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QUANTITATIVE STUDY OF COST EFFICIENCY OF SOLAR POWERED LED LAMPS

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----------ABSTRACT----------
Solar energy is the radiant light and heat from the Sun which is available all over the Earth, albeit in varying amounts depending on the location.The amount of solar energy reaching the surface of the planet is so vast that in one year it is about twice as much as will ever be obtained from all of the Earth's non-renewable resources of coal, oil, natural gas, and mined uranium combined!(1) This very fact and the fact that non-renewable sources of energy are causing global warming and are depleting has lead to an increase in the importance given to solar energy (as it is the largest of all renewable energy sources). However, people are skeptical of turning to solar energy due to the high capital cost.
Similar is the case with LEDs. LED lights have high energy saving potential. A 60 W LED light provides enough light for substituting a 500 W halogen. But owing to the high initial costs, not everyone is inclined towards taking the energy efficient step.
The authors of this paper used a combination of an LED light run on solar power to substitute a halogen run on electricity. We carried out this experiment in a company where we were working as interns. The halogen was being used to light up the storage area of the company during the dark. This paper deals with the energy saved and the number of years needed to break-even with the initial cost. The objective is to give the masses an idea of the cost and energy saving potential of the same.
KEYWORDS – *solar, renewable, LED, energy saving*

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I. INTRODUCTION

In the era past the Industrial Revolution and with the advent of modern technology, man has been depending upon machines to simplify his life. Any machine requires energy to run it and in the last few years, we have depleted a major portion of the non-renewable energy sources like coal, mineral oil and natural gas. Not only has this pointed to a future where these resources will be over, but it has also lead to a major pollution crisis.
Owing to these two points, the stress on energy conservation and use of renewable energy sources has increased tremendously. A lot of research is being done on the development of energy efficient and non-polluting machines.
LEDs or Light Emitting Diodes are light sources that consume very little energy as compared to more popular appliances such as an incandescent bulb or a halogen lamp. This coupled with solar energy to drive the LEDs can lead to a major saving of energy. And as LEDs do not consume a lot of power, the solar energy harnessing equipment doesn't have to be of a high wattage! Hence, the aim of this paper is to indicate, using numbers, the power and money saving potential of the above mentioned combination.

II. THEORY AND BASIC COMPONENT DETAILS

The basic components of theinstalled setup are:

1) LED light – LED light is a light source that consumes very less energy. We used a 60 W LED to replace a 500 W halogen lamp which was initially being used.
2) 150 Watt solar panel – The solar panel is used to convert the radiation from the Sun into electricity used for charging the battery
3) Solar battery (75 Ampere hour) – The solar battery is charged by the solar energy harnessed by the panels. This is then used to power the LED light.

This same setup can also be used to power the halogen lamp, but that would require a 1200 Watt solar panel (which would be huge) not to mention a halogen lamp is a wasteful source of light as a lot of the energy is converted to heat.

Figure 1

Figure1 shows the setup of the LED light system. This was setup in a warehouse which functions as storage

Figure 2

Figure 2 shows the battery used for storing solar energy

III. CALCULATIONS

Wattage of halogen lamp = 500 W = 0.5 kW
No. of hours used per night = 10 hours
Energy consumed per night = 0.5 x 10 = 5 kW-hr
Energy consumed by the halogen lamp in a year = 5 x 365 = 1825 kW-hr
Cost of one unit of electricity =INR.8.4 per kW-hr(2)
Cost of running the halogen lamp for a year = 1825 x 8.4 =INR.15330
If this setup is replaced by an LED run on solar power, the running cost will be INR. 0 and there will be a saving of Rs. 15330 per year.

Cost of 60 Watt LED (with a stipulated life of 50000 hours) = INR.12000
Cost of 45 Watt solar panel = INR 9750
Cost of battery = INR.6850
Labor and hardware charges = INR.4000
Total cost per lamp = INR.32600

IV. RESULTS

The breakeven will be in: 32600/15330 = 2.13 years or approximately 2 years 2 months
Consider a maintenance cost of Rs. about Rs.1330 per year.
So after the period of 2 years and 2 months, the yearly cost saving will be Rs. 14000 per year not to mention 1825 kilo Watt hours of energy!

In principal this is the savings for one lamp. The company for which the experiment was carried out had 8 such halogens for their factory area for security purposes at night. This amounted to savings worth nearly INR.96000 per annum.

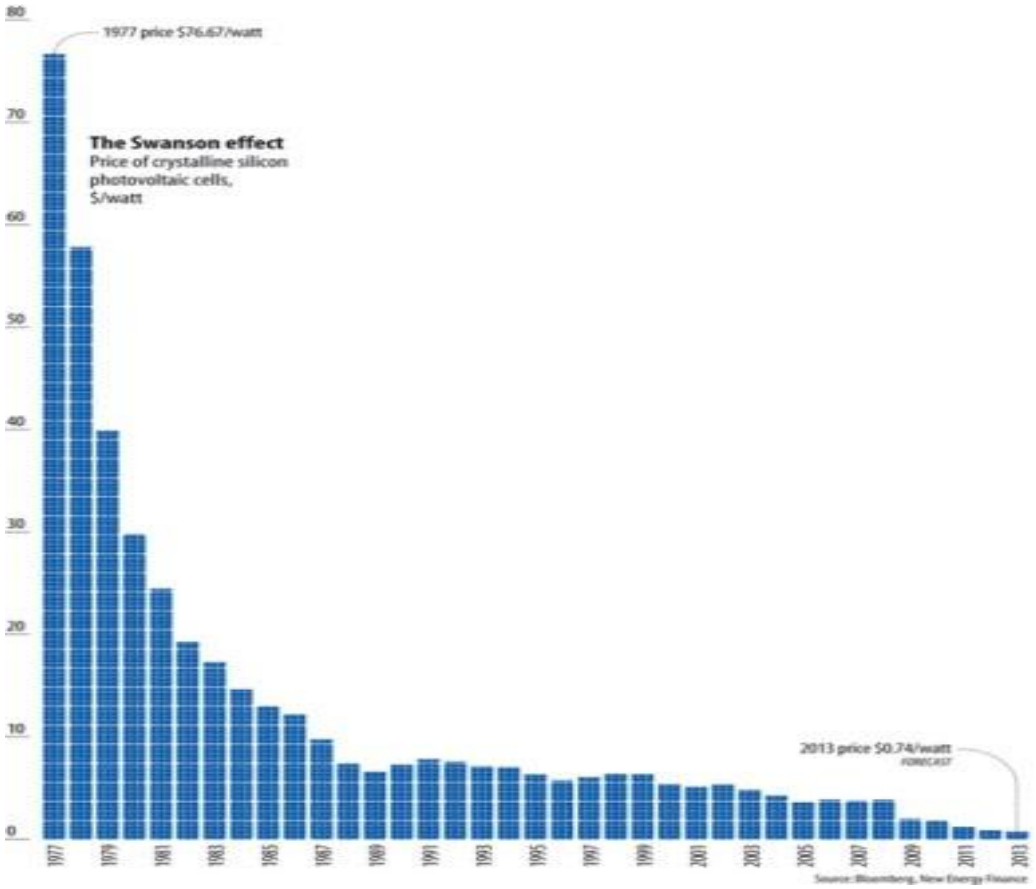

Figure 3

Figure 3 shows the drastic reduction in the prices of crystalline silicon, the material used in making solar panels. This should provide further incentives for encouraging the use of renewable energy.

V. CONCLUSION AND DISCUSSIONS

Majority of India receives about 2600 to 2800 hours of bright usable sunshine (3).With such abundant catchment area available for solar energy little effort has been taken to harvest it. Use of solar power and LEDs is a viable option today considering the reduction in cost and energy saving potential. The main concern with the renewable technology has always been the high initial cost. But we must see that costs of solar panels as well as LED's have drastically declined, and there are innovations happening every day that further reduces the costs. With Solar panels and LED's getting cheaper time is ripe for the companies and civic agencies to incorporate the new technologies that are providing more efficient options for a better today and tomorrow.The figure1 shows Swanson Effect (4) which sees an exponential decline in prices of LED in the world. With increasing research being conducted in renewable energy area the prices for the solar cells are going to go further down.

NOTE:INR 1 = $ 0.015 (approx. As on sep.2015)

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