A Novel Method of Utilizing Hybrid Generator as Renewable Source

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Abstract—Energy production and consumption in the future may depend on renewable energy sources and also depends on the efficiency of utilizing it. Here, a hybrid system, a combination of solar cells and thermoelectric generators is controlled by open circuit voltage method which is normally used for linear electrical characteristics. The proposed system is supported by theoretical analysis and simulation. Lead acid battery is used to accumulate the harvested energy. Cuk converters are used here to improve the efficiency and helps in reduction of noises. Hybrid generators are found to be efficient and more stable.

Hybrid Generator, Renewable Source, Cuk Convertor, Solar Cells, MPPT.

I. INTRODUCTION

A solar photovoltaic (PV) thermoelectric generator (TEG) hybrid system combines the economics of a solar photovoltaic system with the reliability and heating capability of a thermoelectric generator. The solar system is capable of generating energy during climates with abundant sunshine while the thermoelectric generator system provides power and heat as required during seasons with insufficient solar insulation or during extended periods of harsh weather. It is discussed that the operating principle of a thermoelectric generator and solar PV-TEG hybrid system, and turn over two existing sites in northern Canada. It is finalized that, for gaining maximum reliability and still remains profitable, the remote power system's design must be modified closely to individual site needs, regions, and environmental temperatures. It has been found that at locations where delivered fuel costs become significant and stand-alone solar is not a sustainable alternative, a solar PV-TEG hybrid system provides unmatched reliability and economics.

The simplest of the hybrid systems, and the most widely used, is the PV/Thermal (PVT) system consisting of photovoltaic (PV) panel coupled to heat extractor with running water or air. Usually PVT system utilizes a crystalline Si solar PV module, taking benefit of its cooling by heat extracting unit thus increasing its efficiency, and produces 100 – 140 W/m2 of electric energy at peak illumination, and 3 – 6 times as much thermal energy stored in water/air, heated up to 45 – 50˚C. It is important to mention an essential increase in thermoelectric conversion efficiency reached during the last decade and connected with the utilization of nano structured materials for their production.

II. OVERVIEW OF PHOTOVOLTAIC ARRAY

Photovoltaic cell also known as solar cell is used to transfer energy from the sun directly into electrical energy without any form of rotational parts. The fundamental power conversion unit of photovoltaic system is represented by the PV cells. These cells are made from semiconductors and other solid-state electronic devices e.g. diode, transistors and integrated circuits. PV cells are usually arranged into modules and array when implemented practically. There are different types of photovoltaic cells available in the market and yet different types of cells are under progress e.g. dye-sensitized Nano-crystalline cells. The reason for different types of photovoltaic cell, materials and structure is to extract maximum power from the cell and to maintain cost to a minimum. According to efficiency above 30% have been achieved in laboratory and efficiency of practical application is usually less than half of that value [6]. Crystalline silicon technology is well certified and its cell is more expensive but still controls a major part of the photovoltaic market with efficiency approaching 18%. Other types of photovoltaic cells like amorphous thin films are less expensive but with drawback of strapped efficiency. Many factors may affect the electrical performance of a photovoltaic module from operating at optimal point. These factors are Sunlight intensity/irradiation, Cell temperature, Load resistance and Shading. The use of photovoltaic array and maximum power point tracker (MPPT) to restrain these challenges are developing rapidly.

III. THERMOCOUPLE

Thermocouple connected to a multimeter displays the room temperature in degree Celsius. A thermocouple is a temperature-measuring device consisting of two different conductors that contact each other at one or more spots, where a temperature difference is experienced by the different conductors. It usually produces a voltage only when the temperature of one of the spots differs from the reference temperature at other parts of the circuit. It is a widely used type of temperature sensor for measurement and control; it can also convert a temperature gradient into electricity [1]. Thermocouples which are used commercially are low-priced, interchangeable, and are supplied with standard connectors, that can be used to measure a range of temperatures. They are self powered and necessitate no external form of excitation. The restrictions with thermocouples are accuracy; system errors of less than on degree Celsius (°C) which is difficult to achieve.

IV. SEE BECK EFFECT

The See beck effect creates an EMF whenever there is an effect of temperature gradient. This electromotive force produced can be used to perform work, in this it is used to build up an open-circuit voltage. Under open-circuit condition there is no internal current flow in it, the gradient of voltage is directly proportional to the gradient in temperature. A temperature-dependent material property is known as the Seebeck coefficient. The measured voltage can be found by integrating the electromotive forces along the entire path from the negative terminal of the voltmeter to the positive terminal.

V. MAXIMUM POWER POINT METHOD

A maximum power point tracker is a high-efficiency DC-DC converter, which act as an advantageous electrical load for photovoltaic cell. It is universally used for a solar panel or array and converts the power to a voltage or current level which is more suitable to whatever load the system is supposed to drive. PV cells has a single operating point where the values of current and voltage result in a maximum power output for the cell [10]. Maximum power point is basically an electronic system that controls the duty circuit of the converter to enable the photovoltaic module operate at maximum operating power at all condition and not some sort of mechanical tracking system that physically rotate the photovoltaic modules to face sunlight directly. The advantages of MPP regulators are best during cloudy or smoggy days, cold weather or when the battery is thoroughly discharged. There are different types of maximum power point tracker methods developed over the years and they are listed below as follows

(1) Perturb and observe method,

(2)Incremental conductance method,

(3) Artificial neutral network method,

(4) Fuzzy logic method,

(5) Peak power point method,

(6) Open circuit voltage method, and

(7) Temperature method etc.

The MPP plays a very significant role because without the MPPT the desire output electrical power will not be achieved without changing weather conditions. The adopted topology for the MPPT design will comprise four fixings, namely Microcontroller, pulse generator and a Gate which act as a buffer.

VI. OPEN-CIRCUIT VOLTAGE METHOD

The open-circuit time voltage method is an fairly accurate analysis technique used in electronic circuit design to determine the corner frequency of difficult circuits. It also is known as the zero-value based time constant technique. It recognizes the largest contributions to time constants as a guide to circuit improvements. The basis of the method is the approximation that the corner frequency of the amplifier is determined by the term in the0020denominator of its transfer function that is having linearity in frequency. This way of approximating may be extremely inaccurate in some cases where a zero in the numerator is near in frequency. The method also uses a simplified method for finding the term linear in frequency based upon summing the RC-products for each capacitor in the circuit, where the resistance R for a selected capacitor is the resistance found by inserting a test source at its site and setting all other capacitors to zero. Hence the name zero-value based time constant technique. Power point which is coarsely linearly proportional to its open-circuit voltage, Voc. The proportional constant relies on the material and the fabrication know-how of the solar cells technology, fill factor and the climatic conditions, mainly, $K1 = VmppVoc$. A VI characteristic of open circuit method is as shown in figure 2.

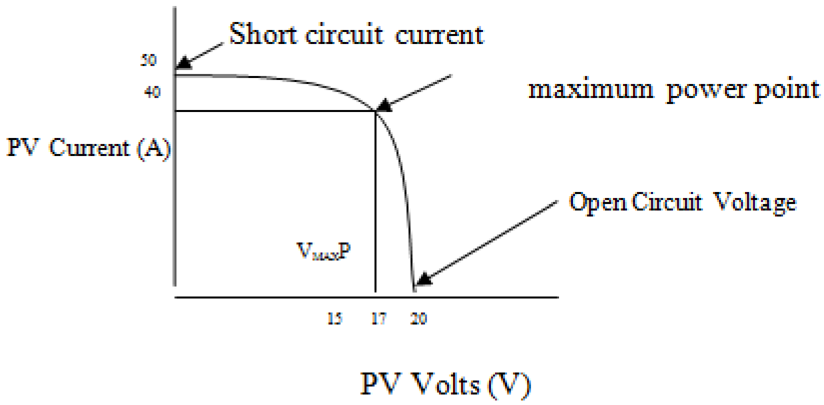

FIGURE 1: VI CHARACTERSTICS OF OPEN CIRCUIT VOLTAGE METHOD

VII.SYSTEM WORKING

From the block diagram, the DC-DC converter is used as a photovoltaic interface between the photovoltaic module and the load to power the load (Led base light, 24V). This is fulfilled by controlling the duty cycle of the DC-DC boost converter. From figure 3, the microcontroller tend to maximize the output power from the photovoltaic module by adjusting the duty cycle so that the photovoltaic module will always be at its maximum power at all contemporaries. This is accomplished by continuously collecting samples of voltage and current from the output of the photovoltaic module including a reference voltage from the output of the converter as shown in figure 3 and employing the microcontroller to increase or decrease the voltage applied to the pulse generator (PWM) in order to change the duty cycle of the converter.

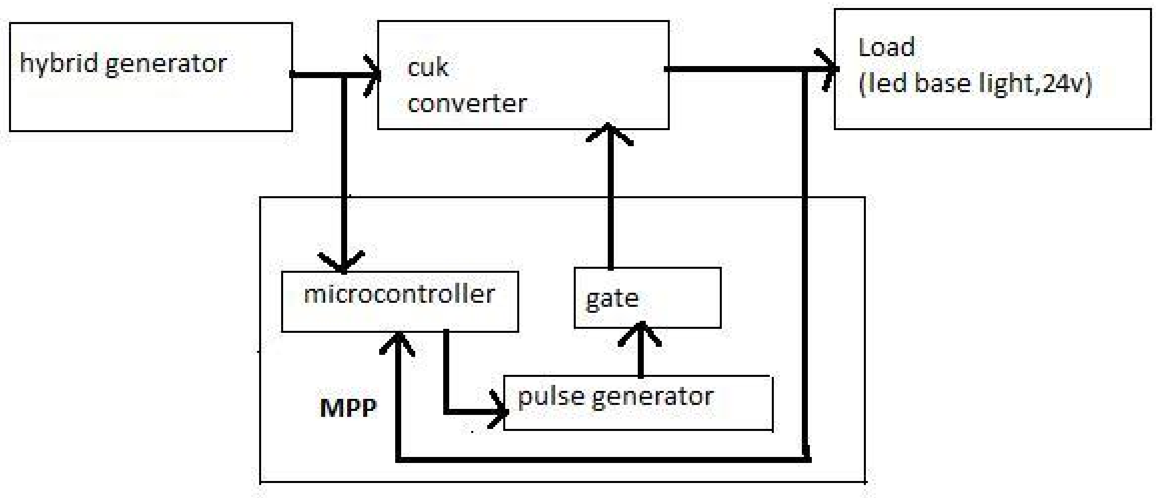

FIGURE 2: BLOCK DIAGRAM

VIII. METHODOLOGY

Combining the economics of a solar photovoltaic system with the reliability and heating capability of a thermoelectric generator. The solar system is capable of generating energy during climates with abundant sunshine while the teg system provides power and heat as required during seasons with insufficient solar insulation. The Ćuk converter a type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is essentially a boost converter followed by a buck converter with a capacitor to couple the energy. Pulse generator circuit (PWM) is one of the major component in the propose MPPT design in the project because continuous changing of the duty cycle determines the steady state output voltage of the Cuk converter with regards to the input voltage. In this paper, we used an astable multivibrator (555 timer circuit), a current source and output voltage of the microcontroller to produce the duty cycle. The microcontroller plays an important role in changing the duty cycle of the Cuk converter by sending DC voltage to the pulse generating circuit after calculating and comparing the maximum powers of the photovoltaic module and reference output voltage of the converter at different intervals. The microcontroller operation will be based on the flow chart. The microcontroller was not applied but when testing the design system a voltage source was used in place of the controller to change the duty cycle when the output of the photovoltaic module (voltage source) was altered to achieve our desired output.PIC microcontroller is fast and easiest controller to implement program when we compare it with other s like 8051. The way of programming and interfacing with other peripherals it became an powerful and successful one. The 40 pins make it easier to use the peripherals as the functions are spread out over the pins. This makes it easy to decide what external devices to attach. The circuit has been simulated as shown in figure 4. The simulation results are shown the figures 4, 5 & 6.

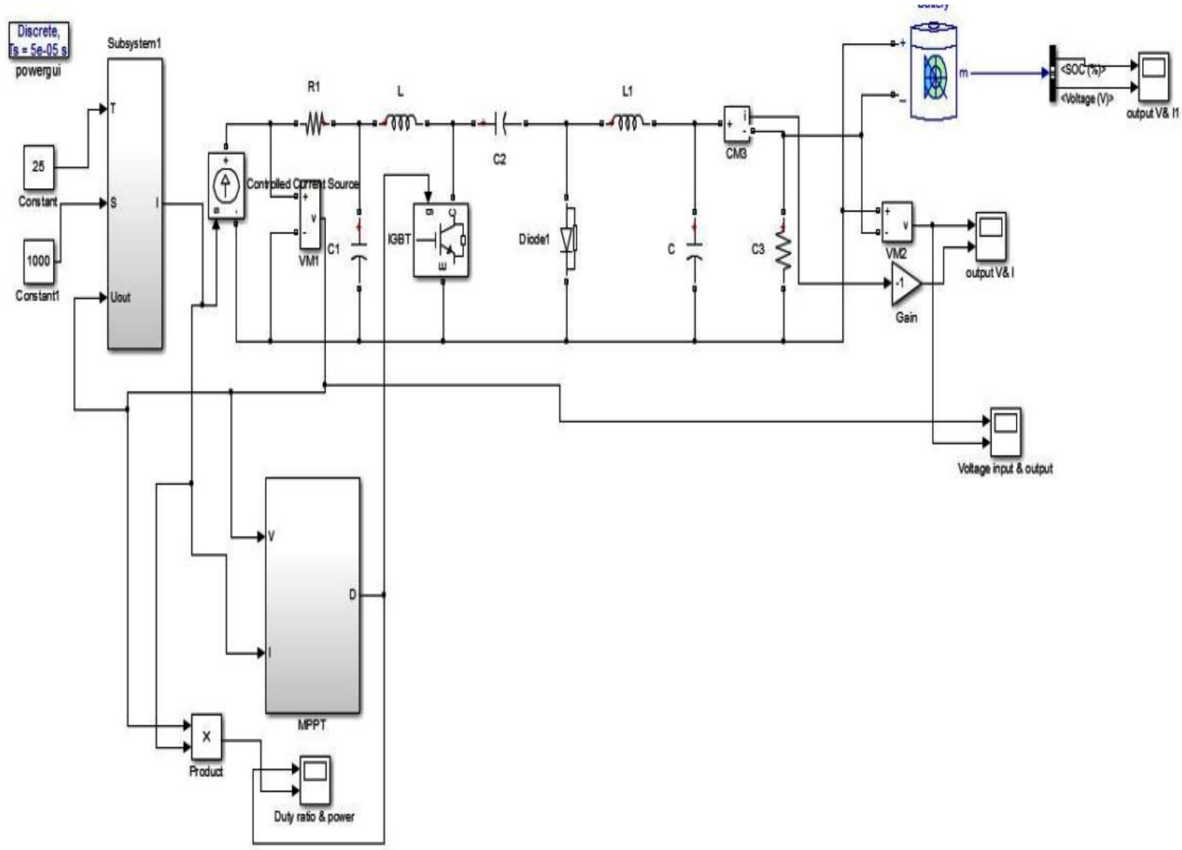

FIGURE 3: STIMULATION CIRCUIT

IX. STIMULATION RESULTS

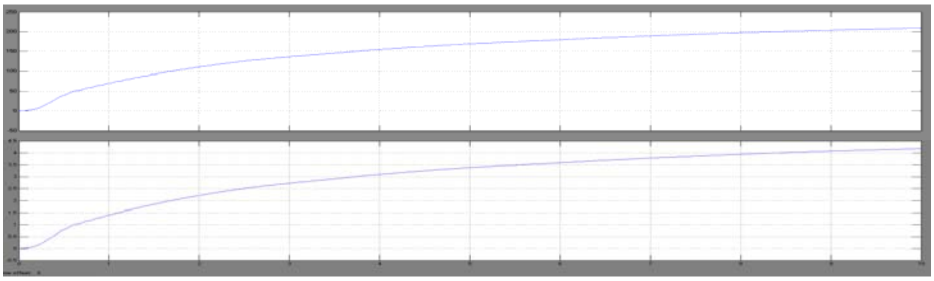

FIGURE 4: DUTY CYCLE RATIO WITH SOLAR

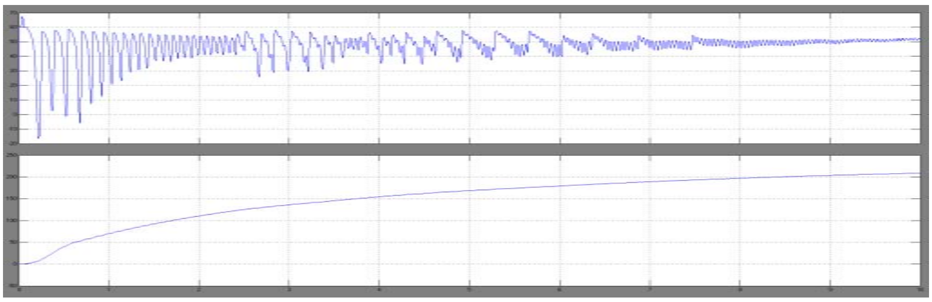

FIGURE 5: INPUT AND OUTPUT VOLTAGE

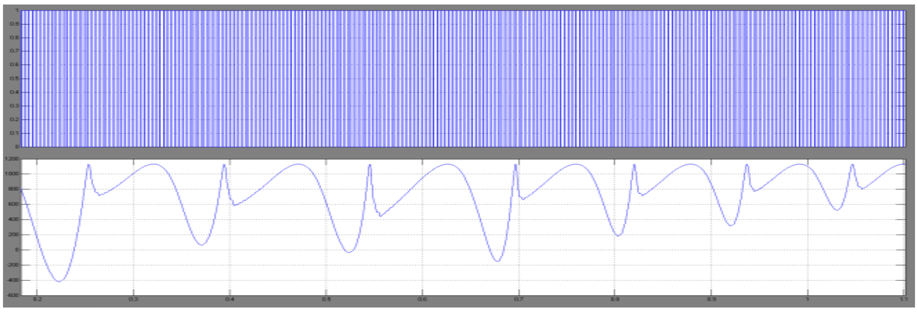

FIGURE 6: OUTPUT CURRENT AND OUTPUT VOLTAGE

VIII. CONCLUSION

This paper presents an innovative technique to obtain the open circuit voltage method for measurement of hybrid generators. It requires only a low cost microcontroller and does not need any expensive sensors.A fast and accurately tracking towards the MPP against the random insolation change.The converter used is a dc–dc non inverting cuk converter,, which can work in Boost, Buck-Boost or buck mode; this guarantees the harvest of power over a wide across the hybrid generator. It also provides a solution for the impedance matching.

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