Faculty of Electrical and Electronic Engineering Technology

A DEVELOPMENT OF A SMART BUS STOP LAMP POST BY SOLAR LIGHTING SYSTEM

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Bachelor of Electrical Engineering Technology with Honours

2022

A DEVELOPMENT OF A SMART BUS STOP LAMP POST BY SOLAR LIGHTING SYSTEM

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A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Electronics Engineering Technology with Honours

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2022

DECLARATION

I declare that this project report entitled “A Development Of A Smart Bus Stop Lamp Post By Solar Lighting System” is the result of my own research except as cited in the references. The project report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

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Date : 31/12/2022

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APPROVAL

I hereby declare that I have checked this project report and, in my opinion, this project report is adequate in terms of scope and quality for the award of the degree of Bachelor of Electrical Engineering Technology with Honors.

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Date : 20/2/2023

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DEDICATION

My dissertation is dedicated to my family and many friends. I am very grateful to my loving parents, En. Abu Samah and Pn. Shariffa, whose words of support and push for persistence continue to ring in my ears. My precious brothers and sisters who have never left my side. I also dedicate this dissertation to my numerous friends and family members who have been there for me throughout the process. I will be eternally grateful for everything they have done for me, especially my fellow friends who have assisted me in developing my technological abilities, as well as the many hours of proofreading and technical competence.

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ABSTRACT

Our project is about developed a smart lighting system at bus stop by solar system. The objective of this project is to create a project that can save the usage of electricity and to ensure the safety of users especially at night. In addition, there are several studies covered in this project, namely, using PIR "Passive Infra-Red" sensors to detect the presence of people at the bus stop. All these objectives are intended to address the problems that arise aswe undertake research to produce this project. Among the problems we identified during our testing process were the authorities the irresponsible people do not turn off switch went not in use. With that, we used a PIR sensor to detect the motion of people and LDR sensor to detect the presence of light. In this project we connected from solar to the solar charger control and supply to the battery to store a voltage. Therefore, at night the load can get a supplied from the battery to run the smart lighting system at the bus stop. For my data and analysis, we collected 7 days of charging battery using solar system with different weather and try to run out the output for 4 hours straight without stop. We collected every 20 minutes and take a reading for how many Ampere/hours Ah are used every 1 hours each. So that we can analyse the charging solar at daytime can accommodate the usage of battery at night. Based on the results of the analysis and debate, it can be determined that the creation of a smart bus stop lamp post with solar lighting has achieved its stated purpose. In addition, this tool has also been proven to save time and energy usage in performing tasks.

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ABSTRAK

Projek kami adalah tentang membangunkan sistem pencahayaan pintar di perhentian bas oleh sistem solar. Objektif projek ini adalah untuk mewujudkan projek yang dapat menjimatkan penggunaan tenaga elektrik dan memastikan keselamatan pengguna terutamanya pada waktu malam. Selain itu, terdapat beberapa kajian yang diliputi dalam projek ini, iaitu, menggunakan sensor PIR “Passive Infra-Red” untuk mengesan kehadiran orang ramai di perhentian bas. Kesemua objektif ini adalah bertujuan untuk menangani masalah yang timbul semasa kami menjalankan penyelidikan untuk menghasilkan projek ini. Antara masalah yang kami kenal pasti semasa proses ujian kami adalah orang yang tidak bertanggungjawab tidak mematikan suis tidak digunakan. Dengan itu, kami menggunakan sensor PIR untuk mengesan pergerakan orang dan sensor LDR untuk mengesan kehadiran cahaya. Dalam projek ini kami menyambung dari solar ke kawalan pengecas solar dan membekalkan kepada bateri untuk menyimpan voltan. Oleh itu, pada waktu malam beban boleh mendapat bekalan daripada bateri untuk menjalankan sistem lampu pintar di perhentian bas. Untuk data dan analisis saya, kami mengumpul 7 hari pengecasan bateri menggunakan sistem suria dengan cuaca berbeza dan cuba menghabiskan output selama 4 jam terus tanpa henti. Kami mengumpul setiap 20 minit dan mengambil bacaan untuk berapa banyak Ampere/jam Ah digunakan setiap 1 jam setiap satu. Supaya kita dapat menganalisis pengecasan solar pada waktu siang dapat menampung penggunaan bateri pada waktu malam. Berdasarkan hasil analisis dan perbahasan, dapat ditentukan bahawa penciptaan tiang lampu perhentian bas pintar dengan lampu solar telah mencapai tujuan yang dinyatakan. Selain itu, alat ini juga telah terbukti dapat menjimatkan masa dan penggunaan tenaga dalam melaksanakan tugas.

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ACKNOWLEDGEMENT

First and foremost, I'd want to offer my heartfelt thanks to the many people and organizations that helped me throughout my graduate studies. First and foremost, I would like to express my heartfelt gratitude to my supervisor, Datin Dr Fadzilah bt Salim, for his enthusiasm, patience, insightful comments, helpful information, practical advice, and never-ending ideas, which have greatly aided me throughout my research and writing of this thesis. His vast knowledge, extensive experience, and professional skills in Electrical Engineering helped me to effectively accomplish my research. This would not have been feasible without his help and supervision. I could not have asked for a better supervisor during my studies. My heartfelt gratitude goes to my parents and family members for their love and prayers during my studies.

I'd also want to thank you to Universiti Teknikal Malaysia Melaka (UTeM) for allowing me to complete my bachelor's degree program. I am also grateful to the following FTKEE university personnel, co-workers, and classmates, as well as those persons who are not included, for their assistance.

Finally, but not least, thank you to everyone in my course for a wonderful four years of sharing premises with you.

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TABLE OF CONTENTS

UTeM
اونيۆرسيتي تيكنيكل مليسيا ملاك
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

LIST OF TABLES

(List of Tables is optional. Please remove this page if it is not used

اونيۏرسيتي تيكنيكل مليسيا ملاك
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LIST OF FIGURES

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

(List of Figures is optional. Please remove this page if it is not used)

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LIST OF SYMBOLS

δ	-	Voltage angle
%	-	percent
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LIST OF ABBREVIATIONS

V	-	Voltage
PIR	-	Passive Infra-red
LDR	-	Light-dependent resistor
PWM	-	Pulse width modulation
A/h	-	Ampere/hour
PV	-	photovoltaic
W/h	-	Watt/hour
	-	

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LIST OF APPENDICES

(List of Appendices is optional. Please remove this page if it is not used)

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CHAPTER 1

INTRODUCTION

1.1 Background

This project is about bus stop lamp post in Malaysia. The bus stop is one of the important facilities in any district. It can be a place to wait for the bus and take shelter if it is a rainy day. Therefore, the bus stop must be in good condition and can be operated well in a very long term.

This project was taken up because mostly bus stop lamp post in Malaysia does not operate well at night and will cause unexpected things to happen. So, there is a need for a solution to prevent it. Besides, many bus stop lamp posts are not in good condition due to lack of maintenance. A lack of workers to do maintenance can also be a major problem.

Developing a lamp post at the bus stop that uses solar system can save electricity. A development of a smart bus stop lamp post using solar lighting system using a sensor to detect the presence of people. In this project we have implemented a motion sensor to detect the present of people. This project can make the city in eco-system. This solar system will charge the battery during sunrise and use the battery using sunset.

1.2 Problem Statement

The bus stop lamp post are mostly not well operated. This is because the bus stop lamp post uses a switch to light up the lamp. The careless attitude of people that some irresponsible people do not turn off the light when not in used can cause a waste of electricity.

In the nutshell, when the using of the bus stop lamp is frequently used it will shorten the life expectancy of the lamp and cost high usage of electricity.

In addition, the frequency of using bus stop lamp post will need a maintenance more often because of the usage. The shortage of workers also lead to this problem. In the event of a damaged bus stop post lamp, the authorities will have to repair it immediately the bus stop lamp post to prevent any discomfort area can cause any kind of crime. Thus, there is a need to develop a smart lamp post in order to save the electricity.

1.3 Project Objective

The objective of this project is as follows:

a) To analyze the solar lighting system at bus stop lamp post development from the previous studies.

b) To design a smart bus stop lamp post using Arduino UNO.

c) To evaluate the performance of a smart bus stop lamp post using PIR “Passive Infra-red” sensor system with solar.

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1.4 Scope of Project

This project scope’s is defined as follows to avoid any uncertainty about the project owing to various limits and constraints :

a) This project is targeted for using at night.

b) The using of PIR sensor is using to detect the presence of people.

c) This project uses Photovoltaic solar panels.

d) The type of microcontroller used in this project is Arduino Uno.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

General topics, issues or areas of focus need to be identified and then provide the appropriate context for the literature review. The overall trend of the topic, suggestions in theory, methodology, evidence and conclusions or new issues should be stated.

In this chapter, further discussion of past research and related information will make important contributions to the field of study, light detection systems or closely related systems. In today's modern civilization, energy efficiency is regarded as one of the most important methods for reducing electricity use and preserving the environment. There are many sources of information about related areas published on the web about bus stop lamp post. The information collected provides suggestions on current methods and examples of opinions. The idea is therefore supported and justified by important past research.

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2.2 Smart Lighting system

Street lighting system's smart technologies are essential for creating a safe environment for residents and businesses. Street lighting in several nations have begun to use smart technologies. The first stage in installing a smart system is to lower energy usage and operating costs. To reduce power usage, advanced smart operating approaches are needed for maintaining, regulating, and communicating street illumination. Smart PIR sensors combined with LED streetlights could be used in urban areas to reduce power usage. Energy conservation and operating costs will be impacted by this integration of streetlights [1].

In this study, a PIR sensor lighting system as shown in Figure 2.1 is suggested for Aligarh University's campus area with the main objective of lowering energy consumption and operating expenses. With integrated smart PIR sensors and an adaptable part-night lighting system using standard LEDs, the proposed smart technique was applied to 36 streetlights. The suggested approach, a traffic-aware smart PIR street lighting system in Aligarh, results in 96-97% less power consumption over the course of six months than the standard lighting system. Therefore, these intelligent lighting systems can control power and cost usage [2].

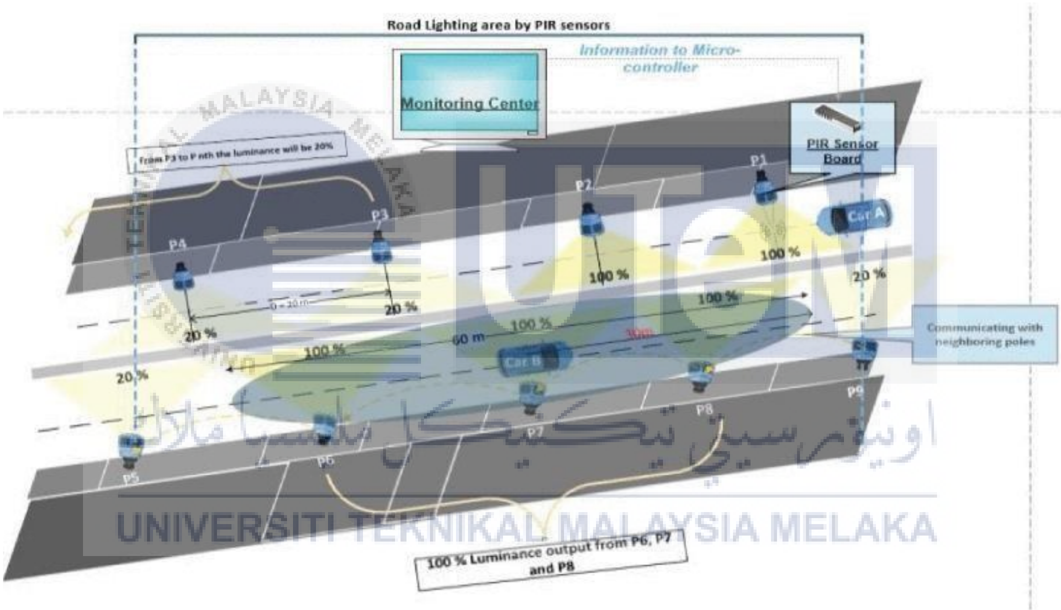

Figure 2.1 Using PIR sensor on Street light

The passive infrared (PIR) sensor is a tiny gadget used to track the movement of objects and track the heat that live things emit. These PIR sensors exchange information with the central management system, which autonomously manages and regulates the smart lighting activities. Additionally, the PIR sensor operates continuously throughout the night when motion is detected, turning on the roadway and executing the system's inbuilt algorithm. A thorough overview of the campus's smart PIR sensor lighting system is shown in Figure 2.1 [2].

2.3 Using PIR for smart concept.

The infrared energy that every living thing emits in the region makes the PIR easily responsive. As an illustration, the sensor will detect infrared energy from the body when a human enters the sensor area field. The purpose of the light, which is housed inside the PIR sensor, is to illuminate when it detects the movement of a live object but not to react to a person who is standing still. A moving living item causes an abrupt change in infrared energy, whereas a static body causes infrared energy to change more slowly [3].

The temperature change in the environment will result in slower alterations. The PIR sensor is the most sensitive and an excellent alternative, but no motion sensor system is perfect. Each form of light sensor developed and invented, such as the photodiode, photovoltaic cells, photomultiplier, phototransistors, charge coupling device, and photo resistor, has a distinct function [4].

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2.4 World electricity use

Figure 2.2 shows the growth of global electricity generation during the last few decades. Take note of how electricity use is overtaking energy consumption, both of which are outpacing the global population [5]. The many drop-down menus affect which countries or regions are displayed, as well as the graph type and variables examined. Take note of the proportionate amount of electricity produced. Around 1 billion people live in Europe, 500 million in North America, and nearly 4 billion in Asia [5].

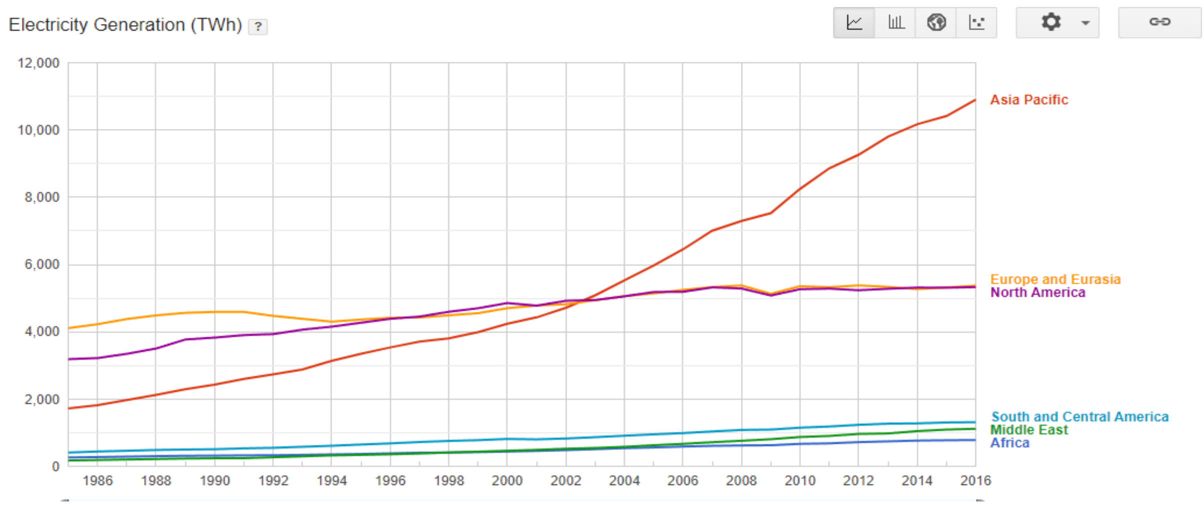

Figure 2.2 The graph depicting world electricity generation

2.5 Solar Energy

Solar energy is defined as the energy that the earth gets from the sun and turns into thermal or electrical energy. It is an important renewable energy source, and its technology is categorised as solar energy or active solar depending on how it gathers, distributes, or transforms solar energy into solar power. Although solar energy has an impact on the earth's climate and weather, it only accounts for 0.5% of the world's electricity. However, scientists predict that sunlight has the capacity to generate 5000 times the amount of energy that the world consumes. Solar energy is a broad phrase that refers to a variety of methods for extracting energy from the sun [6].

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Electricity must be transmitted across long distances from massive power facilities to end consumers. Power is lost during long-distance transmission. Have you ever wondered why solar panels are used? They've installed solar panels on your roof to harness the energy of the sun. Rooftop solar power can help boost electricity efficiency due to the short distance. As a result, the amount of energy used and the amount of money spent on power can be managed.

To summarise, solar energy benefits households and makes life easier for some people, whether they are in businesses, residences, or industries. Communities benefit from solar energy and save more money because their electricity usage is minimized [6].

2.5.1 Photovoltaic system.

A photovoltaic (PV) system is a combination of one or more solar panels, an inverter, and other electrical and mechanical components that generate electricity from the Sun's radiation. PV systems come in a range of sizes, from small rooftop or portable systems to enormous utility-scale power plants. Solar photovoltaic (PV) systems are semiconductor devices that convert sunlight into direct current (DC) electricity via electron transfer. They are a tested technology with a lifespan of 20–30 years.

The energy conversion process is separated with two types: light absorption produces an electron-hole pair in a semiconductor material, followed by the device's structure separating the electron to the negative terminal and the hole to the positive terminal to supply electricity [5]. To create additional electrical energy, solar cells may be connected in series, and many modules can be combined to make an array. Solar-PV systems provide a number of advantages, such as a simple design, a long operating life, high reliability, and the fact that they do not pollute the environment while producing power.

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Monocrystalline silicon, polycrystalline silicon, and thin film PV cell technologies now dominate the worldwide market. High-efficiency PV technologies, such as gallium arsenide and multi-junction cells, are less widely employed due to their high cost, despite their suitability for concentrated solar systems and space applications. Only a few of the innovative PV cell technologies are perovskite cells, organic solar cells, dye-sensitized solar cells, and quantum dots [7].

2.5.1.1 Monocrystalline Silicon Cell

The earliest high-efficiency solar cells were made using monocrystalline silicon, an extremely pure kind of silicon. To make a cylindrical ingot with a single, continuous crystal lattice structure, a seed crystal is extracted from a molten silicon mass. To make the required p-n junction, this crystal is forcibly sheared into thin slices, cleaned, and doped. The cell is finally connected and packed alongside many other cells into a full solar panel after an anti-reflective coating and front and back metal connections are applied. Although monocrystalline silicon cells are extremely efficient, their manufacturing is time-consuming and labor-intensive, price will be higher than polycrystalline or thin-film rivals [8].

2.5.1.2 Polycrystalline Silicon Cell

Polycrystalline (or multicrystalline) cells are made up of numerous small crystal grains as opposed to a single homogenous crystal structure. They are created by forming a tile filament of molten silicon, then splitting and packing it in the same manner as monocrystalline cells. Edge-defined film-fed growth is another approach that involves pulling a thin ribbon of polycrystalline silicon from a mass of molten silicon (EFG). In 2015, polycrystalline silicon PV cells, a less expensive but less efficient option, dominated the international market, contributing for any more than 70% of global PV output [9].

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2.5.1.3 Thin Film Cells

Thin film PV cells are substantially more flexible and robust than crystalline PV cells, which dominate the market. Amorphous silicon (a-Si) is a form of thin film PV cell made by producing thin layers of silicon on a glass surface. As a result, the cell is very thin and flexible, requiring only 1% of the silicon used in crystalline cells. Amorphous silicon cells are significantly less expensive to produce due to cheaper raw material costs and a less energy-intensive manufacturing method. However, their efficiency is greatly reduced since the silicon atoms are much less organized than they were in crystalline forms, generating in 'unpaired electrons' that interact with other elements and leave them electrically inactive. These cells are marketed with power needs based on their lower output since they have a 20% efficiency loss during the first few months of service before stabilizing [10].

2.5.2 Concept of light sources using Photovoltaic system.

There are two types of light sources utilised in photovoltaic (PV) lighting systems which is AC light sources and DC light sources. Fluorescent and high-intensity discharge (HID) lamps are examples of alternating current (AC) light sources, whereas direct current (DC) light sources include light-emitting diodes (LED) and incandescent (including halogen incandescent) lights. Figure 2.3 illustrates how the circuits in PV lighting systems are designed that way for different light sources [7].

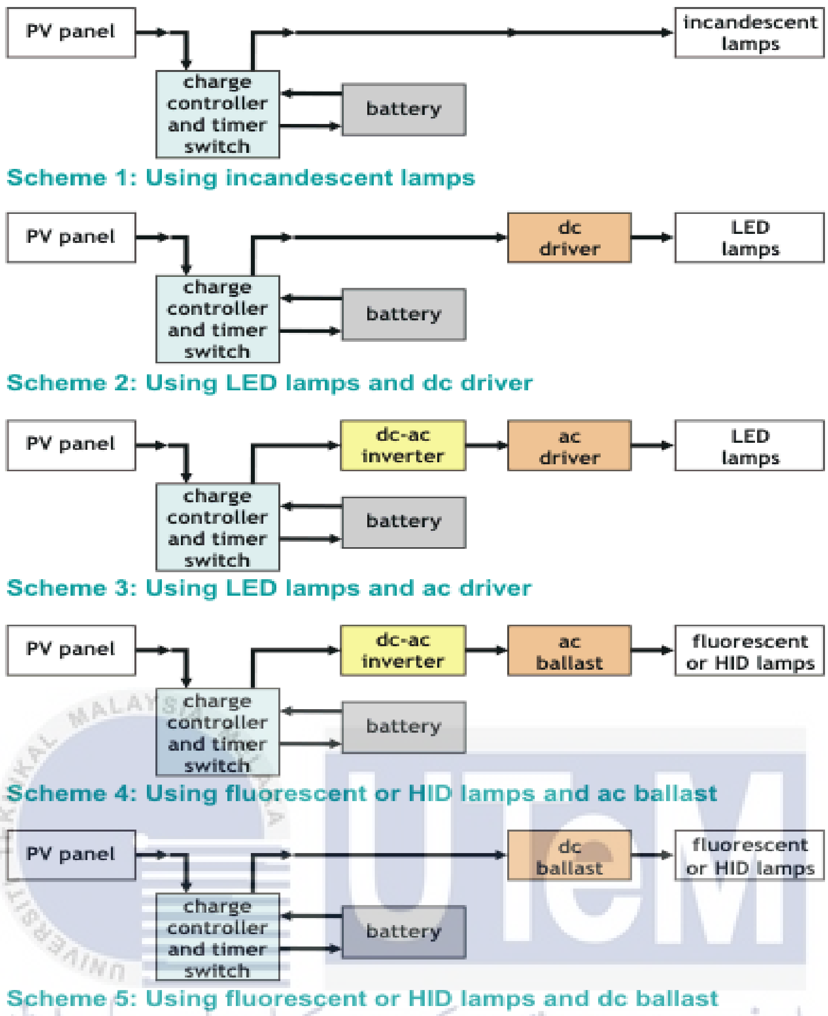

Figure 2.3 Configurations of PV lighting systems with different light sources

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2.5.3 The process to determine the appropriate size of PV panels for a particular application.

Step 1 – How to calculate the daily energy consumed by the light source in watt-hours.

E Daily Consumed = Lamp Wattage × Daily Operating Hours

= 13 watts × 8 hours/day

= 104 watt-hours/day

Step 2 – To calculate the electric energy that the PV panels need to produce each day.

Estimate the battery capacity of the system is large enough to allow necessary charging and discharging for powering the lamp.

EPV Produced = E Daily Consumed / (Electronics Efficiency × Battery Charge/Discharge Efficiency)

= (104 watt-hours/day) / (80% × 60%)

= 217 watt-hours/day

Step 3 – To calculate the amount of solar radiation that the PV panels need to collect each day.

E Solar Radiation Needed = EPV Produced / (PV panel conversion efficiency)

= (217 watt-hours/day) / 10%

= 2170 watt-hours/day

Step 4 - Calculate the size of the PV panels needed.

If the PV panel is in a horizontal position:

Size of PV Panels = E Solar Radiation Needed / Daily Solar Radiation

= (2170 watt-hours/day) / (2900 watt-hours/square meters/day)

= 0.75 square meters

= ~8.2 square ft

If the PV panel is tilted with an angle of latitude plus 15 degrees (facing south):

Size of PV Panels = E Solar Radiation Needed / Daily Solar Radiation

= (2170 watt-hours/day) / (5000 watt-hours/square meters/day)

= 0.43 square meters

= ~4.6 square ft

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2.6 Summary

PV systems are stable devices that directly convert solar energy, the largest global source of energy, into electricity without the necessity of a heat engine or spinning equipment. Photovoltaic cells are constructed from various semiconductors, which are things that conduct electricity only effectively. The most common materials are silicon (Si), cadmium sulphide (CdS), cuprous sulphide (Cu2S), and gallium arsenide (GaAs). When these cells are lit, they are packed into modules that provide a specific voltage and current. To generate higher voltages or currents, modules can be connected in series or parallel. PV systems are solar powered, have no mechanical parts, are adjustable to meet power demands of all sizes, are dependable, and have a longer lifespan. Photovoltaic (PV) systems can be used alone or in combination with other types of energy. Photovoltaic systems are utilized for a variety of purposes, including communications, remote power, remote monitoring, illumination, pump systems, and battery charge.

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CHAPTER 3

METHODOLOGY

3.1 Introduction

The approaches for constructing a development lighting system that is combined with PV solar are discussed in this chapter. The development of this project has included various elements for it to work completely, based on the prior studies in Chapter 2. Primary sources and secondary sources are the two types of sources used. The primary source includes analysis, design idea, and testing procedures, while the secondary source is research from journals, articles, and books available online. This chapter analyses and evaluates the equipment required to reach a compatible outcome.

3.2 Methodology

This project provides a fully integrated lighting system that can work automatically. To complete the function of the development lighting system, a variety of characteristics will be incorporated. The system is developed in stages, beginning with research, followed by hardware development, software development, and lastly data collection. This chapter details all of the methodologies, equipment, and software used. The flowchart for project development is represented in Figure 3. 1.

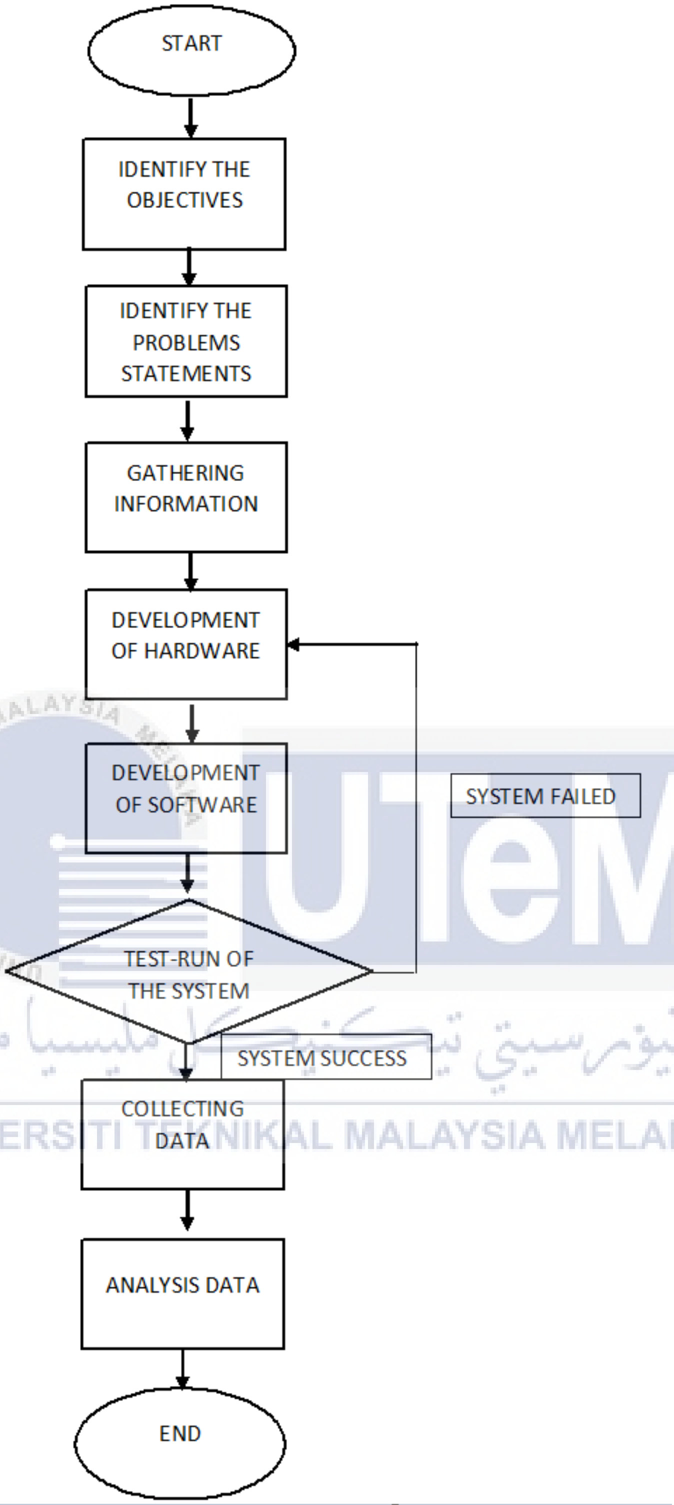

Figure 3.1 Flowchart of the project development.

3.2.1 Development of PV system.

The PV array serves as the project's input and is responsible for powering the entire system, as shown in Figure 3.2's PV system circuit diagram. As a result, the performance of the PV system built should be focused to ensure the system's effectiveness and consistency. Several factors should be considered because they are the primary influences on the PV system's performance.

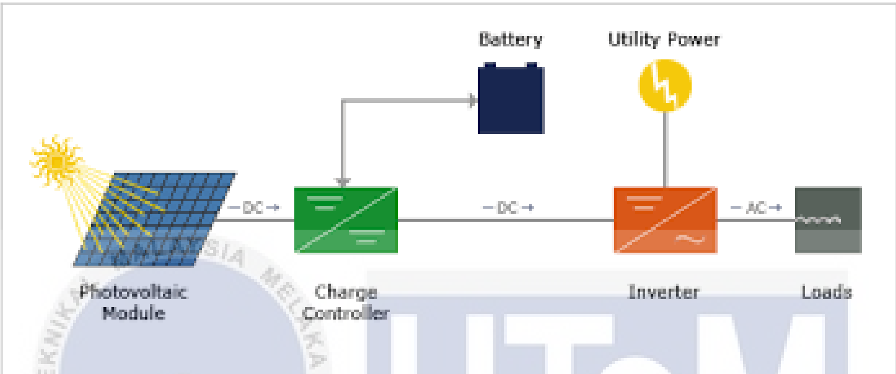

Figure 3.2 PV system circuit diagram.

3.2.2 Circuit Project Diagram

We'll look at a developing lighting system that uses an Arduino and a PIR sensor to detect the presence of a human and turn the lights on and off at the bus stop automatically in this project. Garages, stairwells, restrooms, and other spaces can benefit from this growing lighting system. Also, with the help of a lighting system, you won't have to worry about running out of electricity because the lights will turn off automatically when no one is there. The circuit of this project as shown in Figure 3.3.

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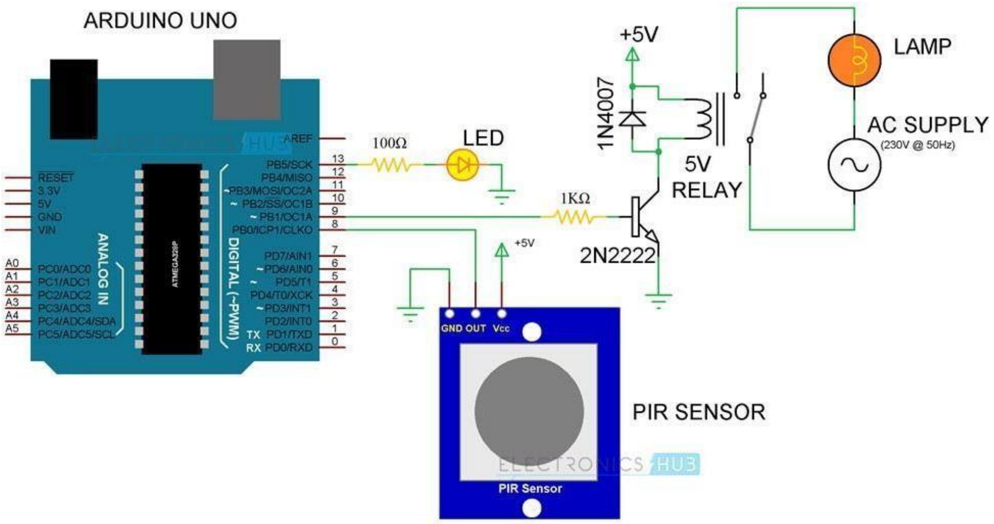

Figure 3.3: Circuit Diagram of this project.

3.3 Hardware Project Development

This section discusses the types of equipment that could be used in this system. Basically, this project uses a lot of hardware input and output, such as Arduino UNO, PIR Sensor, 5V Relay Module, Resistor, Photovoltaic solar array, Led lamp, Inverter, and battery storage, which will be discussed below.

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3.3.1 Monocrystalline Solar.

A monocrystalline solar panel as shown in Figure 3.4 is one that is made up of monocrystalline solar cells. These cells, like semiconductors, are produced from a cylindrical silicon ingot formed from a single crystal of high purity silicon. The cylindrical ingot is cut into wafers, which create cells. The circular wafers are wire sliced to an octagonalform wafer to increase cell use. Because of their octagonal form, these cells have a distinct appearance. These cells are similarly symmetrical in colour.

Figure 3.4 Monocrystalline Solar

3.3.2 Arduino Uno.

Arduino as shown in Figure 3.5 is an openness electronics platform that features basic hardware and software. Arduino boards can read inputs like a sensor light, a touch on a key, or a Twitter tweet and transform them into outputs like running a machine, turning on an LED, or putting anything online. You can operate your board by sending a series of commands to the board's microcontroller. To do this, you need the Arduino programming language (based on Wiring) and the Arduino Software (IDE) (based on Processing). Arduino has acted as the memory of many of projects over the years, ranging from basic domestic devices to complex scientific equipment.

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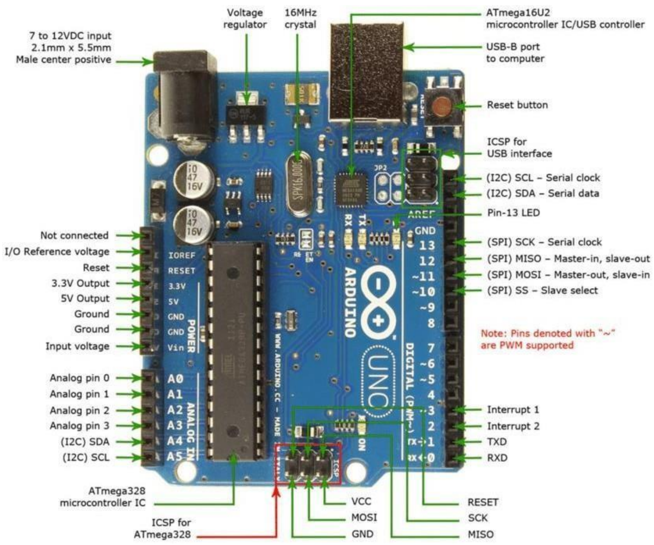

Figure 3.5 Type of Arduino Uno

3.3.3 PIR Sensor.

Figure 3.6 shows the PIR sensor, within 10m of the sensor, a Sensor can detect human movement. The actual detection limit is between 5m and 12m, hence this figure is an average. PIRs are essentially made up of a sensor device that detects infrared light. For a number of crucial jobs or situations where knowing if someone has left or approached the area is required. PIR sensors are wonderful because they provide flat control with no effort,have a wide lens range, and are simple to interact with. Most PIR sensors have a three-pin connection on the side or bottom. One pin will be dedicated to ground, another to data, and the last to power. Power is typically restricted to 5V.

Figure 3.6 The PIR sensor

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3.3.4 5V Relay Module

Figure 3.7 shows a 5v relay module, An electrically charged driven electrical switch is a power relay module. The electromagnet is activated by a separate low-power pulse from a microcontroller. When activated, the magnetic pulls to open or close an electrical circuit. A simple relay consists of a main winding wrapped around an armature, or magnet, an iron yoke that supplies a low resistance path for the magnetic field, a movable iron armature, and one or more contact sets. The yoke is joined to the movable electromagnet, which is linked to one or more sets of moving contacts. When the relay is counter, the spring-held armature leaves a gap in the magnetic. In this case, one of the two will shut connections while the other will keep them open.

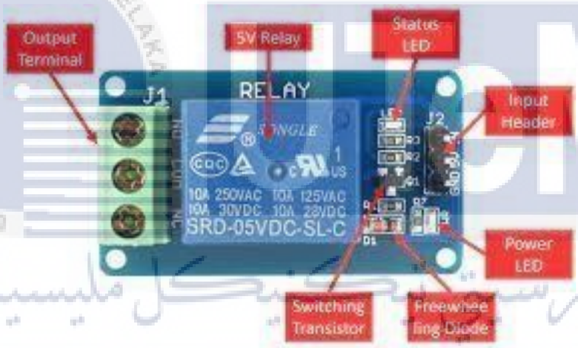

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Figure 3.7 5V Relay Module

3.3.5 LDR sensor

Figure 3.8 shows a light-dependent resistor (LDR) is a type of resistor whose resistance decreases with increasing incident light intensity. It is a passive component that works by altering the flow of current through a circuit based on the amount of light that falls on its surface. LDR sensor are often used in light-sensitive circuits, such as those found in light-sensitive alarms, streetlights, and camera light meters.

LDR sensor are made of a material that exhibits a change in resistance when exposed to light. When light falls on the surface of an LDR, it absorbs photons, which excite the electrons in the material and cause them to move more freely. This reduces the resistance of the material and allows more current to flow through the circuit. When the light level decreases, the resistance of the material increases, reducing the flow of current.

LDR sensor are often used in combination with other electronic components, such as transistors, to create more complex circuits. They are relatively simple to use and are widely available at a low cost.

Figure 3.8 LDR sensor

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3.3.6 PWM Solar Controller Charger

A pulse width modulation (PWM) solar charge controller as show in Figure 3.9 is a device that regulates the flow of electricity from a solar panel to a battery. It is used to charge the battery with the maximum possible power from the solar panel, while also preventing the battery from being overcharged.

PWM solar charge controllers work by rapidly switching the connection between the solar panel and the battery on and off at a high frequency. The duration of each "on" pulse is referred to as the pulse width, and the controller adjusts this pulse width to control the amount of current flowing from the solar panel to the battery. When the battery is fully charged, the pulse width is reduced, which reduces the amount of current flowing to the battery and prevents it from being overcharged.

PWM solar charge controllers are a common choice for small to medium-sized solar panel systems, and they are relatively inexpensive and easy to use. They are not as efficient as more advanced charge controllers, such as those that use maximum power point tracking (MPPT), but they are a good choice for simple, cost-effective charging systems.

Figure 3.9 PWM solar charge controller

3.3.7 Battery storage

A solar battery is a device that stores electricity for future use. Besides this allowing you to keep appliances running during a power outage, use more of the solar energy you generate at home, and even save money on electricity in some cases. When compared to a vehicle battery, they are known as "deep cycle batteries" because of their ability to charge and discharge a considerable amount of electricity. Figure 3.9 depicts a battery solar system.

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Figure 3.10 Battery Solar

3.4 Summary

This chapter demonstrated the development process for “ A Development of a smart bus stop lamp post using solar lighting system. Hardware such as an Arduino UNO, PIR Sensor, 5V Relay Module, Resistor, Photovoltaic solar array, LED lamp, Inverter, and battery storage are required for the project's implementation. The outcomes of this project will be discussed in the following chapter.

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CHAPTER 4

RESULT AND ANALYSIS

4.1 Introduction

The results and analyses of the development of a smart bus stop lamp post employing a solar lighting system are presented in this chapter. The PIR sensor is then used in conjunction with an Arduino UNO to create a mechanism for estimating the solar system. PIR Sensors have been used for many projects including alarm security systems and parking system. A relay module, on the other hand, is an extremely useful component since it allows Arduino, Raspberry Pi, and other Microcontrollers to control enormous electrical loads. We used a two-channel relay module in this experiment, but only one relay. Connecting a sensor to a lighting system, on the other hand, necessitates more forethought to ensure that the appropriate settings are used for the location in which the lights are located. Changing the sensor's sensitivity (range), the time the lights stay on when movement is detected, and whether or not the light is staged to off are all options. With this, all of the components can work together to make this project a success.

4.2 Project Prototype

The research from Chapter 2 and the calculations and simulations from Chapter 3 are used to build the project's prototype using the tools and equipment that have been selected. The hardware is carefully put together in accordance with the circuit simulation performed in Chapter 3 and includes a solar panel, battery bank, solar charge controller, inverter, etc.

The tools and programmed mentioned in Chapter 3 are also used for designing and developing the software. To meet the needs of the system, the software design is tested and adjusted numerous times. The project prototype's setup and design are documented as follows.

4.2.1 Hardware Installation

Figure 4.1 Front view of project prototype

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Figure 4.2 Hardware Project Prototype up view

The project's prototype as shown in Figure 4.1 and 4.2 is made by utilising a box to simulate a bus stop. In order to receive sunlight during the day, the solar panel is mounted on the roof. The solar charge controller, which regulates the quantity of energy entering the system, is connected to the solar panel's output. The battery bank is connected to the solar charge controller's second connection, which enables it to control how much electricity is generated and store it there or draw power from the battery bank as needed. The solar charge controller's output port is linked to the project's DC LED lamp's output. The connection between the LED and the microcontroller that controls its operation to the 5V relay. The PIR motion sensor on the microcontroller detects the user's presence, and the LDR sensor recognises luminance light to send a signal to the Arduino to turn on the LED lamp.

4.3 Coding for Arduino UNO.

Figure 4.2 shows the declaretion for Arduino UNO which is input and ouput for this program. As we know the PIR sensor and LDR sensor is the input to sense the motion and when the sensor sense the motion the LED will light up. The LED is refer as a bulb at the bus stop. The LDR sensor has been set to the limit value which is below 300 to turn ONthe light and PIR motion sensor will be HIGH if detect the motion of human. The coding hasbe programmed if the LDR value is below 300 and the PIR motion sensor is high the lamp will light up.

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```
sketch_dec27
#define LAMP 4  // choose the pin for the RELAY
#define PIR 2  // choose the input pin (for PIR sensor)
void setup()
{
Serial.begin(9600);
  pinMode(LAMP, OUTPUT); // declare lamp as output
  pinMode(PIR,INPUT); // declare sensor as input
}
void loop()
{
  int value_ldr = analogRead(A4); // read LDR value
  int value_pir = digitalRead(PIR); // read input value
  Serial.println(value_ldr);
  Serial.println(value_pir);

 if(( value_pir==HIGH)&&(300>value_ldr) ){
       digitalWrite(LAMP,1);  // Turn ON the light
       delay(10000);
}
else {
  ( value_pir==LOW)&&(0<value_ldr);{
       digitalWrite(LAMP,0); // Turn OFF the light
       delay(500);
  }
}
 }
```

Figure 4.3 Coding declaretion for Arduino UNO

4.4 Experiment Test

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To confirm the accuracy of the data, an experiment has been run to test the system's performance over a period of many days. First, the solar panel's performance is evaluated for 6 hours each day for 7 straight days. To determine whether the system is self-sufficient with the battery life cycle, the effectiveness of the battery capacity for sustaining the entire system has also been examined. Throughout the test, the solar panel has been fully exposedto the sun outside. A solar charge controller attached to the battery bank was wired to the solar panel's output. A PWM solar panel that was connected from solar to the battery and subsequently connected to the battery's output. The load has been tested for 4 hours every day, mainly at night.

4.5 Calculation

$$\text{The usage watt/hour} = \frac{\text{watt/ second} \times \text{every minute record} \times 60\ \text{second}}{60\ \text{second} \times 60\ \text{minutes}}$$

4.6 Experiment Result

The experiment has been carried out from 12/12/2022 until 18/12/2022. The results obtained have been recorded in the table below.

4.6.1 Reading for Day 1

Table 4.1 shows the data obtained on 12/12/2022 from 11 am to 5 pm (6 hours).

Table 4.1 Result For Day 1

CHARGING DAY 1				
TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.28	0.69	12.89	
1140	0.55	0.68	12.93	
1200	0.83	0.93	12.97	1 HOURS
1220	1.16	1.14	13.11	
1240	1.5	0.92	13.24	
1300	1.82	0.97	13.27	2 HOURS
1320	2.19	0.53	13.36	
1340	2.28	0.27	13.32	
1400	2.43	0.24	13.17	3 HOURS
1420	2.53	0.3	13.21	
1440	2.61	0.29	13.27	
1500	2.71	0.2	13.31	4 HOURS
1520	2.76	0.11	13.27	
1540	2.8	0.22	13.21	5 HOURS

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1600	2.85	0.24	13.18	
1620	2.89	0.19	13.15	
1640	3.11	0.14	13.14	
1700	3.17	0.15	13.11	6 HOURS

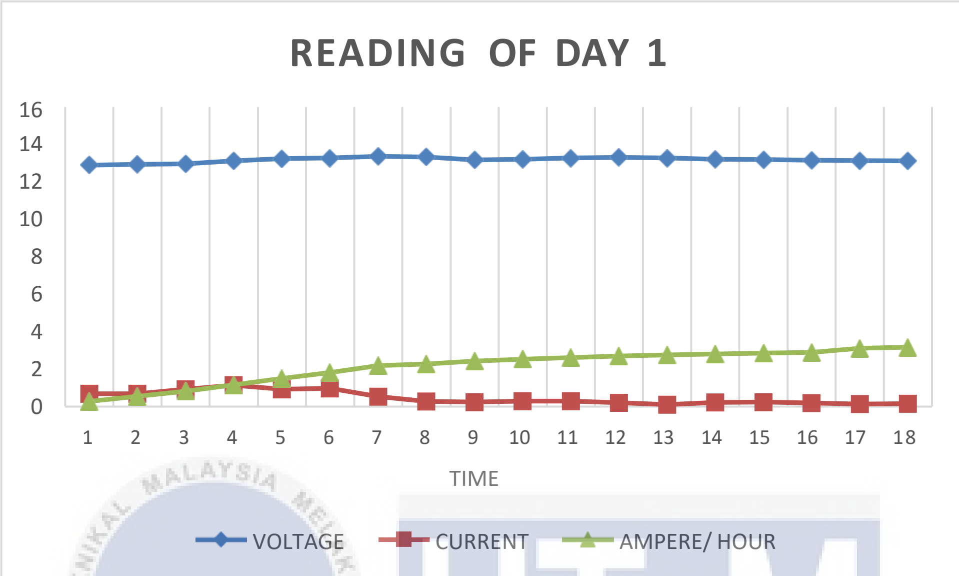

Figure 4.4 Reading for Day 1

Figure 4.3 shows the reading for Day 1 charging solar to battery. The highest peak for the data collected is at 12:20 pm in sunny day because the current value is in the highest among all time collected. Meanwhile, there is a drop in the reading at 4.20 pm because of the weather start to cloudy.

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4.6.2 Reading for Day 2

Table 4.2 shows the data obtained on 13/12/2022 from 11 am to 5 pm (6 hours).

Table 4.2 Reading for Day 2

CHARGING DAY 2				
TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.17	0.51	12.97	
1140	0.36	0.67	13.12	
1200	0.63	0.91	12.97	1 HOURS
1220	0.95	0.97	12.97	2 HOURS

1240	1.27	0.95	12.97	
1300	1.60	1.01	13.15	
1320	1.92	0.91	12.97	
1340	2.21	0.79	13.10	
1400	2.47	0.66	13.12	3 HOURS
1420	2.68	0.59	12.98	
1440	2.87	0.56	13.10	
1500	3.05	0.53	13.10	4 HOURS
1520	3.23	0.49	13.12	
1540	3.38	0.44	12.97	
1600	3.52	0.45	12.97	5 HOURS
1620	3.65	0.37	13.12	
1640	3.75	0.31	13.10	
1700	3.85	0.29	12.98	6 HOURS

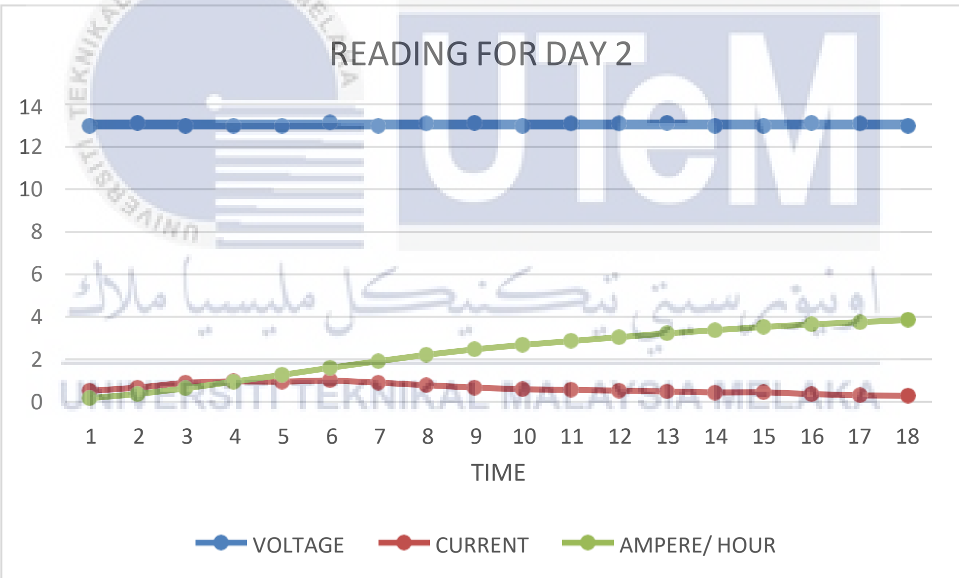

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Figure 4.5 Reading For Day 2

Figure 4.4 shows the reading for Day 2 charging solar to battery. The highest peak for the data collected is at 1:00 pm in sunny day because the current value is in the highest among all time collected. Meanwhile, there is a drop in the reading at 4.40pm because of the weather start to cloudy.

4.6.3 Reading for Day 3

Table 4.3 shows the data obtained on 14/12/2022 from 11 am to 5 pm (6 hours).

Table 4.3 Reading of Day 3

CHARGING DAY 3				
TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.16	0.51	13.10	
1140	0.35	0.67	12.97	
1200	0.62	0.91	12.92	1 HOURS
1220	0.94	0.97	13.15	
1240	1.26	0.95	12.97	
1300	1.59	1.01	12.97	2 HOURS
1320	1.91	0.92	12.98	
1340	2.20	0.79	12.92	
1400	2.46	0.66	13.15	3 HOURS
1420	2.67	0.59	13.15	
1440	2.86	0.56	13.12	
1500	3.04	0.53	13.12	4 HOURS
1520	3.22	0.49	12.97	
1540	3.38	0.43	13.10	
1600	3.51	0.43	13.19	5 HOURS
1620	3.64	0.37	12.92	
1640	3.74	0.31	13.10	
1700	3.84	0.29	13.12	6 HOURS

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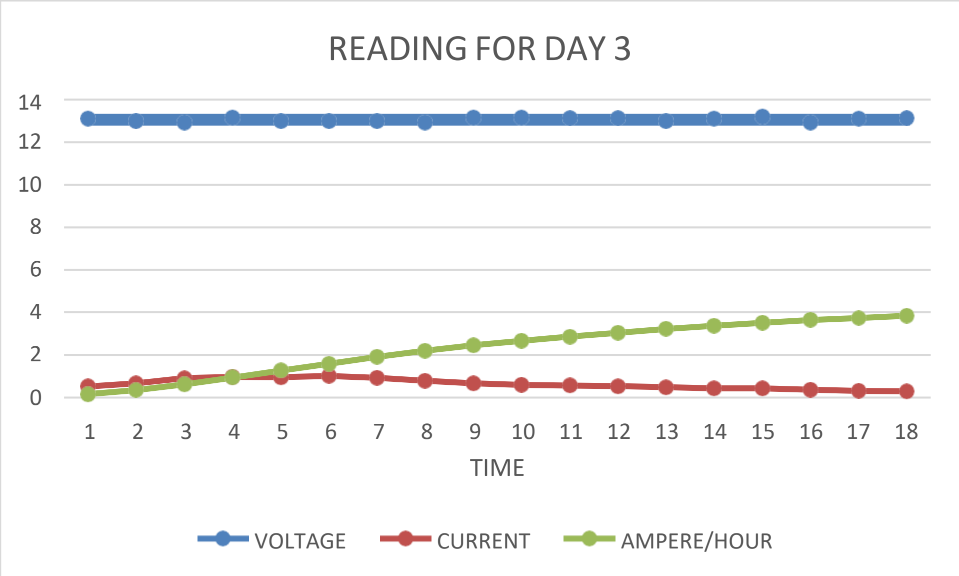

Figure 4.6 Reading for Day 3

Figure 4.5 shows the reading for Day 3 charging solar to battery. The highest peak for the data collected is at 1:00 pm in sunny day because the current value is in the highest among all time collected. Meanwhile, there is a drop in the reading at 4.40 pm because weather start to cloudy.

4.6.4 Reading for Day 4

Table 4.4 shows the data obtained on 15/12/2022 from 11 am to 5 pm (6 hours).

Table 4.4 Reading for Day 4

CHARGING DAY 4 (Rainy Day)				
TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.07	0.20	13.10	
1140	0.14	0.26	13.15	
1200	0.19	0.17	13.15	1 HOURS
1220	0.19	0.00	13.10	
1240	0.19	0.00	13.12	
1300	0.19	0.00	13.12	2 HOURS
1320	0.19	0.00	12.97	
1340	0.19	0.00	12.98	3 HOURS

1400	0.19	0.00	12.97	
1420	0.20	0.06	12.98	
1440	0.22	0.06	13.15	
1500	0.23	0.05	12.98	4 HOURS
1520	0.25	0.05	12.98	
1540	0.29	0.11	12.97	
1600	0.33	0.12	13.10	5 HOURS
1620	0.37	0.12	12.92	
1640	0.41	0.13	13.09	
1700	0.45	0.04	12.92	6 HOURS

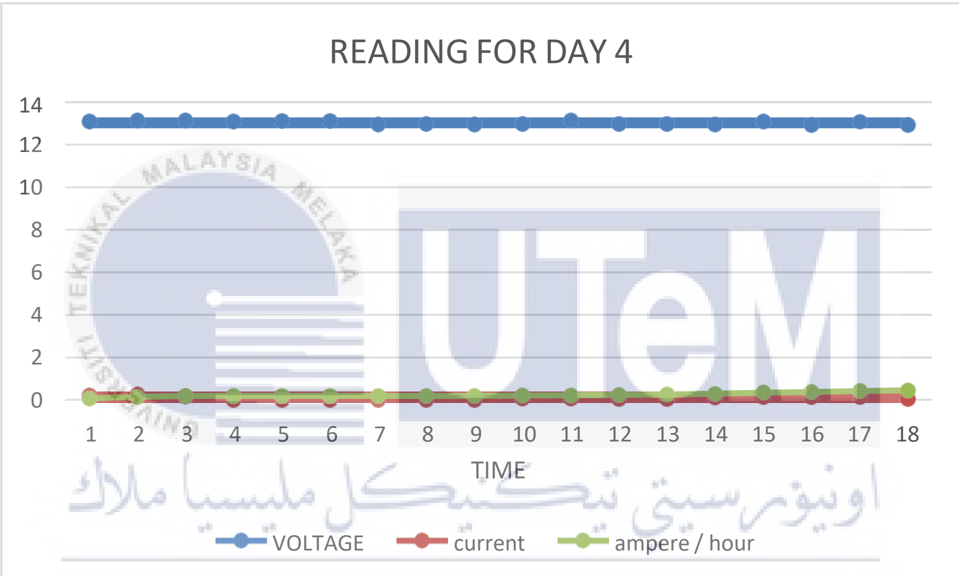

Figure 4.7 Reading for Day 4

Figure 4.6 shows the reading for Day 4 charging solar to battery. The highest peak for the data collected is only 0.26 A because the weather is rainy day after that get a 0 A. There is only 0.45 A/h has been collected in the rainy day.

4.6.5 Reading for Day 5

Table 4.5 shows the data obtained on 16/12/2022 from 11 am to 5 pm (6 hours).

Table 4.5 Reading for Day 5

CHARGING DAY 5

TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.18	0.51	13.12	
1140	0.37	0.67	13.15	
1200	0.64	0.91	12.97	1 HOURS
1220	0.96	0.97	12.97	
1240	1.28	0.95	13.10	
1300	1.62	1.01	13.12	2 HOURS
1320	1.92	0.92	13.15	
1340	2.24	0.79	13.10	
1400	2.49	0.66	13.12	3 HOURS
1420	2.71	0.59	12.97	
1440	2.89	0.56	13.12	
1500	3.08	0.53	12.92	4 HOURS
1520	3.25	0.49	13.10	
1540	3.41	0.47	13.12	
1600	3.56	0.42	13.12	5 HOURS
1620	3.69	0.37	13.12	
1640	3.79	0.31	13.12	
1700	3.88	0.29	13.12	6 HOURS

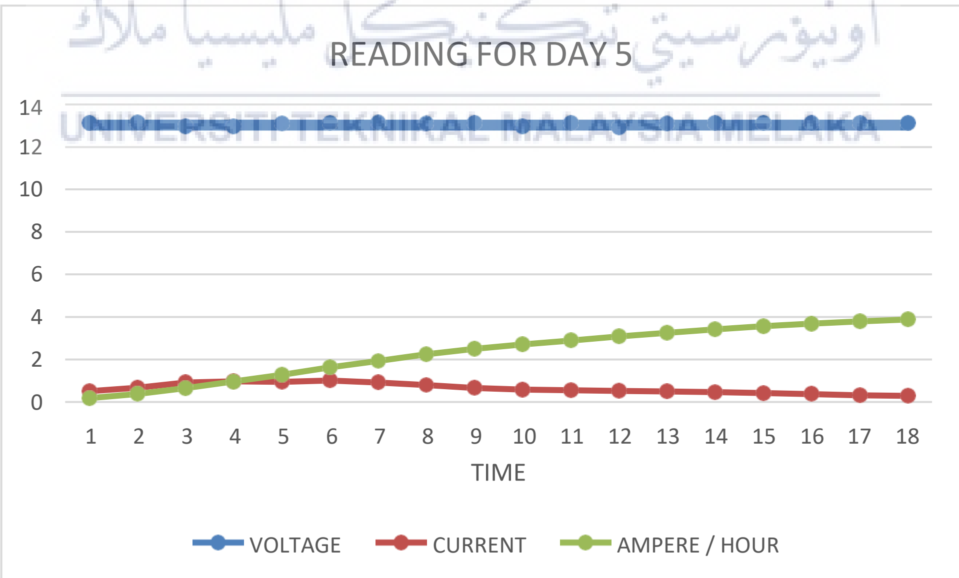

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Figure 4.8 Reading for Day 5

Figure 4.7 shows the reading for Day 5 charging solar to battery. The highest peak for the data collected is at 1:00 pm in sunny day because the current value is in the highest among all time collected. Meanwhile, there is a drop in the reading at 4.40pm because weather start to cloudy

4.6.6 Reading for Day 6

Table 4.6 shows the data obtained on 17/12/2022 from 11 am to 5 pm (6 hours).

Table 4.6 Reading for Day 6

CHARGING DAY 6				
TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.17	0.41	13.15	
1140	0.36	0.67	13.10	
1200	0.64	0.91	13.10	1 HOURS
1220	0.95	0.97	13.15	
1240	1.28	0.95	13.15	
1300	1.61	1.01	12.97	2 HOURS
1320	1.93	0.87	13.19	
1340	2.22	0.79	12.98	
1400	2.48	0.66	12.97	3 HOURS
1420	2.69	0.59	12.97	
1440	2.88	0.56	13.10	
1500	3.06	0.53	13.15	4 HOURS
1520	3.24	0.49	13.09	
1540	3.40	0.47	13.15	
1600	3.54	0.42	13.12	5 HOURS
1620	3.67	0.37	13.12	
1640	3.76	0.31	12.92	
1700	3.86	0.29	13.19	6 HOURS

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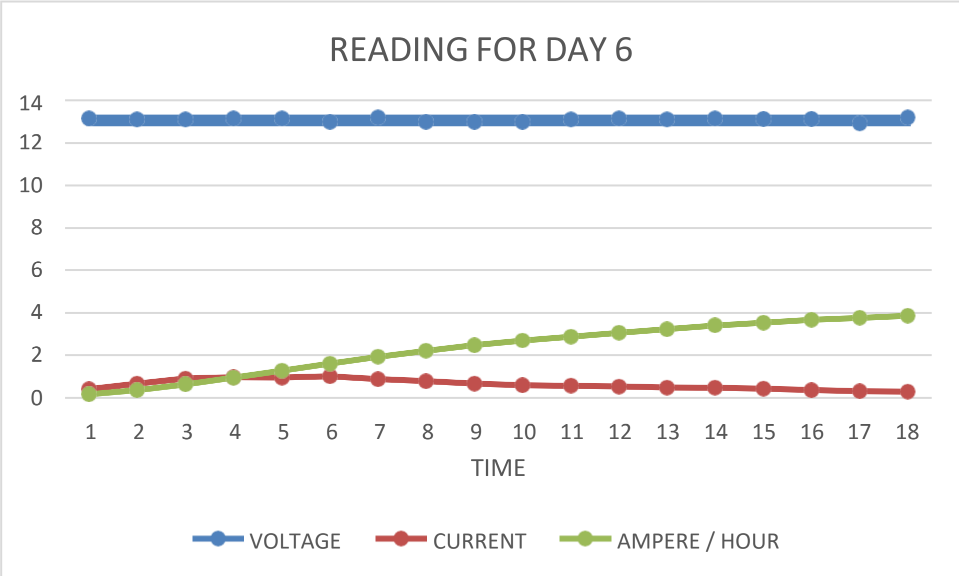

Figure 4.9 Reading for Day 6

Figure 4.8 shows the reading for Day 6 charging solar to battery. The highest peak for the data collected is at 1:00 pm in sunny day because the current value is in the highest among all time collected. Meanwhile, there is a drop in the reading at 4.40 pm because weather start to cloudy.

4.6.7 Reading for Day 7

Table 4.7 shows the data obtained on 18/12/2022 from 11 am to 5 pm (6 hours).

Table 4.7 Reading for Day 7

CHARGING DAY 7				
TIME	AH	CURRENT	VOLTAGE	HOURS
1120	0.18	0.51	12.97	1 HOURS
1140	0.37	0.67	12.98	
1200	0.64	0.91	12.97	
1220	0.96	0.97	12.97	2 HOURS
1240	1.28	0.95	12.92	
1300	1.61	1.01	13.15	
1320	1.93	0.88	12.97	3 HOURS
1340	2.22	0.79	13.12	
1400	2.48	0.66	12.92	

1420	2.69	0.59	13.10	
1440	2.88	0.56	13.15	
1500	3.06	0.53	12.97	4 HOURS
1520	3.24	0.49	12.98	
1540	3.40	0.47	12.97	
1600	3.54	0.42	13.19	5 HOURS
1620	3.67	0.37	13.09	
1640	3.76	0.31	13.15	
1700	3.86	0.29	13.09	6 HOURS

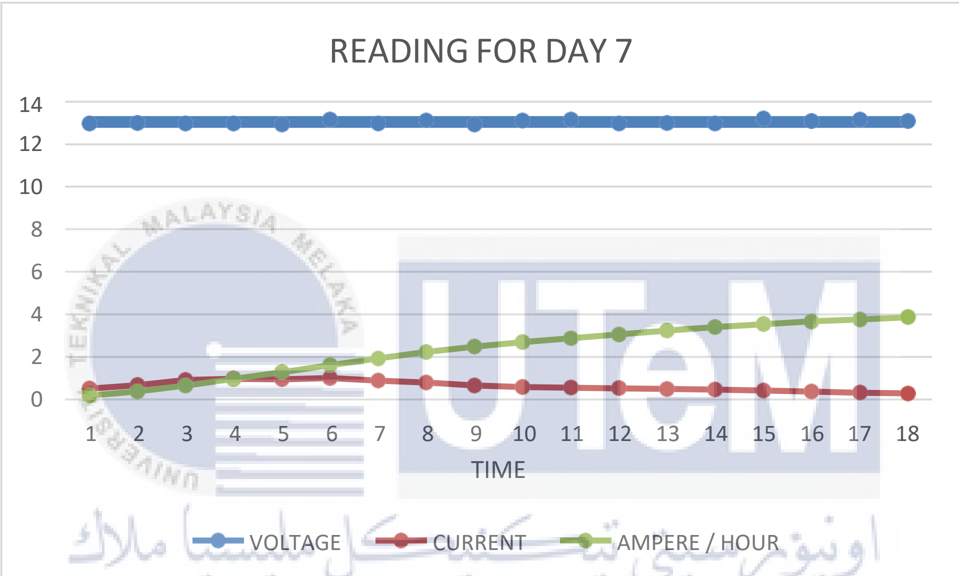

Figure 4.10 Reading for Day 7

Figure 4.9 shows the reading for Day 7 charging solar to battery. The highest peak for the data collected is at 1:00 pm in sunny day because the current value is in the highest among all time collected. Meanwhile, there is a drop in the reading at 4.20pm because weather start to cloudy

4.7 Reading for Discharge Load

Table 4.8 shows the time taken reading of discharge load every 20 minutes for 4 hours. 2.2 A/h and 25.4 W/h were used for 4 hours. The time was taken from 7 pm to 11 pm. Its expected time peak of people used the bus stop.

Table 4.8 Reading Of Discharge Load

DISCHARGE LOAD					
TIME	AH	CURRENT	WH	VOLTAGE	HOURS
1920	0.2	0.61	2.4	11.94	
1940	0.39	0.6	4.77	11.87	1 HOURS
2000	0.58	0.59	7.07	11.82	
2020	0.87	0.58	9.34	11.73	
2040	1.01	0.56	11.51	11.7	2 HOURS
2100	1.26	0.55	13.61	11.63	
2120	1.35	0.54	15.71	11.6	
2140	1.55	0.53	17.74	11.53	3 HOURS
2200	1.71	0.52	19.71	11.48	
2220	1.89	0.5	22	11.41	
2240	2.04	0.49	23.7	11.33	4 HOURS
2300	2.2	0.47	25.4	11.26	

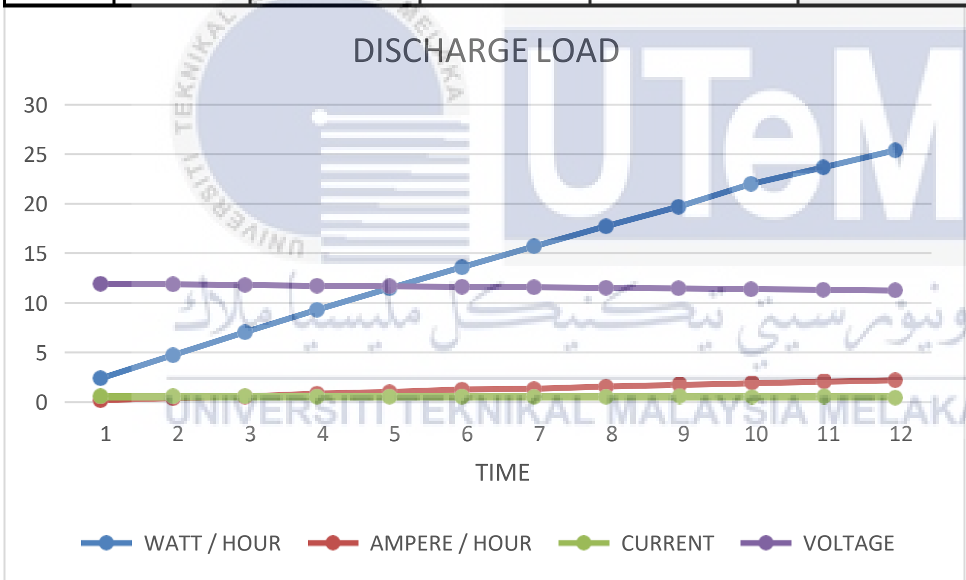

Figure 4.11 Reading for Discharge

Figure 4.10 shows the Reading for Discharge for 4 hours. This is because of the time peak for people used the bus stop from 7.00 pm to 11.00 pm. This is what have been expected on this project. The total of the A/h used in 4 hours 2.2 A/h.

4.8 Analysis Of the Result

Based on data collection, the analysis for 7 days charging, and 1 day's discharge can be made. Among all 7 days charging there is 1 day on a rainy day which is in day 4. All the sunny day collect above 3 A/h battery storage meanwhile in the rainy day only collect 0.45 A/h. For day 1 we succeeded in collecting 3.17 A/h while for day 2 3.85 A/h and day 3 is 3.84 A/h because the weather is sunnier. For day 4 is a rainy day we only succeeded collect 0.45 A/h only. The reading is a big difference from the sunny day. For day 5 we succeeded in collecting 3.86 A/h because of the sunny day same goes to day 6 and 7 we succeeded to collect 3 A/h and above.

For the discharge day we only collect for 1 day because that is our expected quantity usage of the A/hour. The time taken we took 4 hours and collect the reading every 20 minutes. We took only 4 hours because it's a peak time for the people back to work and use the bus stop. Using PIR sensor and LDR sensor saves maybe below 4 hours the usage of the load. So that the 4 hours is a save time taken to cover from 7 pm to 7 am.

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4.9 Sensor

Sensors are an important component of this project to save the usage of current. There are two sensors that have been used in this project which are PIR sensor and LDR sensor.

4.9.1 PIR Sensor

The PIR motion sensor is applied to this project to control the condition of the lamp when detect a motion.

Table 4.9 Condition Of PIR motion Sensor

Condition of sensor	Time delay (s)
On (sensor detects motion and switch on the lamp)	10
Off (no motion detected and switch off the lamp)	0.5

As Table 4.9 shows, the PIR motion sensor is codded to turn on and turn off the light automatically by detect a motion. When the PIR motion sensor detect a motion in the range 3 – 7 meters the PIR motion sensor will send a signal to the Arduino to switch on the light for 10 seconds. While, when no motion detected the light will switch off by 0.5 seconds.

4.9.2 LDR Sensor

The LDR sensor is to detect the presence of light to send signal to the relay to comand the light to switch on or switch off depends on the condition of the luminance value that have been programmed. Condition of LDR sensor is shown in Table 4.10.

Table 4.10 Condition Of LDR sensor

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Condition Sensor	LDR Value to detect
Turn ON (the value reach the limit to switch on the light)	Below 300
Turn OFF (the value reach the limit to switch off the light)	Over 300

4.10 Summary

We reviewed the project's working concept using a circuit diagram, the project's essential features, and the alterations that must be made for it to be implemented in an AC line in this chapter. The project's mechanism was demonstrated, along with the requisite figures for each of the project's features. This idea can be applied to a variety of areas, such as street lighting. We demonstrated the system's versatility of application, demonstrating that it may be used in a variety of domestic appliances as well as industrial machinery. We also looked at how much energy is wasted in traditional lighting systems and how much energy may be saved by using our proposed method. The system is long-lasting, user-friendly, and simple to use. The system's correct implementation will save a lot of energy and people, effectively digitising the entire system. The significant contributions and recommendations for further work will be discussed.

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CHAPTER 5

CONCLUSION AND FUTURE IMPROVEMENTS

5.1 Conclusion

The strategy for calculating the development of a smart bus stop lamp post employing a solar lighting system is presented in this thesis. The proposed methodology is effective and robust for obtaining good results with only somewhat precise data and minimal network measurement information. The great and expected results of our experiments are inferred from the fact that. we have successfully avoided the issue of bus stop lamp post and continue to grow without problems and shortcomings, thanks to sensors that can detect the presence of people while at the same time benefiting consumers. The system works with the principle of detecting the presence of people and then only operate at night. While methodological studies were utilised to develop the project production process using flow charts as a guide for project planning and testing, the end result was that the entire project ran smoothly.

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5.2 Project Objectives

This project has been successfully carried out. The three objectives stated in Chapter 1 have been satisfied.

5.2.1 To analyze the bus stop lamp post from the previous work

From this project, we can conclude that from chapter 2 we do research about lighting systems and solar. The best solar type to produce electricity is monocrystalline and more efficient.

5.2.2 To design a smart bus lamp post using Arduino UNO

From chapter 3, the equipment that we used such as solar, PWM solar controller charger and battery to charge the battery from solar system and store current. Besides, we used Arduino UNO and 2 sensors which is PIR sensor and LDR sensor.

5.2.3 To evaluate the performance of a smart bus stop lamp post using PIR sensor system with solar

PIR sensor is important to this lighting system because it will detect the presence of people to light up the lamp. Meanwhile, LDR sensor is functioning to detect the presenceof light. This can be adapted to the operation time of smart lighting system project which is from 7pm to 7 am. This concept is very efficient to save the usage of electricity.

5.3 Project Limitation

The limits and difficulties encountered during the project's development had an impact on the outcomes. The reasons that restrict this project's growth are noted so they can be avoided in the future.

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The period chosen for the experiment to gather data throughout is the biggest restriction, thus it should be carefully considered. At the conclusion of the year, an experiment examining the performance of solar panels is conducted as part of this project's data collection phase. The weather is primarily cloudy or wet during this time because Malaysia experiences rainy seasons at the end of the year. As a result, the amount of sunlight during this time is less than what one would typically find in Malaysia. As a result, it will appear like solar panels are performing worse during this time.

5.4 Recommendation

From our overall project and our analysis, we can make future improvements. This project will be better if there is using IOT system to detect when the lighting system is not operating well. They will receive notifications from the IOT system that the lighting system is not functioning.

Lastly to maintain our efficiency we can use a timer to operate the lighting system which will operate from 7 pm to 7 am only. So that if the sensor doesn't operate well there is a timer that operates the lighting system following what we have programmed.

5.5 Project Potential

Overall, the project reported in this report has contributed to a better understanding of the need for an effective and practical system-wide estimating approach for the construction of smart bus stop lamp posts that use solar lighting system. To offer speedy, compelling, representative, and reasonably accurate results, the proposed method requires fewer computations and uses an acceptable type and amount of data input, as well as simple mathematical manipulations. Furthermore, the project has included the development of tools for measuring and assessing solar systems, as well as the justification and prioritization of any expenditure to reduce power consumption, due to cost reduction of adding new or expanding existing infrastructure. As a result, it establishes a foundation for the proposed to be a new smart lighting system in every state in Malaysia.

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APPENDICES

Appendix A Example of Appendix A *(optional)*

No.	Parameters	No.	Parameters
1.		25.	
2.		26.	
3.		27.	
4.		28.	
5.		29.	
6.		30.	
7.		31.	
8.		32.	
9.		33.	
10.		34.	
11.		35.	
12.		36.	
13.		37.	
14.		38.	
15.		39.	
16.		40.	
17.		41.	
18.		42.	
19.		43.	
20.		44.	
21.		45.	
22.		46.	
23.			
24.			

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Appendix B Example of Appendix B *(optional)*

Time	Residential	Industrial	Commercial

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