SOLAR LED BASED TRAFFIC LIGHT

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DEDICATION

Thanks to Allah. To my beloved family especially my mother gives the support to me completely this project until successful. I’m also giving thanks to my friends help me and assisted in completely my project. Without their project can’t completely. Thanks all.

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ABSTRACT

Solar traffic light is the new technology providing a reliable, inexpensive, affordable and environmentally friendly source for modern traffic management systems. These "green" lights will also to help reduce electric energy usage. With no trenching, wiring or electrical work required, solar powered traffic lights are perfect for road safety and traffic control applications. Solar traffic lights are fitted with the latest technology in electronics. They are based on photovoltaic or PV for short. A solar panel which is located on the top of the pole converts sunlight into electrical power. A solar charger regulates the voltage coming out of the solar panel. The regulated power obtained is used to charge a battery. During daytime, the traffic lights can use voltage direct from solar panel. At the same time, the battery can be charge for using at night. Lighting is produced by arrays of extra bright LEDs that are much brighter than bulbs. LED last for years and is very energy efficient. LEDs are small, but it can produce a significant amount of light. Solar powered traffic lights and solar traffic signs are becoming more and more widespread around the world because they are portable, easily deployable, energy efficient, good for the environment and require minimum maintenance. One of the biggest problems in developing countries is power outages. An obvious advantage of solar traffic lights is that they will continue working as their main purpose is to keep traffic flowing even during power cuts. Solar directional signals and solar street lights offer an interesting and practical solution.

ABSTRAK

Lampu lalu lintas suria merupakan teknologi baru menyediakan sumber yang dipercayai, murah, terjangkau dan ramah persekitaran untuk sistem pengurusan lalu lintas moden. Lampu "hijau" ini juga akan dapat membantu mengurangkan penggunaan tenaga elektrik. Dengan tidak adanya penggalian, kord atau kerja elektrik yang diperlukan, lampu lalu lintas bertenaga suria yang sempurna untuk keselamatan lalu lintas jalan dan aplikasi kawalan. Lampu lalu lintas suria dilengkapi dengan teknologi terkini dalam elektronik. Ia didasarkan pada photovoltaic (PV) yang pendek. Sebuah panel suria yang terletak di bahagian atas tiang menukar sinar matahari menjadi tenaga elektrik. Sebuah pengecas suria akan menetapkan voltan yang keluar dari panel suria. Kekuatan kuasa yang diperolehi akan digunakan untuk mengisi bateri. Pada siang hari, lampu lalu lintas boleh menggunakan voltan terus dari panel suria. Pada masa yang sama, bateri boleh dicaskan untuk digunakan pada malam hari. Cahaya yang dihasilkan oleh LED yang lebih terang daripada lampu. LED yang terkini boleh bertahan selama bertahun-tahun dan sangat hemat tenaga. LED kecil, tetapi boleh menghasilkan jumlah cahaya yang signifikan. Penggunaan lampu lalu lintas bertenaga suria dan tanda lalu lintas suria menjadi lebih meluas di seluruh dunia kerana mereka mudah alih, tenaga mudah tersebar, cekap, baik untuk persekitaran dan memerlukan selenggara yang minimum. Salah satu masalah terbesar di negara-negara membangun adalah kuasa penerimaan sinaran matahari dalam tahunan. Keuntungan yang jelas dari lampu lalu lintas suria adalah bahawa ia akan terus bekerja sebagai tujuan utama adalah untuk menjaga aliran lalu lintas bahkan selama elektrik terputus. Isyarat arah suria dan lampu jalan suria menawarkan penyelesaian yang menarik dan praktikal.

TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREAVIATIONS AND SYMBOLS

STC	-	Solar Temperature Coefficient
NOCT	-	Nominal Operating Cell Temperature
G	-	Irradiance
Ta	-	Ambient Temperature
V	-	Voltage
mA	-	miliampere
mW	-	miliwatt

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

For introduction, it is base on some general information about Solar LED based Traffic Light, the advantages and disadvantages of project, problem statement, objectives and the scope of project. All this information will discuss on the next pages.

1.1 Background

Figure 1.1: LED Traffic Light.

Traffic light, which may also be known as stop light, traffic light lamps, traffic signals, stop-and-go lights, robots or semaphore are signaling devices positioned at road intersection, pedestrian crossing and other places that suitable to control competing flows of traffic. They assign the right of way to road users by the use of lights in standard color (Red-Amber-Green) such as in Figure 1.1. In a typically cycle, illumination of the green light allows traffic to proceed in the direction denoted, illumination of the amber light denoting if safe to, prepare to stop short of the intersection, and illumination of the red signal prohibits any traffic from proceeding.

Nowadays, many types of traffic light on the intersection road such as single aspect, dual aspects, three or more aspects and pedestrian or cyclist crossing lights. Usually traffic light that can be applies to control and reduce the traffic jam at the peak time. Based on this project "Solar LED based Traffic Light" is powered by solar power at the daytime and charging the battery for used back up at the night time.

The advantage of this project is no trenching to do for stick upright the pole of traffic light. It is also no wiring from power supply to connect at the pole traffic light. Although and by using LED is small but it can produces a significant amount of light and brighter than bulb light. Solar LED traffic light is easy installation and inexpensive.

The disadvantages however are power battery for using at night time. It becomes problem to functioning the traffic light at night time when the battery was not fully charging during daytime. If rainy season or cloudy, the solar panel not receive the sunlight to convert sunlight power to electricity.

1.1. Problem Statement

The problem in developing countries is power outages, like Malaysia which located at equator grid that has received the amounts of sunlight in monthly. This is good news for used renewable energy like solar energy to appliance work in a day. Like

Russia, they has receive the little amount of sunlight in monthly because the day time is short than night time. Therefore, Russia is not suitable country to use Solar LED based Traffic Light.

The different between Solar LED and Bulb Traffic Light are the types of lamp that was used. The total amount of energy usage LED is much save than bulb and LED also much brighter than bulb. So, it can reduce the energy usage by using the LED as lamp of traffic light.

1.2. Objectives of the Project

The main objectives of the project are:

i. To build a traffic light using solar powered.
ii. To provide efficient backup power supply to signalized traffic intersections.
iii. To produce a working prototype solar LED based traffic light.

1.3. Scopes of Project

In order to achieve the objectives of the project, there are several scope had been outlined. The scope of this project includes using:

i. Solar panel and rechargeable battery 12V.
ii. Solar panel placed on the top of the system to get the consistent power electricity produced.
iii. In this project, solar LED based traffic light is limited for 2-way traffic and pedestrian crossing.

CHAPTER 2

LITERATURE REVIEW

This chapter describes the study about the types of solar panel and the placement of solar panel at the top of system that can improved the power electricity produced. It is also briefly discuss about solar panel and rechargeable battery.

From Nelson A. Kelly, Thomas L. Gibson paper, it is well-known that 2-axis tracking, in which solar modules are pointed at the sun, improves the overall capture of solar energy by a given area of modules by 30-50% versus modules with a fixed tilt. On sunny days the direct sunshine accounts for up to 90% of the total solar energy, with the other 10% from defuse (scattered) solar energy. For sunny conditions, a system that orients solar modules so that they are perpendicular to the direct rays from the sun, produces the most solar energy for a given photovoltaic module area 30-50% more solar energy than a PV system with fixed tilt. [1]

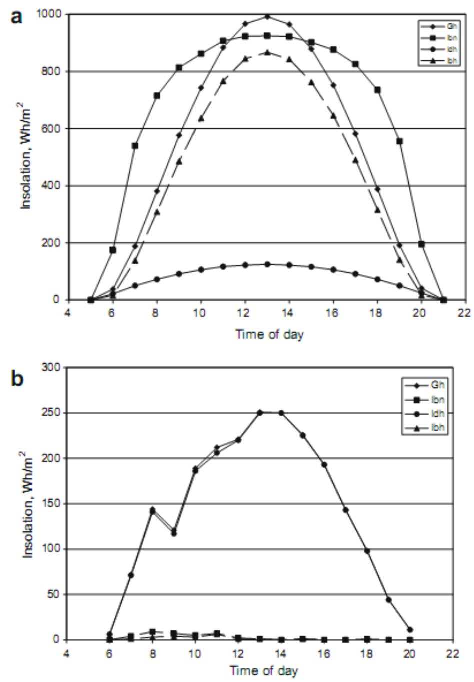


Figure 2.1: Global horizontal beam normal. [1]

Figure 2.1(a) shows the graph global horizontal beam normal time a sunny day, the direct irradiance increases rapidly following sunrise and exceeds global horizontal value throughout the day, except for a few hours around “solar noon”. Figure 2.1(b) shows the graph time a cloudy day, the insulations terms were largest in figure 2.1(a) are now the smallest. On a long term basis, the most solar energy can be obtained from a given area of solar modules by having the modules mounted in a 2-axis tracking system. In such as a tracking system, the modules are positioned such that the angle of incidence of incoming beam radiation with the solar module 90. This maximizes the “cosine” response to the beam radiation. There are several types of 2-axis tracking systems (Photovoltaic Systems Assistance Center, 1991; Rothetal, 2005), ranging from systems that can accommodate over 18m^2 of typical solar modules (ArrayTechnologiesInc.) to small trackers for mounting pyrheliometers (Yankee Environmental Systems Inc.). Some systems use active tracking methods, in which the motors and/or hydraulic devices are used to position the modules (Array Technologies Inc.), while others use passive methods, in which normally unused energy, such as heating of a fluid, is used to provide module alignment with the sun. [1]

A.A Al-Baali however describes in improving the power of a solar panel by cooling and light concentrating paper, the effects of solar radiation and temperature on the characteristics of a solar panel was studied in order to improve the power output of the panel. A systems consisting of two stages was used: a water circulation system was found to be necessary to overcome the degradation in Voc with panel temperature and at the same time, a reflecting mirror was utilized to increase the solar radiation on the surface, i.e. to increase $I_{sc,}$ an increase in the power output and in hot water can be obtained. [2]

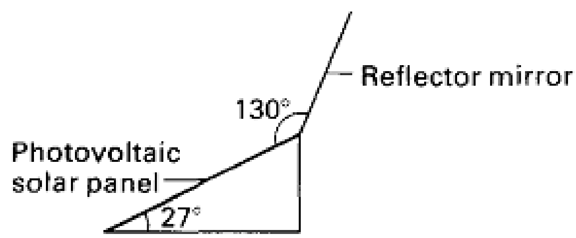


Figure 2.2: System layout diagram. [2]

Figure 2.2 shows the reflector mirror was utilized to reflect the instead of lenses, and causes an increase in the radiation level received by the panel. The reflector were placed adjacent to the surfaces of the second and third panels at an angle 130° and the systems was connected as shown in Figure 2.2. [2]

On the other hand, W.X.Shen said that the size optimization of solar array and battery in a standalone photovoltaic (SPV) system is investigated. Based on the energy efficiency model, the loss of power supply probability (LPSP) of the SPV system is calculated for different size combinations of solar array and battery. For the desired LPSP at the given load demand, the optimal size combination is obtained at the minimum system cost. One case study is given to show the application of the method in Malaysian weather conditions. [3]

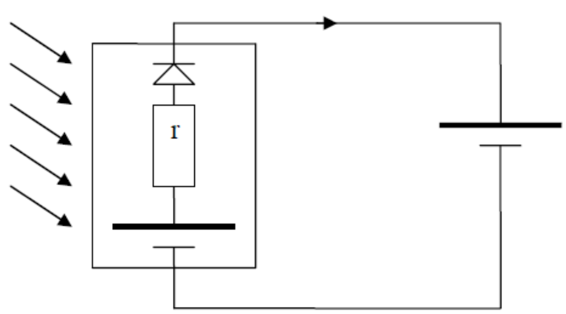
By Traffic Engineering Division Department of Public Works City of Little Rock in final report, the Light Emitting Diode (LED) Traffic Signals have become an efficient and effective alternative to traditional incandescent signals. The two main advantages of LED signals are very low power consumption (10 W to 22 W) and very long life, as high as 7 to 10 years. When compared with the typical energy needs of an incandescent bulb, which is 135 Watts, the savings resulting from the low energy usage of LED signals can be as high as 93%. In addition to the low energy usage, the long life of LED signals means low maintenance costs, which makes LED signals a worthwhile investment and also environment friendly. [4]

Other benefits of LED signals include elimination of catastrophic failures. Unlike an incandescent bulb which has only one filament, an LED signal is made out of a matrix of several dozen LEDs. The signal continues to function even if several of these miniature diodes stop working. On the other hand, when the filament of an incandescent bulb fails, the display goes dark requiring immediate replacement. LED signals are brighter compared to incandescent traffic signals, which enhances intersection safety. Elimination of phantom effect, incandescent traffic signals use reflectors behind the bulbs. For signals on east-west approaches during morning and evening hours, all colors seem to light up when the sunrays fall directly on these signals. This problem is eliminated when LED signals are used because there are no reflectors in LED signals. [4]

Observation of LED signals in operation has resulted in the following findings LED Signals are brighter than conventional signals, due to their low wattage, LED signals do not burn the lens coverings like the conventional incandescent bulbs. Incandescent bulbs tend to burn the lens coverings and darken them after a few years of operation, which reduces the brightness. The visibility of LED signals tends to be very directional which causes problems for signals attached to span wires. During times of high wind, the swaying signals appear dim depending on the degree of tilt. This can be solved by tethering the signal heads on both the top and bottom sides. Since LED signals require very low power to operate, it is feasible to run the signals with battery back-up during power failures. Since LED signals draw very low power, the intersection wiring will not deteriorate as rapidly resulting in less maintenance. [4]

Due to the many advantages of in terms of operation and energy consumption, the benefits of LED signals outweigh the initial investment. The City of Little Rock decided to retrofit all the traffic signals with LED signals and as a result of the citywide retrofit project, all the traffic signals in the City now use LED signal displays. The city now 6 requires LED signals on all new traffic signal installations. Thus far, the performance of LED signals has been very satisfying. [4]

On the other hand, A.A Azooz, J.M Sulayman said in their paper Electronic Control Circuit for Solar Battery Charging. For any particular solar cell panel, the open circuit voltage increases exponentially with the intensity of solar radiation, reaching a limiting value. The cell voltage will assume the value of the battery terminal voltage which is an approximately fixed quantity except for the case of a highly drained battery. It is common practice to design photovoltaic solar systems for battery charging with solar panel open circuit saturation voltage being 1.5 times the nominal emf of the battery to be charged. Even with such design, a good deal of sun energy under morning, after noon hours and cloudy weather may not be exploited properly due to the fact that the operating point will slip back into the exponential regions. [5]



$$ir = E - E_0 .$$

Figure 2.3: Solar charging equivalent circuit. [5]

In order to gain more insight on the problem let us consider the simple equivalent circuit of the battery charging process shown in figure 2.3. The solar panel is represented by a voltage source *E*, an internal resistance *r*, and a diode D. When the electromotive force *E* exceeds that of the battery to be charged *E*0, charging current *i* will flow in circuit. The power stored in the battery will be 0 *P* = *iE*. The solar panel internal resistance *r* is equal to the open circuit voltage *E* divided by the short circuit current 0 *I*. [5]

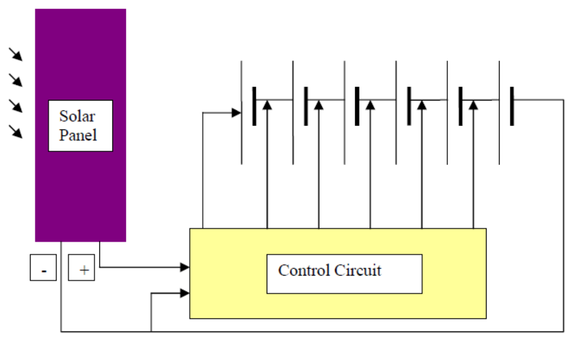


Figure 2.4: Block diagram of the controlled charging process. [5]

Figure 2.4 shows a block diagram of the controlled charging process. One way to put the above argument into action is through the isolation of a certain number of unit cells from the battery, while charging only a proper number of series cells, in practice, such a process needs two things. The first continues monitoring of the solar panel electromotive force. The second is a reliable switching mechanism that can transfer the charging current to the appropriate number of series unit cells within the battery while excluding the remaining ones for the time being. For example and for 12V lead-acid battery consisting of 6 cells x2V, the circuit and after monitoring the panel voltage, must direct the current to charge only the first cell when the solar panel voltage is between 2-4V. The charging current must be redirected to the series combination of the first and second cells for solar panel voltages fall in the range 4-6V, etc. If the monitored voltage is above 12V, the whole battery will be in a charging state. Finally and in order to avoid any overcharging situation, the charging process must seize if the panel voltage exceed a certain limit 14.3V for example. A block diagram of such arrangement is shown in Figure 2.4. [5]

CHAPTER 3

METHODOLOGY

In this project the PIC microcontroller used as the main controller to control the traffic light. The block diagram of the system is shown in figure below.

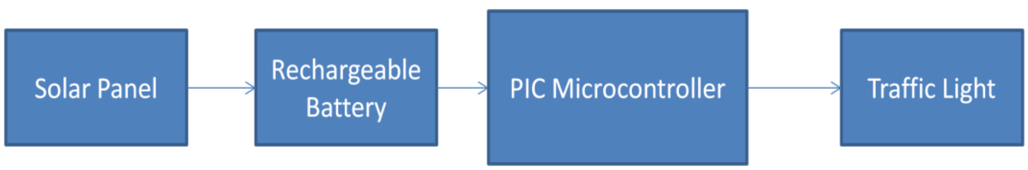


Figure 3.1: Block diagram of project.

In generally figure 3.1 shows the description about the project. The solar panel used to convert the sunlight energy to produce electricity and then store the electricity to battery. The battery used to supply the voltage to PIC microcontroller and at the same times it charging for appliance at the night time. From the microcontroller, it has been produce the output at the traffic light signal board based on program that designed.

3.1. Hardware Implementation

This chapter covered about the components that had been used included in this project such as solar panel, battery solar 12V, PIC microcontroller 16F877 and LEDs.

3.1.1. Solar Panel

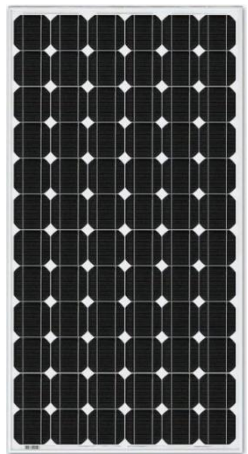


Figure 3.2: Solar panel.

Figure 3.2 shows the solar panel that had been used in this project. The solar panel function to converts the sunlight to electricity and then store it into rechargeable battery 12V. This project had been used the solar panel from SOLARLAND brand. The types of solar panel are SLP005-12 polycrystalline silicon cell. More specifications solar panel that had been used show in table 3.1.

Table 3.1: Specifications solar panel

Specifications	**SLP005-12**
Cells	Polycrystalline silicon solar cell
No. of cells and connections	36(3x12)
Module dimension	222mm (8.74in.)X270mm (10.63in.)X17mm (0.67in.)
Weight	0.75kg(1.65lbs)