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Role of Solar Powered Automatic Traffic Light Controller for Energy Conservation

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Abstract - *Solar energy is one of the major renewable sources and efficient way without polluting the environment energy saving applications is need of the day, and rising energy prices, growing environmental awareness, and energy conservation is becoming one of the most important criteria for solar powered traffic systems design. Monitoring of traffic lights and changing the waiting time of vehicles and gives priority based operation done by emergency vehicles such as ambulance and fire services etc., the smart green energy powered traffic light is controlled on the basis of traffic on road and day/night time [3]. The system is programmed to automatically turn off during the unavailability of vehicles and it can sense the vehicles density. Many times we see that roads are more traffic even during normal time. In order to address these issues the proposed solar powered traffic lights are PV fixed-array, charge controller, lead-acid battery and traffic light. Crystalline silicon solar cells were used in this project because it is the most favorable type for traffic stop light signals, due to its availability in the market, and its higher efficiency. The timing sequence of light signals was managed via an AVR microcontroller and it's more efficient to conserve the energy*.

Key Words*: *Solar Powered Traffic Systems, AVR Microcontroller, Emergency Vehicles, PV Fixed-Array, Lead-Acid Battery.

1. INTRODUCTION

The main objective of the present study is to reduce the power consumption and efficient utilization of renewable sources for the application of traffic signaling [1]. Hence, this paper is aimed at design and implementation of an automatic system to control the traffic and reduce energy consumption of a town's public lighting system up to the maximum possible extent[5]. The density of traffic is sensed by using an array of Passive Infrared Sensors (PIR), which senses the traffic movement. LDR is used to detect the presence of day light. The proposed system is able to control the traffic during the day as well as night. In this system, the streetlights are switched ON/OFF automatically during the presence of the traffic only during the nights. Solar energy technologies, which harness the sun's energy to generate electrical power, are one of the fastest growing sources of renewable energy on the market today. Engineers and scientists are collaborating to lower the material costs of solar cells, increase their energy conversion efficiency, and create innovative and efficient new products and applications based on photovoltaic (PV) technology around the world [6]. On the other hand, vehicular travel is increasing throughout the world, particularly in large urban area. Traffic control systems have also increased in installation as a result. However it is still economically difficult to provide traffic control in country and rural areas, primary due to cost of building power infrastructure over long distances[12]. Solar traffic signs have many uses. They can be used in manufacturing facilities, for pedestrian safety, stop and yield signs, vehicle directions, emergency instructions, parking and school zone safety[4]. The introduction of this document gives a brief idea of this research. Methodology section describes the processes involved in this project, which gives the idea of the development plan. Finally the reference section is defined and also covers more background area.

2. ENERGY SURVEY

The energy survey is necessary to analyze and find the total energy saving through the solar power and it has play major role in the solar system design such as selection of battery capacity and number of solar panel etc., in Tamil Nadu, the city Salem was considered for the power usage of traffic lights and taken detailed energy survey made that has shown in the table 1.1 and 1.2.

Table 1.1 Traffic light data

Name of the City	LED box Power Rating	No of LED box in Single Unit	No of Traffic Signals
Salem	20 watts	20	22

$$E_{cd} = P_{LED} * N_{LED} * 24 \text{ in} \frac{KW}{hr} \quad (1)$$

Where as
E_{cd}- Energy consumption per day in KW/hr
P_{LED}- Power consumption in each led boxes in Watts
N_{LED} – Number of led box operated

$$E_{cy} = E_{cd} * 365 \text{ in } KW \quad (2)$$

Where as
E_{cy}-Energy Consumption per Year in KW
E_{cd}- Energy consumption per day in KW/hr

Table 1.2 power usage estimation

Number of traffic units	Power consumption in each led boxes in Watts	Energy Consumption Per Day in KW/hr	Energy Consumption per Year in KW	Energy saving per year in KW
1	20	4.8	1752	1752
22	20	105.6	38544	38544

2.1 SOLAR POWERED TRAFFIC LIGHTS

A solar traffic light system as shown in Fig. 1 composed of the four major components as following: (1) Solar panel that includes solar cells, (2) DC to DC converter to maintain the output voltage at a constant level, (3) Charge controller to control the flow of charge through the battery and charges it when needed, (4) Battery to store electric energy and use it during the absence of sunlight.

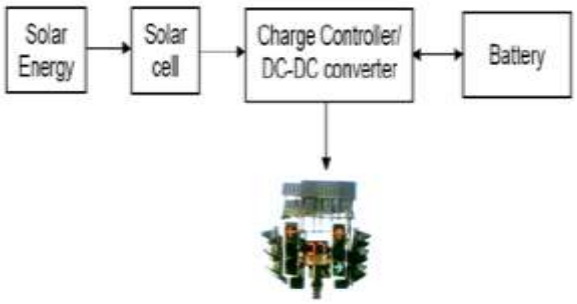

Fig 1. Energy flow in a solar powered system

2.2 Photovoltaic Cells

Photovoltaic energy is the conversion of sunlight into electricity through a photovoltaic (PV) cell, commonly called a solar or PV cell. PV cells are constructed out of semi-conducting materials so that when light shines onto the cells a certain amount of the light is absorbed. The energy of the absorbed light knocks the electrons loose from their atoms allowing them to flow through the compound. The photovoltaic cell is the basic part of the building block of a PV system. PV cells can be arranged in a series configuration to form a module to supply electricity at a certain voltage, such as a common 12 volts system. Modules can then be connected in parallel-series configurations to form arrays. When connecting cells or modules in series, they must have the same current rating to produce an additive voltage output, and similarly, modules must have the same voltage rating when connected in parallel to produce larger currents. Fig. 2 shows a sample cell, module, and array. The following factors are affected on the performance of a solar cell:

- Sunlight and the angle that the sunrays hit the PV cell.
- Climate conditions such as clouds, fog, dust.
- The atmospheric layer's absorption and reflection.
- Temperature of the surroundings.

Charge Controller

Charge Controllers come into functionality since solar panels do not output a constant stream of voltage. The output from the panels is variable and needs adjustments before they are stored to the battery or supplied to the load. Charge Controllers work by monitoring the battery voltage. In other words, they fetch the variable voltage from the photovoltaic panels, condition to suit the safety of the storage lead acid battery, and once full charge is reached, the controller can short the solar panel leads together to prevent further accumulation of charge in the battery. Charge Controllers, are therefore, mainly 'Choppers' or DC-DC Converters. The main functions of charge controllers are to prevent overcharging of battery from solar panels, over discharging of battery to the load, and to control the functionalities of load.

2.3 Operational principles of charge controllers

Switches are used to operate Charge Controllers. The switch can be either a Relay or a solid state switch such as a MOSFET or power transistor. Relays contribute to less power loss due to their smaller resistance, but they have a limited life span. On the other hand, MOSFETS have a higher longivity, but also a higher rate of power loss in times of high current flow. Control circuits are used to regulate the switching on-off of controller switches. One of the most popular techniques, and the scheme preferred for this system, is the Pulse Width Modulation (PWM). In this scheme, the switching time is determined by the percentege of the signal at high voltage. Loss is very less in this system, but the switch used has to be a MOSFET in order to use PWM. Most controllers measure the amount of voltage in the battery and accordingly supplies current to the battery or stops current flow completely. This is done by measuring the Ah(Ampere Hour) of the battery, rather than looking at the State of Charge (SOC) of the battery. The maximum battery voltage allowed to reach is known as the 'Charge Set Point'. Factors such as prevention of Deep Discharge, Battery Sulfation, over current and short circuit current are also prevented through the controller. Deep discharge can be detected by the microcontroller and it will run an auto boost charge to keep the battery activated.

2.4 Energy Storage

Stand-alone PV systems require energy storage to compensate for periods without or within sufficient solar irradiation, such as during the night or during cloudy weather. Chemical batteries are the most candidates. The most suitable battery technologies to use in a standalone photovoltaic system are: lead acid batteries, Lithium-ion batteries, Ni-Cd batteries. Currently, the lead-acid battery is the most common form of energy storage in photovoltaic applications due to its low cost, low rate of self discharge and its ability to work at higher temperatures. Although, it has a low mass/energy ratio, that doesn't affect their performance in solar traffic light application as the battery is stationary.

2.5 Traffic Light

Nowadays LED bulbs are replacing the old incandescent bulbs. LED's is very efficient, with low energy consumption and a long life span. The most recent technological innovation reached in the traffic industry is using solar traffic light systems. In this paper, we have used LED traffic lights with rating 12 V, 8 W [6]. It always is supplied from the battery.

Resent traffic system facing lat of problems during pick and half peak hours because of waiting time traffic man also present over there to control the vehicles movement in order to avoid complexity between the peoples. If the traffic system are operated automatically based on availability of vehicle density of all direction of the road, there is no necessity of the traffic man, changing of signal timing, etc., in our proposed system will be fully green powered and automatically operated. The research aims were to reduce the environmental pollutions, power consumption and waiting time of vehicle time.

4. RESULTS AND DISCUSSION

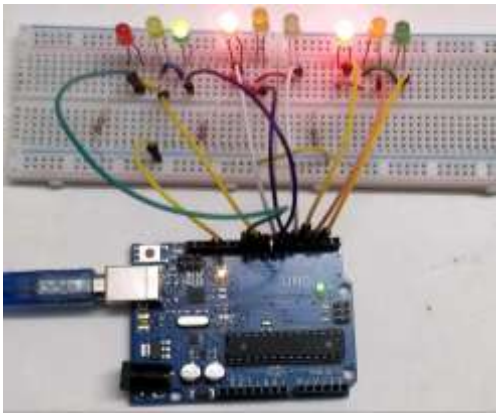

Fig 2. Solar powered traffic light system

This system basically consists of a Light Dependent Resistor "LDR", photoelectric sensor are the two main conditions working in the circuit. The light sensor, which is used in this circuit, will be utilized as a darkness detector. After dusk, the light sensor will activate the system, and will get ready to detect any object by photoelectric sensors, on the road to turn on the traffic lights. The street light can be successfully controlled by the microcontroller. The commands from the microcontroller the lights will be ON in the places of the movement when it is dark. Finally this control circuit can be used in long roadways between the cities. After dusk, the light sensor will activate the system, and will get ready to detect any object by photo electric sensors, on the road to turn on the traffic lights. The traffic light can be successfully controlled by the microcontroller. The commands from the microcontroller the lights will be ON in the places of the movement when it is dark. Finally this control circuit can be used in long roadways between the cities.

4. CONCLUSION

This system is operated with purely solar energy, the process is shown in energy flow diagram in fig.1, hence the solar power usage is increased day by day, emergency based operating vehicle also operated if the system is implemented in all major cities in India approximately 400KW energy has been saved per hour, environmental pollution, also reduced by the usage of vehicle time and save the human during emergency furcating. So we finally conclude that our proposed traffic system will be more suitable for all cities to protect and save the environment and the peoples.

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