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The reliability of the photovoltaic utilization in southern cities of Libya

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Abstract

Solar energy can be converted to electrical energy by means of two methods: the first one is a direct method with photovoltaic (PV) systems and the second is an indirect one by solar thermal power generation. The main disadvantage of the PV systems is the high sensitivity of the output electrical characteristics to their temperature surface. The increase of the surface temperature leads to reduce the power output according to its power temperature coefficient. For this purpose we have to locate the zones where the PV systems can work efficiently as high as the standard test condition (STC) efficiency. The aim of this research is to determine the surface cell temperature of a working PV system under real operational and environmental conditions (Load, Solar radiation and ambient), further to evaluate the electrical behavior of PV systems and to estimate the failure of their function. The experiment has been carried out in order to measure the following parameters: output power, surface temperature, solar radiation, ambient temperature and wind speed. An experimental model has been designed and built up in the Solar Energy Laboratory at the Department of Mechanical Engineering, in Brack. Brack City is located at 27.6°N and 14.2°E, 600 km away to the south from Tripoli (Capital). According to the results of the experiment, the maximum cell's surface temperature reached 125.4°C in 6/5/2003 at 2:30 PM. The solar radiation was around 896 W/m^2. The percent of the failure of the power was found to be 69% of the nominal power at STC. This is why we have to be careful concerning the use of PV cells for Multi-Mega-Watts power generation, especially, which classified as hot regions, in most of the Arabic countries, especially in those which are classified as hot regions, such as North Africa and South Asia.

Keywords: Photovoltaic; Libya

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1. Introduction

The sun presents the main and safe source of energy on the earth. As we know, the energy produced by fossil fuels causes environmental pollution and contamination, furthermore the risk of their depletion in the near future. Electrical energy, due to its characteristics, is the most favorable, and it is easy to convey and convert it to other forms of energy. The electrical power can be extracted from solar energy directly with PV cells and indirectly by means of solar thermal generation. Solar thermal and PV electricity generation are two promising technologies for climate compatible power. They have such an enormous potential, that theoretically they could cover much more than just the present worldwide demand for electricity consumption. Both technologies provide an important contribution to climate protection. PV systems have advantages for low-power demand, stand-alone systems and building integrated grid connected systems.

The relative high cost of the PV technology is the main obstacle for their global utilization and it is only restricted to the rural and faraway electrical network regions. Because of the well developed PV production technology, the costs are reduced, which help to adopt this technology in lots of applications.

The aim of this research is to study the electrical and thermal characteristics of PV cells under real conditions of load and weather. To achieve this purpose, an experimental model was designed and connected to the measuring instruments to monitor both the electrical and the thermal characteristics of the model, such as voltage, current, and cell temperature, and also, the climatic parameters, such as, solar radiation, ambient temperature, and wind speed. This experiment has been carried out by the Solar Energy Laboratory of Sebha University in Libya.

2. Parameters affecting the performance of PV cells

The response of the PV cells is affected by many factors, such as the intensity of incident solar radiation, the surface cells temperature, the load size connected to the system and the manufacturing characteristics of the PV cells.

From the experiment's observations it was found that a small increase in the voltage and an augment in the current occurred with increasing of solar intensity, and this causes the increase of the power of the PV system. Contrarily, the increasing of temperature surface cell, which is

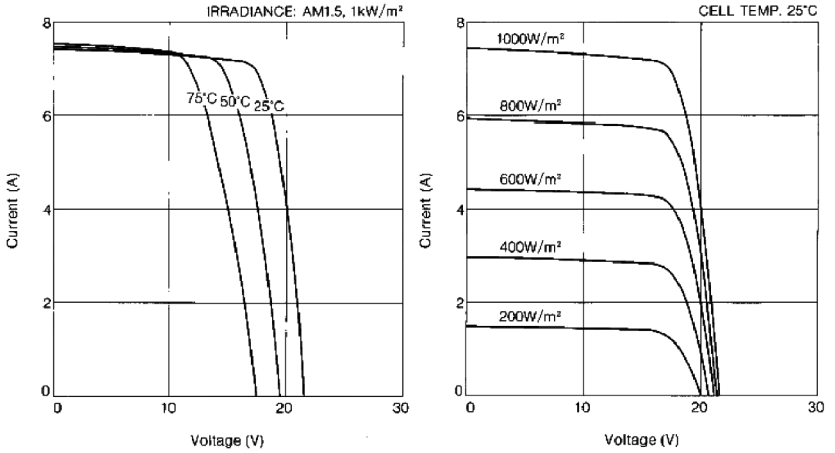

Fig. 1. Voltage - Current characteristics of PV module KC120-1 at various solar radiation levels [1].