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Hybrid Power Generation System using Solar and Peltier Plate

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Abstract

Nowadays, there is a demand to increase the power generation capacity because of steadily rising electrical energy consumption. In order to achieve this, renewable energy sources are the best option. However, the reserves of fossil fuels will soon be depleted, since oil is a limited resource. So overcome this we can use the renewable energy sources as it will also provide a cleaner environment for future generations. Renewable energy can be created by many methods; for example, solar energy, wind energy, hydro energy, nuclear energy, and many more. For each of these different forms of creating electricity, there are certain limitations. Among all the renewable energy sources, solar power generation system tops the list. But solar energy can only be created when there is sunlight, so overcome this by we can hybrid with other technologies, so here using hybrid generation using the solar and peltier plate. So when there is no sun then we can be get generate energy using the peltier plate. The solar and peltier energy obtained is stored to a battery. By hybrid which increases cell life, improve performance, and provide operational benefits under different environmental conditions. The battery which is used can be recharged with the two generation inputs like solar and peltier. The battery is connected to the inverter. From this energy the ac motor can be controlled using inverter design.

Keywords— *Solar plate, Peltier plate and Inverter.*

1. Introduction

Combination of different energy generation systems based on renewable energies or mixed is known as hybrid system. In this work a hybrid power system is designing with solar and thermo electric generator. However, the reserves of fossil fuels will soon be depleted, since oil is a limited resource. Over the years, the cost of electricity has risen to unprecedented levels due the limited supply of oil and economic and political factors. Thus, renewable energy is a more attractive alternative to electricity generation, as it will also provide a cleaner environment for future generations. In the world today, there are many great solutions to renewable energy. Renewable energy can be created by many methods; for example, solar energy, wind energy, hydro energy, nuclear energy, and many more. For each of these different forms of creating electricity, there are certain limitations. Solar energy is the most commonly form of renewable energy that is used in applications ranging from household power to spacecraft electrical systems. However, solar energy can only be created when there is sunlight, necessitating the use of alternate energy sources, or a method of storing energy for later use. Wind energy, hydro energy and with other technologies which have their own limitations, making them insufficient for wider usage.

The most important factors for choosing the kind of renewable generators are location, time and user needs. Location associates information about climate, energy sources availability and environment conditions, this information is very important to decide. Energy is a major input for overall socio-economic development of any society. Power plays a great role wherever man lives and works. The electricity requirement of the world is increasing at an alarming rate due to industrial growth, increased and extensive use of electrical gadgets. According to world energy report, we get around 80% of our energy from conventional fossil fuels like oil (36%), natural gas (21%) and coal (23%). It is well known that the time is not so far when all these sources will be completely exhausted. So, alternative sources should be used to avoid energy crisis in the nearby future. Converting the energy from the Sun directly to electricity is an efficient way. Solar energy is the largest and most abundantly available renewable energy resource on the planet, and is environmental friendly.

One of the energy is solar converts radiant light into electrical energy and peltier plate converts heat energy into electrical energy. The solar system provides power during seasons with abundant sunshine while the thermoelectric generator system provides power and heat as required during seasons with in-sufficient solar. Hybrid system which increases cell life, improves performance, and provides operational benefits under different environmental conditions. The battery is used here can be recharged with the two generation inputs like solar and peltier.

2. Introduction of Peltier Module

A peltier module (thermoelectric) is a device that consists of a p-type and n-type semiconductors. This structure can be used to convert heat energy to electricity by using a principle known as the Seebeck effect. A thermoelectric (TE) power generation occurs when a voltage is generated from a temperature difference across two different semiconductor materials. This phenomenon is called the Seebeck effect. When a voltage is applied to a circuit formed by two semiconductors a temperature difference will be created across these two

junctions. This is known as the Peltier effect. Furthermore when electric current flows through a single conducting material and when this single material already has a temperature difference across it heat energy will be either absorbed or dissipate throughout the material this effect is known as the Thomson effect. The thermoelectric device is an energy converter based on these effects which can be used for power generation or refrigeration.

Peltier device devices typically consist of two ceramic plates that connected by electrical conductor to semiconductors legs (p and n type) thermoelectric generator consist number of legs (N & P types) and every pair legs forms a thermoelectric couples. Heating one side of a thermoelectric material causes the electrons to move away from the hot end toward the cold end consequently, an electrical current is occur. The most efficient configuration is where a p and n TE component is put electrically in series but thermally in parallel. One side is attached to a heat source and the other a heat sink that converts the heat away.
The good thermoelectric materials should possess:

- Large Seebeck coefficients
- High electrical conductivity
- Low thermal conductivity

Thermoelectric generation can be a suitable energy source especially in situations where other power sources cannot operate. An alternative energy source is photovoltaic's which actually have a much higher efficiency. The advances in technology created a new market for long life, high reliability and low maintenance power sources.

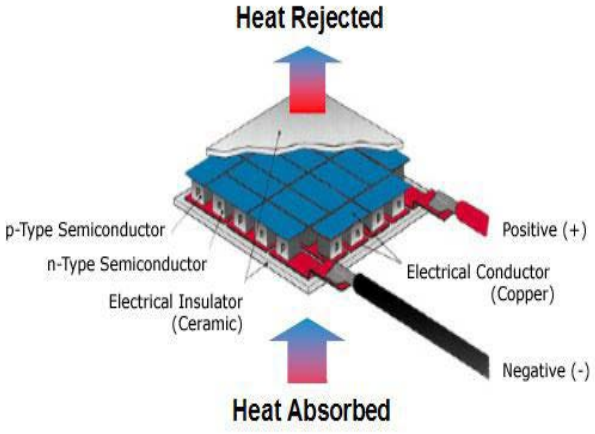

Fig 1.1 Schematic of a TE device

A thermoelectric generator is a device that consists of a p-type and n-type semiconductors connected in series, shown in figure 1.1.This structure can be used to convert heat energy to electricity by using a principle known as the Seebeck effect. When heat is applied to one surface of the thermoelectric generator the electrons in the n-type semiconductor and the holes in the p-type semiconductor will move away from the heat source. This movement of electrons and holes gives rise to an electrical current. The direction of the current is opposite to the movement of the electrons and in the same direction as the movement of the holes. By creating the appropriate electrical connections the current of the thermoelectric generator flows in a closed loop through the p-type and n-type semiconductors and an external load. This pair of n type and p-type semiconductors forms a thermocouple. A thermoelectric generator can consist of multiple thermocouples connected in series which increases the voltage output and in parallel to increase the current output.
Some benefits are as, long life, makes absolutely no noise and does not vibrate, no moving internal parts to damage when in transit, slim and compact, excellent quality.

Thermoelectric generation can be a suitable energy source especially in situations where other power sources cannot operate. An alternative energy source is photovoltaic's which actually have a much higher efficiency. A thermoelectric generator can provide power where a solar cell would fail.
Thermoelectric power generation (TEG) devices typically use special semiconductor materials, which are optimized for the Seebeck effect. The simplest thermoelectric power generator consists of a thermocouple, comprising a p-type and n-type material connected electrically in series and thermally in parallel. Heat is applied into one side of the couple and rejected from the opposite side. An electrical current is produced, proportional to the temperature gradient between the hot and cold junctions.

3. Solar Module

The solar energy is one of the most important renewable energy due to its easy availability, cleanness and cheap energy resources. Now days, a number of solar energy approaches are in progress and solar cells have paid more attention due to rapidly developing technology and potential applications to cater the energy demands of the developing world and the society. The solar cell is a device which directly converts electrical energy from the solar radiation which is based on the photovoltaic effect. Mono-crystalline silicon (mc-Si) solar cell is a part of silicon solar cell family and it has a number of advantages like low maintenance cost, high reliability, noiseless and eco-friendly. The overall performance of solar cell strongly depends on the environmental parameters such as light intensity or irradiance, tracking angle and cell temperature. Some Advantages are, low maintenance cost, reliability, commonly available, solar energy is free of pollution, no fuel cost, easy to replace.

The Solar cells which as the name implies of (photo meaning "light" and voltaic meaning "electricity"), it directly converts sunlight into electricity. A module is nothing but a group of cells which are connected both electrically and packaged into

a frame (commonly known as a solar panel), and then can be grouped into a larger solar arrays. Photovoltaic cells converts Photons to Electrons. These Photovoltaic cells are made with special materials called as semiconductors such as silicon, which is currently used. Basically, when the sun light strikes any cell a small certain portion of it is absorbed within the semiconductor material. This means that the energy which is absorbed from the light is transferred to the semiconductor. This energy knocks all the electrons to lose allowing them to flow freely.

4. Block Diagram and Its Explanation

It consists of solar panel, peltier plate, charging circuit, rechargeable battery, DC motor, inverter, step up transformer and AC load as AC motor.

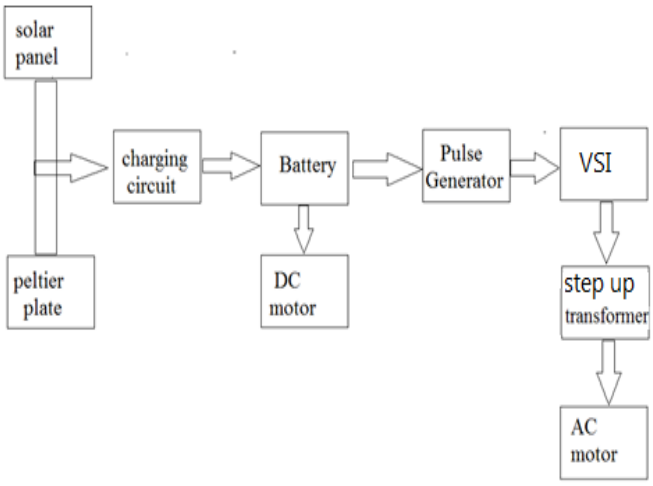

Fig. 4.1 Block Diagram of the Proposed System

Place the solar panel at any place where daylight is available. This solar panel contains photocells. In daytime this photocells convert the energy of light directly into electricity by the photovoltaic effect. The solar cell works as, Photons in sunlight hit the solar panel and are absorbed by semi conducting materials, such as silicon. Electrons (negatively charged) are knocked loose from their atoms, causing an electric potential difference. Current starts flowing through the material to cancel the potential and this electricity is captured. Due to the special composition of solar cells, the electrons are only allowed to move in a single direction. An array of solar cells converts solar energy into a usable amount of direct current (DC) electricity.

The peltier plate converts heat energy into electrical energy using Seebeck effect. When provide heat to the peltier plate at one side of the plate gets hot and at other side of the plate gets cold means that the temperature of the both end is different is called the Seebeck effect.

The output of the both solar and peltier plate is connected to the battery through the charging circuit. The charging circuit functions as a voltage regulator, i.e. the process of converting variable voltage to constant regulated voltage. The main function of a controller is to prevent the battery from being overcharged by the hybrid system. When a battery is fully charged, the controller will either stop or slow down the amount of current flowing into the battery from the generating systems. Battery can be used for storage purpose. Hence this hybrid system will work at day time as well as at night time. The output of the battery is DC, that can be directly connects to any DC load. Move the slide switch that is present on the charging circuit board to run the DC motor.

The output of the battery is DC only, for required AC power have to convert from DC to AC form. The inverter is used for converting DC to AC and the battery is connected to an inverter board to convert generated DC into AC voltage. The pulse generator generates pulses and its given to the MOSFET. Which are be done in voltage source inverter circuit. This inverter board takes DC input from battery and converts it to. A LED which is placed at the top right hand corner of the inverter board will glow to indicate that the power supply is working properly. A step up transformer is installed to receive low voltage from two MOSFET's and the transformer will step up the voltage The transformer high voltage i.e. secondary side is connected to the AC appliances i.e. AC motor.

5. Experimental Setup and Its Results

Fig. 5.1 Experimental Set Up of Hardware

The figure 5.1 shows the experimental set up of the hardware unit. It consists of solar panel, peltier plate, rectifier IC, capacitor filter, charging circuit, rechargeable battery, DC

motor, inverter, MOSFET, step up transformer and AC load as AC motor.

Place the solar panel at any place where daylight is available. This solar panel contains photocells. In daytime this photocells convert the energy of light directly into electricity by the photovoltaic effect. In this hybrid system the solar array feeds of DC and peltier plate of DC to the rechargeable battery. Hence this system will work at day time as well as at night time. The battery is connected to an inverter board to convert generated DC into AC. This AC voltage will feed to switch ON AC appliances via step up transformer.

The hardware is connected as shown in figure 5.1. The required supplies are turned on then the battery stores the energy. From battery the DC motor and parameters are measuring through Digital Storage Oscilloscope DC voltage represented below.

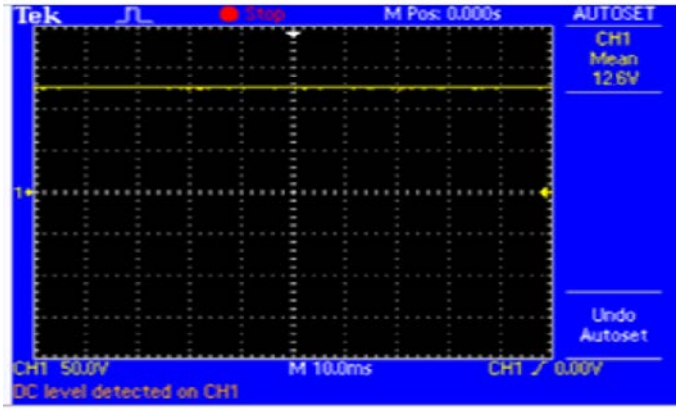

Fig 5.2 DC Voltage Waveform

The figure 5.2 shows the DC voltage waveform with 12.6V DC volts.

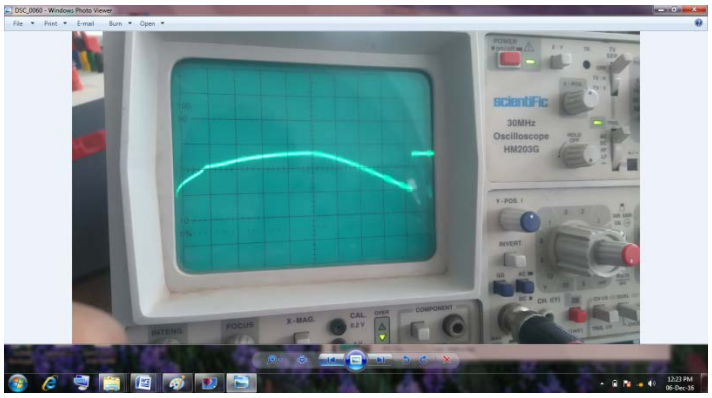

Fig 5.3 3PWM Pulses Waveform

The above figure 5.3 represents the PWM pulse signal waveform. These waveforms are PWM pulses generated by driver circuit and are given to the MOSFET switches for switching action. The PWM pulse is of magnitude peak to peak 24.1 mV, 4.88 KHz.

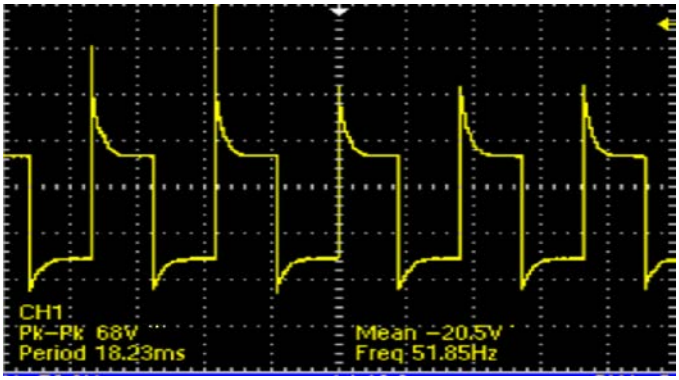

Fig 5.4 AC Voltage Waveform

The above figure 5.4 shows the voltage waveform of peak to peak magnitude of 68 volts with frequency 51.85 Hz.

6. Conclusion

A model to generate electric energy from solar energy and heat energy has been successfully implemented. A hardware is developed that the power is generated from two different sources (solar and heat energy) are combined and utilised to run the DC motor as well as AC motor. The outputs of hardware are found quite satisfactory. The generated electrical energy is in the form of DC voltage. The DC voltage obtained from solar and from the peltier module are combined and used to run DC motor. The DC voltage of 12volts converted into AC voltage to run AC motor. This type of model can be used where only solar energy is not sufficient to meet the requirements there a energy is boosted by using hybrid power generation with the help of peltier plate.

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