

DESIGN AND FABRICATION OF A LOW COST SOLAR STREET LAMP FOR METROPOLITON CITIES OF BANGLADESH

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Abstract- *Solar energy has been harnessed by humans since ancient times using a range of ever-evolving technologies. Solar radiation, along with secondary solar-powered resources such as wind and wave power, hydroelectricity and biomass, account for most of the available renewable energy on earth. Only a minuscule fraction of the available solar energy is used. Solar powered electrical generation relies on heat engines and photovoltaic cell. Solar energy's uses are limited only by human ingenuity. A partial list of solar applications includes space heating and cooling through solar architecture, potable water via distillation and disinfection, lighting, solar hot water, solar cooking, and high temperature process heat for industrial purposes. To harvest the solar energy, the most common way is to use solar panels. We have designed & fabricated a low cost solar street lamp using solar panel which will help us to reduce the pressure on the demand of electricity. Every night huge amount of electricity is used for street lighting in our country. If we could use this type of light in this purpose, it will be economical & environment friendly for the under developed country.*

Key words: Solar energy, Street lamp, Solar radiation, Street lighting.

1. INTRODUCTION

Population is increased all over the world day by day. So the area of the existing cities is increased as well as new cities are formed. People always love to live in cities because it provides maximum facilities for livelihood. Communication and transport system is very important criteria for development of a country. For this purpose roads are used. Street lighting¹ is very important for safety in night on the road. Good street lighting can improve the road safety. A solar street lamp or light is a light powered by solar energy obtained from solar panel on the top of lamppost. Sun is not only a source of heat and light but also it is a source of electricity. Solar cells also called photovoltaic cells are used to convert sunlight to electricity. Solar cells are used to provide electricity all kinds of equipment such as calculators, watches, roadside light, phones, recreational vehicles etc. Solar panels are becoming common on many homes. In Bangladesh large amount of natural gas is used to produce electricity. But it is an important fuel for industry. Electricity is also important. So we have to rely on other fuel or source for producing electricity. Sunlight is one of the best sources for electricity because solar energy system can provide heat and electric power without

producing any CO₂ emission, so it helps in global climate change by reducing CO₂ emission.

1.1 Advantages of solar energy:

Although solar energy² has its disadvantages, this will surely be covered by its advantages as further researchers are done to bring the use of solar energy into a higher level. Here are some of the advantages of solar energy.

- Solar energy is a renewable source of energy. Though we cannot harness it during night time or on cloudy days, we can still rely on its availability day after day.
- Solar energy cost nothing. The energy from the sun is free so after giving up a little bit of money, the source of energy is practically free.
- Solar cells do not require much maintenance once these are brought up to their maximum efficiency.
- Solar cells are quite collectors. They produce no noise unlike any other energy sources.
- Solar panels are very reliable. With parts fixed and not moving, these can last longer than any other energy source.
- Solar energy is clean. It does not produce pollution at all. Solar power plants emit zero pollution and does not cause harm to the environment.

- Because of the improvements in the solar energy technology, the cost of it is getting cheaper, making it more acceptable to utilize as one of the most commonly used energy sources.

1.2 Advantages of solar street lamp:

The development of solar is very fast. The solar lighting require no wire, this make it possible to install lighting in great amount of areas that are difficult to lay cables. I want to introduce you the great advantages of solar street lighting.

1.2.1 Installation:

A major bonus of solar lighting is the straightforwardness of installation. Seeing as they are generally self-contained systems and won't need cabling to the mains, installing them is a extremely easy. Backyard outside lights is sometimes supplied in a pedestal design together with a spike which you drive into the ground. Decking and feature lights can require attaching to posts or fitting in the decking -- either way removing these to be concerned about wiring is a key bonus. Any person that has rudimentary Die ability really should have no problem setting up virtually any of these kinds of lights.

1.2.2 Energy-saving:

Solar lights incorporate a normal rechargeable power³ supply and one or more photovoltaic. These photocells change sunshine into electrical power so they can recharge the batteries during daytime. At twilight, the lights will automatically turn themselves on and will probably have a sufficient amount of electrical power to stay on all through the night. As a result, they're especially economical since no additional electrical power is necessary. They're at the same time eco-friendly for similar reasons (however, bear in mind that if you have to dispose of them, it should be done properly as so-called heavy metals, including nickel and cadmium, utilized in some sorts of chargeable batteries can leach into groundwater when they are placed in land fill sites)

1.2.3 Safety:

Since the lights operate using very low voltages and no mains power, there isn't any danger of electrical shock. As such, they are an exceedingly safe choice.

2. METHODOLOGY

Name of components which have used to do the job are:

2.1 Solar Panel: The function of solar panel⁷ is to convert solar radiation into electricity and stores in batteries. Properties of the panel which has been used for this project are

- 1) Maximum power 10 watt
- 2) Tolerance of P_{max} (0 to 3)
- 3) Rated voltage 17.2 volt
- 4) Rated current 0.58A
- 5) Open circuit voltage 21.6 volt
- 6) Short circuit current 0.68A
- 7) Maximum system voltage 600 volt
- 8) Weight 1.8 kg

2.2 Controller: It is also called charge discharge controller⁸. It is very important because it can decide the life time of a battery. The controller model which has been used is SN 1000. Rated voltage of the controller is 12 volt & maximum rated current is 10A.

2.3 Battery: As the solar PV system, the input energy is very unstable. Therefore it is essential to configure the battery⁹ correctly. In addition batteries are subjected to high and low temperature. Rechargeable sealed lead-acid battery has been used & the lead-acid chemicals are non-spillable.

2.4 Light Source: 3 watt DC bulb is used for light source. There is no such thing as a DC bulb or an AC bulb. All [incandescent] bulbs could be powered by AC or DC.

2.5 Light Pole: $\frac{3}{4}$ steel pipe has used which is 3 feet in length.

2.6 Battery Box: A box made of wood has been used for battery box. Top of the battery box has used as light pole base.

2.7 Light ON-OFF Controller Circuit: The circuit¹⁰ will control the light ON-OFF automatically during the dark & sunny.

2.8 Breadboard: A thin plastic board used to hold electronic components (transistors, resistors, chips etc.) that are wired together used to develop prototypes of electronic circuits.

No soldering is required so it is easy to change connections and replace components. It is reusable.

2.9 Relay: An electric current through a conductor will produce a magnetic field at right angles to the direction of electronic flow. If that conductor is wrapped into a coil shape, the magnetic field produced will be oriented along the length of the coil.

2.10 Voltage Regulator: A voltage regulator¹¹ is designed to automatically maintain a constant voltage level. A voltage regulator may be a simple "feed-forward" design or may include negative feedback control loops.

2.11 Resistor: A resistor¹² is a component of an electrical circuit that resists the flow of electrical current. A resistor has two terminals across which electricity must pass, and is designed to drop the voltage of the current as it flows from one terminal to the next. A resistor is primarily used to create and maintain a known safe current within an electrical component.

2.12 Transistor: Transistors¹³ can be regarded as a type of switch, as can many electronic components. They are used in a variety of circuits. They are central to electronics and there are two main types; NPN and PNP. Most circuits tend to use NPN.

2.13 Capacitor: A capacitor is a passive two-terminal electrical component used to store energy in an electric field. The forms of practical capacitors vary widely, but all contain at least two electrical conductors separated by a dielectric (insulator). Capacitors are widely used as parts of electrical circuits in many common electrical devices.

2.14 Integrated Circuit(IC): Integrated circuits¹⁴ are called chips or electronic circuits where all the components (transistors, diodes, resistors and capacitors) have been manufactured in the surface of a thin substrate of semiconductor material.

2.15 Light Dependent Resistor:

LDRs or Light Dependent Resistors are very useful especially in light/dark sensor circuits. Normally the resistance of an LDR is very high, sometimes as high as 1000 000 ohms, but when they are illuminated with light resistance drops dramatically.

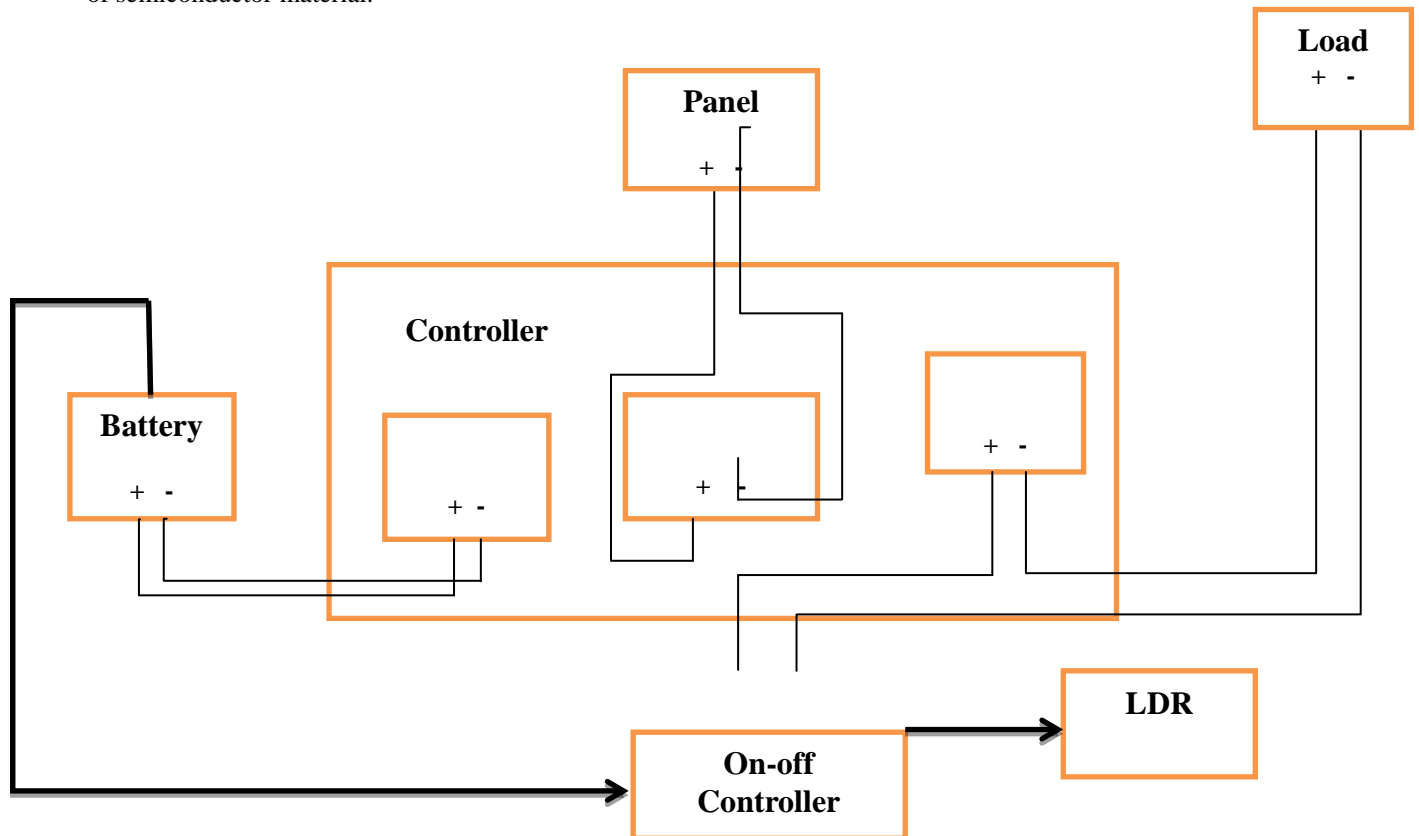


Figure 1: Connection layout

CONNECTION LAYOUT:

Solar Panel is directly connected with the controller where energy conversion takes place. From controller, others equipments are attached as shown in figure 1, and their functions are discussed earlier.

3. DESIGNED LOW COST AUTOMATIC SOLAR STREET LAMP

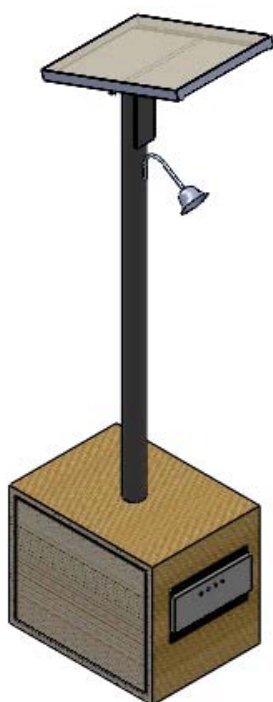


Figure 2: Designed low cost automatic solar street lamp



Figure 3: Fabricated solar street lamp

4.2 COST EFFECTIVENESS:

Solar street lights avoid the need for trench excavation and conduits. Most of the time Solar panel ensures lifetime warranty. Controlled charging prolongs the battery life. Scheduled maintenance is not needed because self-contained-light on-off controlled by automatic daylight sensing.

In spite of high initial cost¹⁵, it is good and cheap in case of long run which is badly needed for our country because conventional street light always contained higher running and maintenance cost which is too much costly our small economy.

Table 1: Cost Analysis

Name of Item	Capacity	Cost (BDT)	Type of Cost	Warranty	Maintenance Cost
Solar Panel	10 W	850	Fixed	20 Years	No
Controller	10 Amp	500	Fixed	5 Years	No
Battery	12 V	1000	Running	1 Year	Yes
Bulb	5 W DC	120	Running	1 Year	No
Others		530	-	-	-
Total Cost		3000			
Per unit Production Cost	0.0090 BDT Per Watt (Considering minimum 1 Year Running Period)				

5. RESULT AND DISCUSSION

Power consumption in street lighting is much. Conventional streetlight consumes huge amount of electricity everyday in our country. Today our main energy resources such as petroleum, natural gas, coal etc. are facing the danger of exhaustion. So it is a great option for decreasing pressure on conventional fuel which is used in most power plants. Solar Street light saves 50%-60% power than traditional lamp. If solar led street lights are assumed to substitute for grid-connected LED streetlights, then the energy savings per light is the 0.53 kWh/day usage incurred by an LED fixture or 193.5kWh/year. For 1,000 solar streetlights this amounts to an annual energy savings of 193,500 kWh. If solar LED streetlights are assumed to substitute for grid-connected high-pressure sodium lamps, then the energy savings per light will be the 1.3 kWh/day usage incurred by a high-pressure sodium fixture, or 474.5kWh/yr. For 1,000 solar streetlights, this amounts to energy avoided of 474,500 kWh/year. From the point of view of environmental protection, it has the advantages of easy installation, high efficiency and energy conservation, health and environmental protection, safety and harmony, economy and utility. From the point of view of economy, it saves energy and cost.

6. CONCLUSION

Fuel is the main factor for the economy of a country. And demand of fuel is increasing rapidly day by day. Petrol & diesel are the main fuel used in worldwide. But all of these are non-renewable sources of energy and are very harmful for our environment. Combustion of these types of fuel produces different types of toxic gases which pollute air and at the same time, sources of this type of energy are limited. So, alternative fuel must be searched to solve our energy problem and to make free our environment from pollution.

Solar energy is one of the most effective renewable sources energy. In Bangladesh, power crisis is very much and that's why we must need to use renewable energy such as solar energy. From this point of view, solar streets light for road lighting will be beneficial and economical for our country.

- [1] M. Luckiesh(1920),Artificial light,The century company.
- [2] Fielding H.Garrison, History of Medicine.
- [3] S.P Scott(1904), History of the Moorish Empire in Europe,3 vols.
- [4] U.S Department of energy: The History of Solar.
- [5] Danish Solar Energy: Photovoltaic-A clean solution.
- [6] www.photonsolar.in
- [7] Animakono Limited
- [8] www.streetlights-solar.com
- [9] www.blueboolighting.com
- [10] www.wikipedia.com
- [11] www.dx3enterprisesltd.com
- [12] www.Greenshire.com
- [13] <http://energyboom.com>
- [14] <http://www.solarilluminations.com>
- [15] www.gcpud.org

REFERENCES