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Investigation of Temperature Effect on Solar System Output- A Case Study

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ABSTRACT

The solar energy is a non-vanishing renewable source of energy which is free from environmental pollution, global warming and serious threats caused to human life. Everyday sun sends out tremendous amount of energy in the form of heat and radiations called solar energy. The key factor responsible for generation of electricity is the temperature of solar panels. So the effect of temperature on energy generation has been studied in this paper and results have been discussed.

Keywords

Solar energy, temperature.

1. INTRODUCTION

Energy is the primary and most universal measure of all kinds of work by human beings and nature. Everything what happens in the world is the expression of flow of energy in one of its forms.[1]

Mainly the energy is obtained from many sources; renewable energy sources and non-renewable energy sources. Renewable energy sources are those which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat. Non-Renewable energy sources are those which cannot be readily replaced by natural means on a level equal to its consumption. Most fossil fuels, such as oil, natural gas and coal are considered non-renewable resources.

The shortage of energy resources and environmental issues associated with non-renewable energy sources such as global warming andincreasing air pollution has attracted much attention in renewable energy.[2]So there is great need to use renewable energy sources to save our earth. In this article the focus is on sun and its solar energy which is a fine source of renewable energy.

Solar energy is a limitless source of energy which is available at no cost.The major benefit of solar energy over other conventional power generators is that the sunlight can be directly harvested into solar energy with the use of small and tiny photovoltaic (PV) solar cells.[3]

2. LITERATURE REVIEW

Field-test data from a 50 kW photovoltaic (PV) system installed at The Nara Institute of Science and Technology (NAIST) were analyzed in detail. We found that the PV system operated in a wide temperature range and was strongly affected by the temperature coefficient of conversion efficiency when the module temperature became high. The temperature coefficient dependence of the system performance was analyzed and it was found that the annual output energy of the PVsystem increased about 1% by an improvement of 0:1%=1C in the temperature coefficient. [4]

Photovoltaic solar cell generates electricity by receiving solar irradiance. The electrical efficiency of photovoltaic (PV) cell is adversely affected by the significant increase of cell operating temperature during

absorption of solar radiation. Experiments were performed to check temperature effect with and without water cooling. A linear trend between the efficiency and temperature wasfound. Without cooling, the temperature of the panel was high and solar cells achieved an efficiency of 8–9%. However, when the panel was operated under water cooling condition, the temperature dropped maximally by 40C leading to an increase in efficiency of solar cells by 12%.[5]

Another author investigated the use of phase-change materials (PCM) to maintain the temperature of the panels close tothe ambient. The main focus of the study is the CFD modeling of heat and mass transfers in a system composedof an impure phase change material situated in the back of a solar panel (SP). A variation of the enthalpy methodallows simulating the material thermo-physical change of properties. Results show that adding a PCM on the back of a solar panel canmaintain the panel's operating temperature under 40°C for around two hours under a constant solar radiation of1000W/m².[6]

The simulation of module temperature from Nominal Operation Cell Temperature (NOCT) is widely used to easily estimate module performance along the year. In this context, it is important to determine this parameter in a reliable way, as it is used to compare the performance of different module designs and can influence system predictions. This work presents the results obtained when applying these standards to different types of PV modules. NOCT values so calculated have been used to estimate the yearly module temperature and performance for different orientations and tilted angles, analysing temperature influence in these estimations.[7]

Generally, the performance ratio decreases with latitude because of temperature.However, regions with high altitude have higher performance ratios due to lowtemperature. The southern Andes, the Himalaya region, and Antarctica have the largestPV potentials. Although PV modules with less sensitivity to temperature are preferablefor the high temperature regions, PV modules that are more responsive to temperaturemay be more effective in the low temperature regions. The correlation between theestimates obtained by current framework and results from a more data-intensive methodincreases when the temperature effects are considered.[8]

The term "temperature coefficient" has been applied toseveral different photovoltaic performance parameters,including voltage, current, and power. The procedures for measuring the coefficient for modules and arrays arenot yet standardized, and systematic influences arecommon in the test methods used to measure them. There are also misconceptions regarding their application. Yet,temperature coefficients, however obtained, play animportant role in PV system design and sizing, where often the worst case operating condition dictates the array size.This study describes effective methods for determiningtemperature coefficients for cells, modules, and arrays; identifies sources of systematic errors in measurements;gives typical measured values for modules; and providesguidance for their application in system engineering.[9]

3. PROBLEM FORMULATION

Photovoltaic (PV) electric energy generation is a best technology for obtaining non-conventional energy from solar irradiation. However, the output of PV is influenced by its operatingconditions, so dealing with these conditions is a complexproblem.

Solar panels results out be most efficient one, when the ambient temperature remains upto a normal range, with the increase of temperature the output of PV cells decreases rapidly, which causes to lose of efficiency. This temperature parameter influences widely the output of PV panels. 1-3° Celsius increase of temperature cause drastic change in solar power output for large solar plants.

In summer reason, there is large amount of sunlight available in Punjab. But this large amount of sunlight causes increase of ambient temperature, which decreases the output of solar plant.So it was planned to study the effect of temperature on solar panel efficiency and record the data of two plants to analyse the problem.

4. METHODOLOGY

The proposed study investigated the factors affecting the efficiency of solar photo-voltaic system is carried out. There are many factors affecting the efficiency of photo-voltaic system, but here we will study only the

effect of temperature on solar photo-voltaic system output. For analyzing the temperature effect, data were noted down fromsolar plant setup by Azure power limited at Banwala (Sri Muktsar Sahib).

5. RESULTS AND DISCUSSION

The operating temperature plays a key role in the photovoltaic conversion process. So in this section we will discuss about the output energy calculated from Solar plant at Banwala (Sri Muktsar Sahib) with change in temperature with the passage of time, and further the results so obtained will be discussed.

Fig. 1(a) shows the results of energy generated on single day in the month of April along with the corresponding temperature of that moment. From Fig. 1(a), it is clear that the energy generation increases with increase in temperature upto a certain limit and then it decreases with further increase in temperature. In this temperature range, the efficiency of solar panel system decreases. Fig. 1(b) also shows the similar trend for the data recorded a month later in May. So it is clear that the efficiency of the solar panel system depends directly on the temperature.

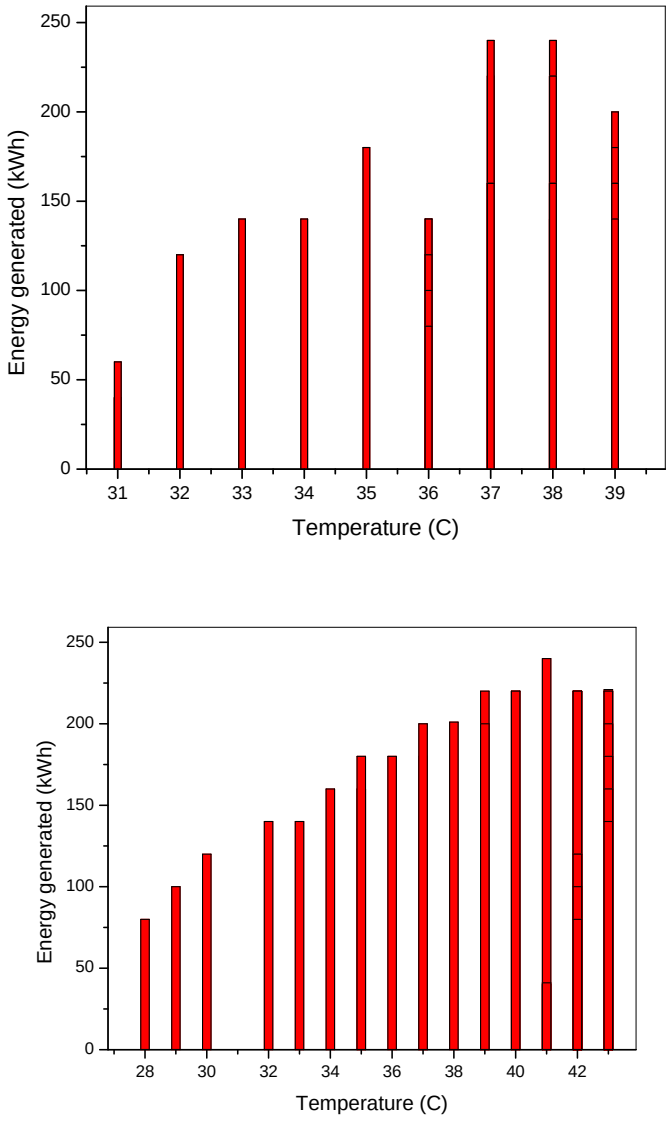

Figure1.Energy generated with temperature

Solar cell performance decreases with increasing temperature, fundamentally owing to increased internal carrier recombination rates, caused by increased carrier concentrations.

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