 sq.mm THW Wire	20mm dia. PVC

- Design and Installation of Power Supply

Formerly, the installed burglar alarm system uses 12VDC lead acid battery with 100 W solar panel. Sealed lead acid batteries can have a design life of anywhere from 3 to 5 years depending on the manufacturing process of the battery. However, it cannot be stored in a discharged condition, it has low energy density, it allows only a limited number of full discharge cycles, it is not friendly to the environment and thermal runaway can occur with improper charging. Lead acid batteries produce a substantial amount of heat when charging. Because of this, they require a “cool down” period afterward (Andrew Lerma, 2019).

- Sizing of Solar Panel

The solar panel comes from different sizes and type. The accessibility of the panel is also to be considered. For the Principal’s Office with a 12VDC system in Sta. Barbara Elementary School (see appendix G.1 for citation), the solar cells installed is in mono crystalline panels and are sliced-cut from pure drawn crystalline silicon bars. The entire cell is aligned in one direction, which means that when the sun is shining brightly on the cell at the correct angle, it is extremely efficient. It has a uniform blacker color to be able to absorb most of the light. The rating of the panel depends on the load computation needed in the system. Because the solar panel is still working and capable, the researchers use the same panel for this study.

- Selection and Sizing of Battery

A deep cycle battery is used in the system to store the quantity of electrical energy produced by the solar panel (see Appendix A for reference). This type of battery needs maximum current given by the solar PV module. Similarly, this lithium-ion type of battery was designed to be regularly discharged. Basic principle in the DC circuits is that when charging a battery, the charger must have higher voltage than the battery because the current will follow the direction of the higher voltage component.

Based on the result of the computation, a battery with at least 58.73 Ah is needed for the system (see Appendix A and B for citation). The researchers decided to use a 12V, 100 Ah deep-cycle Lithium-ion battery (see appendix G.2 for reference) for the system to accommodate the ampere-hour requirements of the components.

- Sizing of Charge Controller and Power Inverter

Additional electronic element which needs to be considered is the charge controller (see appendix G.3 for reference). This element controls the battery charge level to avoid overloading and over discharging that may lessen the life extent of the battery. Charge controller also supports to normalize the rate at which electric current is added or drawn from electric batteries. The size of the charge controller calculated is 8.33 Amperes (see appendix C for reference).

The figured size of the inverter is 93.75 Watts (see appendix C for citation). Given that there is no 93.75-watt inverter, 200-Watts was operated instead, 12VDC/230VAC to premeditate the future load expansion. Based on computation, a 20-Ampere and 12/24 Volt charge controller is used. This component is recognized to convert the DC voltage stored in the battery to AC voltage used as supply in the system. The Project needs 62.5 Watts to supply, a 200-Watt, 12VDC/230VAC pure sine wave inverter was used.

- Sustainable Management Plan

Battery management system, they regulate how the battery works and how well it performs under different conditions. Batteries must be monitored and maintained. To avoid being damaged or destroyed, it is vital that these battery systems stay within parameters. A decent BMS will also help your batteries last longer by avoiding oxidation and plate damage. They will always be good value for money in the long run. BMS monitor a variety of variables, including voltage, current, temperature, and, in certain cases, specific gravity.

High ambient temperature, excessive current draw, and overvoltage are examples. These readings are then recorded and processed to establish the battery's state of charge and health, offering more insight into its performance.

The only consistent preservation required for your solar panels is cleaning and a yearly examination. Or else, if your panels are working properly, they won't need additional maintenance throughout the year.

For the charge controller, it needs to be clean rarely with a non-abrasive cleaner and make sure the mounts and fasteners are tight. Vibration, expansion, and contraction from temperature changes, can loosen the mounting hardware. Modern charge controllers also use solid state electronics with no moving parts.

- Assessment of the Power Supply

The power supply was assessed on how it supplied the load. The battery was tested if it is charging on daytime to sustain the demand of the load at night-time using the charge controller. The loads such as the two 25-Watts Flood lights and the alarm system were only operated at night. Another investigation was done to examine if the power supply (battery) can sustain the demand of the load even during power interruption and its capabilities to charge fast when connected to the solar panel.

III. RESULTS AND DISCUSSION

- DATA AND RESULTS

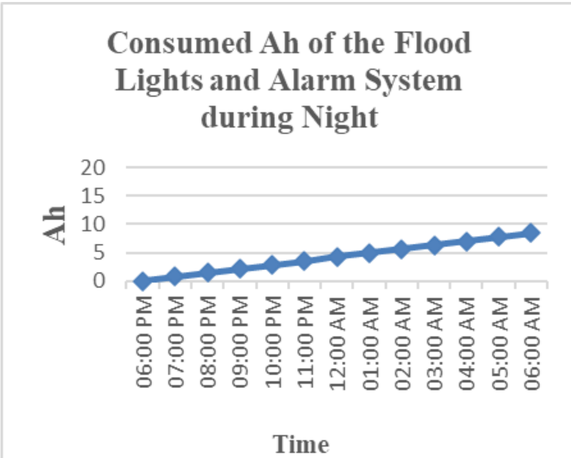

Figure 3. Consumed Ah of the Lights and system at night

The information shown on Fig. 3 (see Appendix D.1 for reference) was the consumed capacity of the battery in Ah throughout the night. The load associated on the system were two 25-watts flood lights and the anti – theft alarm system. The capacity of the battery used is 100 Ah and 14.2 V when the solar panel is connected. The loads run for 12 hours. The total consumed Ah for 12 hours using the charge controller was 8.45 Ah. The battery capacity still has 91.55 Ah remaining. This illustrates that the system can supply the specified load demand.

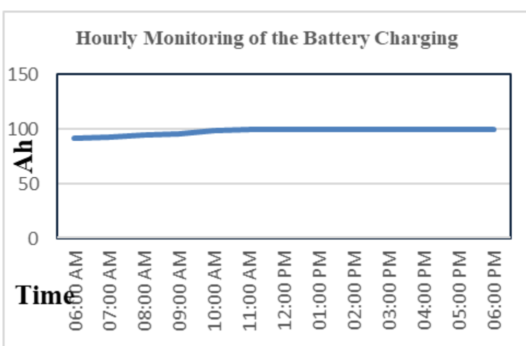

Figure 4. Hourly monitoring of the battery charging

The starting capacity of the battery once charging was 91.55 Ah. The capacity of the battery (see Appendix D.2 for reference) during discharging was based on the open circuit voltage reading of the battery. A diagram was shown on how to obtain the capacity of the battery base on the voltage reading of the charge controller. The battery attains the full charge state after 5 hours. When the voltage reading of the battery reached 14.2 Volts (100 Ah), the capacity of the battery is at its 100 percent. The 100 percent of the battery was achieved at 11:00 AM with the help of the connected solar panel.

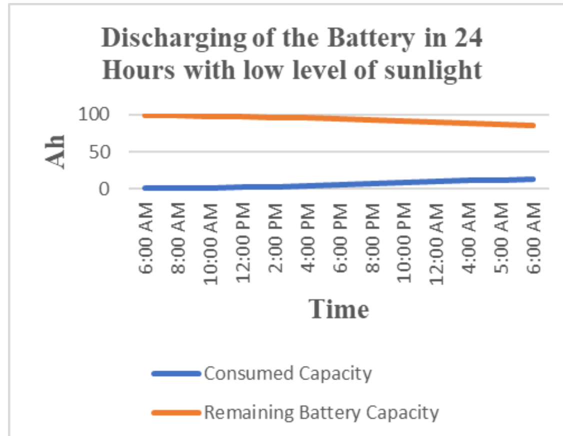

Figure 5. Battery discharging in 24 hours low level of sunlight

The initial capacity of the battery (see Appendix D.3 for reference) at 100 percent is 14.2 Volts (100 Ah). In this scenario, there is a power interruption/low level of sunlight in Sta. Barbara Elementary School. After twelve hours (6:00 am to 6:00 pm) of using the battery to provide power source to the flood lights and the anti – theft alarm system with a minimal help of the solar panel, the capacity of the battery is still 94.37 Ah. At night, the researchers observe that the average of the battery discharge is approximately 1.46 Ah per two hours. By this information, the proponents detect that the power source/battery type provided can supply the specified load in 24 hours with low level of sunlight and has a remaining battery capacity of 85.92 Ah.

With the information of the old system that the charging time of this battery until 100 percent capacity and without supplying a load is 6 hours, the proponents observed that the new provided system is faster because it only takes 5 hours to achieve its full charge state. In line with this, after 12 hours of consumption in the previous battery, the total consumed Ah was 19.54 Ah, while in the new battery, total consumed was only 8.45 Ah. This just shows that the system provided is much better than the former system installed.

CONCLUSION

The power supply accomplished its main goal of providing a maintainable and operative power source to the connected alarm system. The data attained verified that the battery provided can sustain the power needed by the alarm system all throughout the day, even during a low level of sunlight. Sustainable Management Plan for the components used are also included. It shows that the power supply improved when it comes to its charging period and its capacity to supply the load during a long extent of time. The researchers also assess that the lithium-ion battery's specifications are impressive and effective.

RECOMMENDATION

Founded on the data and results collected, it is recommended to always check the system and the power supply to avoid the desolation of it. Maintain the cleanliness and continuously monitor the wiring of the system. It is also endorsed to upgrade the solar panel's size together with the lithium-ion battery's capacity to provide more efficient power supply.

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