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Enhanced Energy Extraction from a Solar Panel

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Abstract

Due the movement of the sun throughout the day, the insolation level incident on the fixed panel surface varies largely. The maximum level of insolation occurs only around noon. This leads to the panel to be under-utilised. To maximise the utilisation of the panel during the day, mechanical solar tracking is used. This method not only increases the utilisation of the, but increases the power being extracted from the panel. Solar tracking using one axis tracking increases the energy yield from the solar panel by 40 percent.

Extended Abstract

During the span of a day the sun's movement has been shown in figure 1. As the day passes by, the level of incident solar radiation (insolation) changes. This change takes place due to position of the sun. The angle at which the sun's rays fall on the photovoltaic panel affects the insolation level available for the panel to convert into electrical energy. For the fixed panel, the sun's rays are not normal to plane of the panel most of the time. This causes the panel to be under-utilised. To extract more energy from the same panel, solar tracking is required. This follows the sun's movement thereby increasing the insolation level throughout the day. This increase in the insolation level is due to the fact that the angle between the normal to the solar panel and incident light is to be kept minimum.

Figure 1: *Sun's movement throughout the day*

The principle of a single axis solar tracking has been shown in figure 2. The solar tracking can be accomplished by four methods: active tracking, passive tracking, chronological tracking and manual tracking [1]. Active trackers measure the light intensity from the sun using light sensors which give signal to the controller and driving mechanism. Passive

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trackers commonly make use of a low boiling point compressed gas. This gas is filled in two canisters each placed in east and west directions. The heating of the fluids cause the panel to tilt over to the side with more sunshine. These will have viscous dampers to prevent excessive motion in response to wind gusts [2]. A chronological tracker uses a rotation mechanism to counteract the effect of Earth's rotation. A simple rotation mechanism, turning at a constant speed of one revolution per day or 15 degrees per hour, is adequate for many purposes, such as keeping a photovoltaic panel pointing within a few degrees of the Sun. This can easily be achieved by the use of a stepper motor control.

Figure 2: *Principle of single axis solar tracking*

The data for the insolation level and temperature for the whole year have been obtained from the NASA website for Aligarh and Doha [3]. The simulations have been run assuming that there is no condition of partial shading. For the purpose of simulation of energy output during the day, five solar panels of 250 Wp were taken in parallel to give a total of 1.25 kWp of power under STC. The energy outputs for the months throughout the year were obtained for two conditions: first for the fixed panel condition, and second for the panel with continuous one-axis solar tracking. The results have been compared and shown for Aligarh and Doha in figures 3 and 4 respectively. In figure 5, the percentage increase in the energy output for each month has been shown for both the cities.

Figure 3: *Daily energy yield from a 1.25 kWp solar array on a monthly basis in Aligarh*

Figure 4: *Daily energy yield from a 1.25 kWp solar array on a monthly basis in Doha*

Figure 5: *Increase in daily energy yield on a monthly basis*

References

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