EFFICIENT AND COST EFFECTIVE MODEL FOR AN ECO-FRIENDLY SOLAR COLONY

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ABSTRACT

A simple and successful design is developed which has the objective to put together a cost effective model, scaled down both in size and energy required for an average residential home driven through Solar Panels. It also deals with the autonomous illumination of streets of a model colony through solar panels to meet the requirements and attain the maximum efficiency of the available energy. The Photovoltaic system along with an inverter and intensity control circuit counts for the basic design. The effort deals with the efficient, cost effective and needful implementation of Photovoltaic systems which would be useful primarily in rural and remote parts of India for both social and economic development of the people.

KEYWORDS

Solar cell, intensity control circuit, compact fluorescent lamps, inverter transformer, LDR, eco-friendly, economic.

1. INTRODUCTION

Development of electricity infrastructure is one of the main hurdles in the development of rural society. India's grid system is considerably under-developed, with major sections of its populace still surviving off-grid. As of 2004 there are about 80,000 un-electrified villages in the country. Of these villages 18,000 could not be electrified through extension of the conventional grid [1]. Keeping in mind the vast and diversified contour of a country, it is hard to install grids in the remote areas such as forests, deserts and hilly regions. Again manual control of the street lamps in such areas is an impossible task. Autonomously operated solar powered CFL lamps through intensity control circuits are the best possible way to provide electricity in these areas which will be able to bring out a social, economical and most importantly eco-friendly development in the society.

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2. Analysis

In India the theoretical solar power reception on its land area alone is about 5 Peta Watt-hours per year (PWh/yr) for 300 clear, sunny days in a year. The daily average solar energy incident over India varies from 4 to 7 kWh/m^2 with about 1500–2000 sunshine hours per year (depending upon location), which is far more than current total energy consumption [1].

A model colony and a prototype house had been designed based on solar energy to implement the circuitry showing its real life application. Figure 1 shows the entire block diagram and it has been divided into two parts - the prototype house in which a Compact Fluorescent Lamp (CFL) has been illuminated by the photo generated energy and on the other hand a model colony which constitutes of such solar houses and street lamps powered by solar panels operated through autonomous intensity controlled switching circuit.

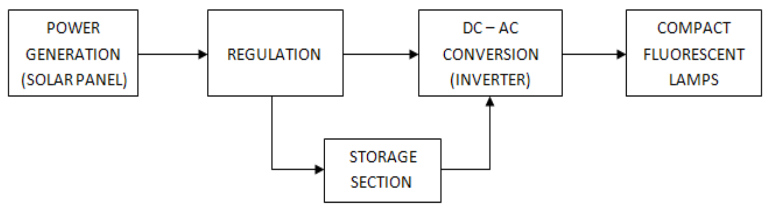

Fig.1.a. Block diagram for solar house

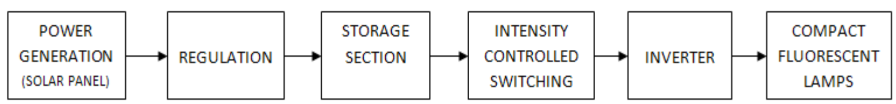

Fig.1.b. Block diagram for the solar panel based intensity controlled street lamps

A solar panel of 10 watts [2, 3, 5] is used as the primary source of power and also to simulate the entire experiment. The prototype house installs the solar panel which drives a regulation circuit shown in figure 2. Voltage regulators in various configurations are used in this block to regulate the photo generated power and remove backflow [4, 5]. This regulated power is used to charge various kinds of storage elements such as Lead-acid, Nickel-Cadmium and Lithium-ion batteries to be used for different household purposes [4]. A Lead-acid battery (12 Volts and 7 Amperes) is used to deliver power to a Compact Fluorescent Lamp (CFL) rated at 9 watts in the house.

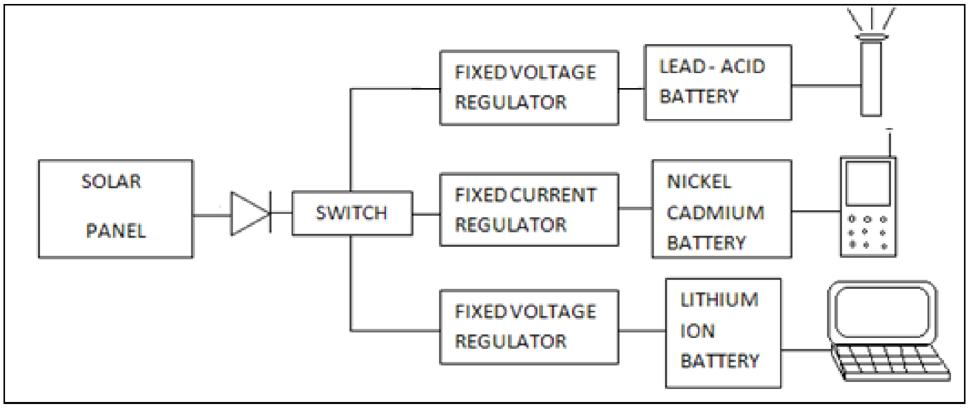

Fig.2 BLOCK DIAGRAM OF THE CIRCUIT

In addition to the rural areas, this project can also be implemented in the urban areas with an aim to reduce pollution. Since there is an abundance of AC operated equipment in urban areas, an inverter circuit is used to illuminate the CFL. The inverter circuit consists of miniature high frequency inverter transformer that has a 25mm x 20mm x 5mm ferrite core, 30 turns of primary, 15 turns of feedback, and 250 turns of secondary all concentric, wound on plastic frame then wrapped with a 'yellow' adhesive tape as shown in figure 3.This is a single transistor oscillator circuit. Current passed through primary winding inducts a magnetic field to the core and the core gives the energy back to the feedback winding with a delay determined by the core material and windings. The system then oscillates continuously on a frequency depending on this timing [3, 4, 5, 6].

As discussed earlier, autonomously operated solar powered CFLs along with intensity control circuits would be the best possible way to provide as well as conserve electricity in the remote and desolate areas. The street lamps consist of a circuit that incorporates a Light Dependent Resistor (LDR) and controls a relay through a transistor to switch on CFLs according to the intensity of the available sunlight. This circuit, as already stated, brings enormous help in areas where it is not possible to physically operate street lamps [5].

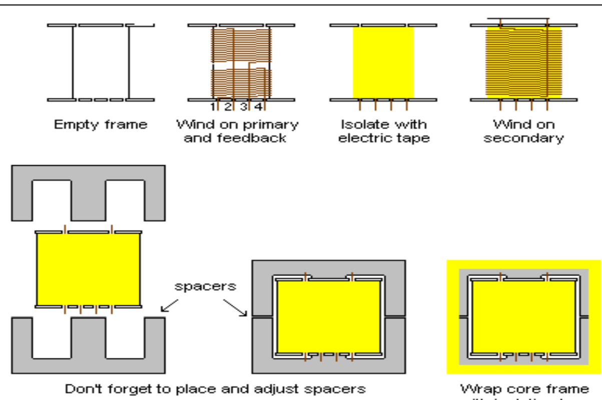

Fig. 3.Assembly of high frequency ferrite core transformer.

The circuit has a simple transistor switch shown in figure 4 with the base of the transistor connected to a voltage divider. The voltage divider has two resistors. The first is the 220KΩ potentiometer. The second resistor is the LDR. As light falls on the surface of the LDR, the LDR changes it's resistance. Higher the intensity of available light, leads to less the resistance of LDR and in turn of which the voltage drop across it becomes less. The less the light, the more the resistance and thus the voltage drop across it increases. As the voltage drop increases, so does the V_B of the CL100 transistor and therefore the I_{CE} increases accordingly, until the time that the current is enough to actuate the relay.

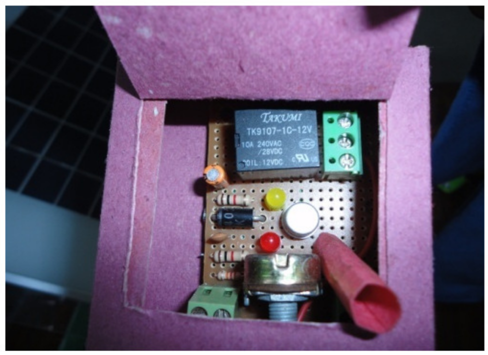

Fig.5. Autonomous intensitycontrolled circuit

fig.5. Practical application

The amount of light needed to actuate the relay can be changed by changing the 220K potentiometer. Basically, any change to the potentiometer will have an effect on the voltage drop of the LDR, i.e. its sensitivity is adjustable depending on the available light intensity. Practical applications are shown in figure 5

3. RESULTS

In the present work the practical circuits have been developed on Veroboard and also successfully simulated and the results are tabulated below.

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Table1. Regulator Blocks

PORT NAMES	**DESIRED OUTPUT**	**PRACTICAL OUTPUT**	**BATTERY CONNECTED**
PORT A	12 Volts	11.79 Volts	Lead-Acid
PORT B	5 Volts	4.99 Volts	Lithium-ion
PORT C	12 V, 0.6 Amps	12 V, 0.6 Amps	Nickel-Cadmium

Table2. Inverter block

PARAMETERS USEI	**DESIRED OUTPUT**	**PRACTICAL OUTPUT**
OUTPUT WAVEFORN	Sinusoidal	Modified Sine Wave
VOLTAGE	220 V	≈ 150 V
POWER	40 Watts	More than 40 Watts
FREQUENCY	High Frequency	High Frequency

Table3. AUTONOMOUS INTENSITY CONTROL SWITCH

TIME	**RESISTANCE OF LDR**	**STATUS OF RELAY**	**STATUS O YELLOW I**	**STATUS OF RED LED**
DAY	A few Ohms Depending on intensity of light	Turned Off	Off	On
NIGHT	In range of mega Ohms	Turned On	On	On

Figure 6 shows the modified waveforms of the inverter block.

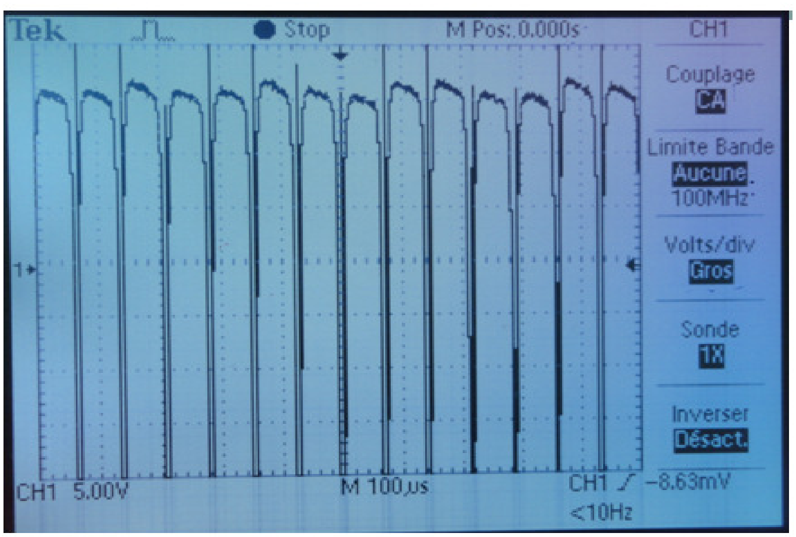

Fig.6. Output waveform of inverter block

4. CONCLUSION

The concept of solar powered prototype house along with the intensity controlled switching circuit when implemented in the long run on practical fields to manage rural and urban development would definitely be a big leap towards reducing Global Warming and attaining a Green Country stature.

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