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To Analysis and Improvement of System Efficiency by Using Thermoelectric Device

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Abstract: Solar energy is one of the energy which can be use in various forms like solar heaters, solar cookers etc. For that purpose PV panel is required. Each module is related by its dc output power under standard test conditions (STC) and typically ranges from 100 to 320 watts. In this project, photovoltaic panel were used to integrate the extraction of light energy and thermal energy. The need of this project is to study of thermoelectric cooling effect to remove heat in the photovoltaic. The use of thermoelectric cooling system improves the power capacity of photovoltaic by 2%-20% and enhances the power efficiency of the photovoltaic by 2.29%-3.37%. Through the combine application of photovoltaic and thermal technologies, the total energy of the overall system can be improved by 37%-60%.

Keywords – Thermoelectric Energy Conversion, Efficiency, Solar Cells, Thermoelectric module, Temperature sensor, solar voltage.

1. INTRODUCTION

Recently, human being required different types of energy demand and which increases rapidly. Due to use of conventional energy (non renewable energy). The energy get crises for useful structure. Due to increasing of population the energy demand also increases and the graph of non renewable energy sources get decreases. The solar energy is the renewable energy source and it is easily available in nature. It is also the most important renewable source energy and it is free from pollution, it also helpful to decrease the green house effects. In this paper, solar system is one of the ways to generate electricity through directly of the sun rays, so due to sun energy we generate electricity and heat also. The output of PV system depends on solar irradiance, operating voltage due to high and low temperature. Electrical energy is one of the components of solar energy conversion process. A PV module has ideal conversion efficiency in the overall range of 15% [3]. The remaining energy is converted into heat and this heat increases operating temperature of PV system which affects electrical power production of PV modules [2]. The module temperature increases up to 60 degree c. This effects causes on PV module structure and gets its lifespan shorten and lower its conversion efficiency. So generate the excess heat from PV module (peltier module). In order to enhance the heat transfer from the PV module, there effectively reducing the operating temperature and improving the efficiency of the PV module with the help of TE (Thermoelectric) module.[7].Thermoelectric technology provides alternative to traditional methods of power generation, heating/cooling and generation from waste heat. Thermoelectric module can convert heat energy into electrical energy directly [2]. A thermo-electric element which uses the Peltier effect has advantages such as Eco-friendliness, simple structure, high reliability and noiselessness [4]. Thermoelectric modules can be formed by P and N type semiconductors which are connected in series electrically and parallel thermally among two ceramic layers. A TEG is made by heating one side and cooling the other side of the thermoelectric module and connecting a load to the module end points [5]. The thermoelectric effect is the direct conversion of temperature differences to electric voltage and vice-versa. Thermoelectric devices can convert electrical energy into a temperature gradient. This phenomenon was discovered by Peltier in 1834[6]. The application of this cooling or heating effect remained minimal until the development of semiconductor materials [6].

2. Related Work

Now days, thermoelectric power generation technology is one of the clean energy source. Because it is simple and low cost. This technology can be a viable alternative to many non renewable techniques to produce heat. The conversion of heat into electrical energy makes it possible that waste heat energy may be stored in electrical form. Although the efficiency of this kind of conversion is low. It has been attending because of renewability [1]. Early in 19th century, Thomas Seebeck discovered that, if a thermal gradient establish between two dissimilar conductors an electric current will flows. Also the Jean Peltier found that the electrical current through the two dissimilar conductor's causes heat in bonding material be absorbed [1]. In twentieth century, many studies carried out to find semiconductor materials and which are suitable for using two mentioned effects and getting the desired results. There are several obstacles in energy harvesting in thermoelectric method some of them are low rate, toxicity and limited access to chemical elements that are used in it. But some advantages are quiet, compact size, light weight, reliable, simple maintenance requirements and also ability to operate in small and large units. Using these generators in solar cells it is very suitable because of harvesting more electrical energy form solar irradiation of the sun [1].

2.1 An Overview of Solar Cell Model

In here we assume a silicon pn junction like solar cell and that is suitable for examine efficiency of PV cells in hybrid system. The PV module temperature needs to be determined by ambient temperature and solar radiation of the sun. For simplification we assume that the difference of PV module temperature (TM) and ambient temperature (TA) is proportional to radiation rate G :(Drews, et al; 2007) [1]

TM=TA+CG

The coefficient C depends on installation conditions, as shown in fig.(Sauer; 1994).
Table 1,3- Parameter c and module temperature TM at G = 1000 W/m2 and TA = 25 0C as a function of the integration type of PV system installation(Sauer; 1994)[1] .

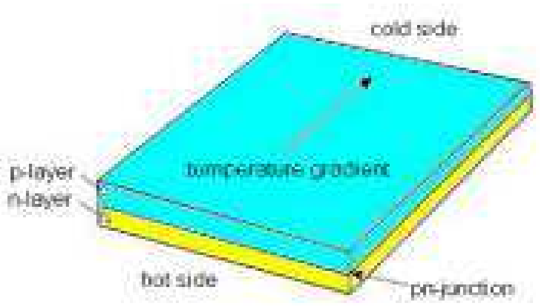

Fig.1: Large area pn junction with temperature gradient (Wagner, et al; 2005) [1].

In this paper, a new approach to thermoelectric power generation using large area of the pn junctions is presented. And which has higher efficiency and lower cost in compare to other methods of TE power generation. Initially, we investigate the effect of temperature on the efficiency of a conventional solar cell. Then we also calculate the amount of electric power generation in TE device resulting of waste energy (heat) in photovoltaic cell and finally calculate the efficiency of the hybrid system [1].

3. Proposed Methodology

- The hardware and software setup are used.
- Hardware setup consists of different components.
- Observe the voltage drop at high temperature and low temperature also.
- Observe efficiency of the system.

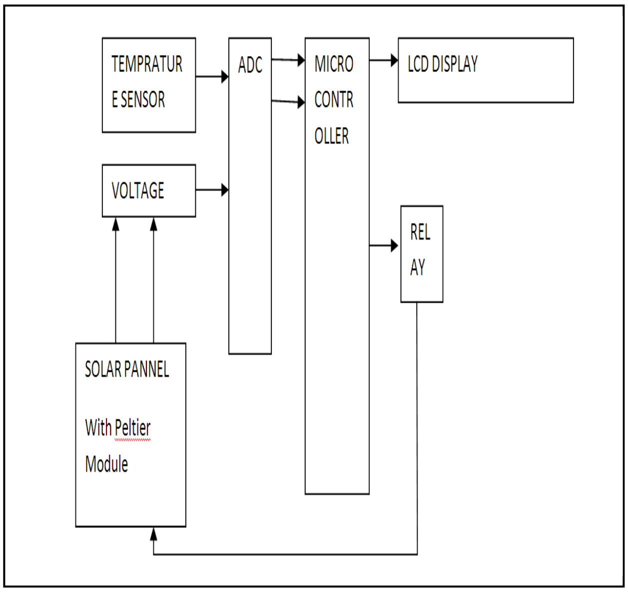

Fig. 2: Block Diagram

3.1 Principle of Solar Energy Generation

Solar panels convert light energy into electrical energy i.e. volt. Therefore we get dc volt from solar panel and solar charge controller control dc volt and current and given to battery for charging and solar charge control also give the output voltage to load.

3.2 Peltier History

Early 19th century scientists, Thomas Seebeck and Jean Peltier, first discovered the phenomena that are the basis for today's thermoelectric industry. Seebeck found that if you placed a temperature gradient across the junctions of two dissimilar conductors, Electrical current would flow Peltier , on the other hand, learned that passing current through two dissimilar electrical conductors, Caused heat to be either emitted or absorbed at the junction of the materials. It was only after mid-20th Century advancements in Semiconductor technology; however, those practical applications for thermoelectric devices became feasible. With modern techniques, we can now produce thermoelectric "modules" that deliver efficient solid state heat-pumping for both cooling and heating; many of these units can also be used to generate DC power at reduced efficiency. New and often elegant uses for thermoelectric continue to be developed each day.

3.3 Thermoelectric Module

Heat absorbed at the cold junction is pumped to the hot junction at a rate proportional to carrier current passing through the circuit and the number of couple. The semiconductor materials are N and P type because either they have more electrons than necessary to complete a perfect molecular lattice structure (N-type) or not enough electrons to complete a lattice structure (P-type). The extra electrons in the N-type material and the holes left in the P-type material are called "carriers" and they are the agents that move the heat energy from the cold to the hot junction of the area. The heat absorbed at the cold junction is pumped to the hot junction at a rate proportional to carrier current passing through the circuit and the Number of couple. Good thermoelectric semiconductor materials such as bismuth telluride greatly impede conventional heat conduction from hot to cold area, and it provides an easy flow for the carriers. These materials have carriers with a capacity for transferring more heat. In this project both hardware and software setups are used. The hardware setup consists of PV panel, peltier module, temperature sensor, ADC, microcontroller, relay and the LCD display. With the help of hardware setup observe the voltage drop at high temperature and low temperature and also observation of efficiency.

In the software setup, MATLAB software is used to understand the graphical nature of temperature by simulation. For that Embedded C programming is prefer to use.

4. Conclusion

In this paper, we conclude that as the use of thermoelectric (TE) cooling system improves the power capacity of the

Photovoltaic by 2%–20% and enhances the power generation efficiency of the photovoltaic by 2.29%–3.37%. Through the combined application of photovoltaic and thermal technologies, the total energy of the overall system can be improved by 37%–60%. Also the total efficiency depends on type of module integration and material type also assumption of the backside is sufficiently cooled such that it is at ambient temperature of the system.

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