International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 04 Issue: 10 | Oct -2017 www.irjet.net p-ISSN: 2395-0072

PERFORMANCE ENHANCEMENT OF PV COOLING SYSTEM BY USING TRACKING MECHANISM

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Abstract: There are various techniques for increasing the solar fraction. The main ingredients of solar photovoltaic cooling system are photovoltaic panels cooling system and building. So the solar fraction can be increased by increasing the power generation from the photovoltaic these techniques are single axis tracking and double axis tracking mechanism. Here analysis is presented with fixed panel and with panel tracking arrangement. Analysis is carried out for a building having area of 225 m^2. The analysis is carried out for four cities situated in different climatic zones in India It has been observed that t the annual power generation increases about 10-20% using single axis tracking and further 5-15% using double axis tracking mechanism. Due to high cost of tracking mechanism payback time also increase.

Keywords: Solar Fraction, PV System, Payback.

1. Introduction

The achieved solar fraction of solar photovoltaic cooling systems is significantly lower than the solar thermal cooling systems. In the Solar thermal cooling system there is a storage device (hot storage tank) between the solar thermal collector and cooling machine resulting in continuous operation of vapour absorption machine without using the grid power for small fluctuation in solar radiations. Solar photovoltaic cooling system with battery storage is not analysed because initial analysis shows that the capital cost of storage system is very high and it is also linked with annual maintenance cost. System also requires reoccurring cost at every 4-5 year for replacement of batteries. In the solar photovoltaic cooling system the annual solar fraction is calculated without considering the storage device. The vapour compression machine (Packaged air conditioner) requires a fix amount of power to drive the compressor, if instantaneously it is available on PV it is supplied to the cooling system otherwise it is taken from the grid and not accounted for the annual solar fraction [13].

There are various techniques for increasing the solar fraction. The main ingredients of solar photovoltaic cooling system are photovoltaic panels cooling system and building. So the solar fraction can be increased by increasing the power generation from the photovoltaic these techniques are single axis tracking and double axis tracking mechanism. In the cooling system side solar fraction can be increase by using Variable Refrigerant Flow (VRF) in place of Packaged Terminal Air Conditioners (PTAC) and in the building, cooling load may be reduced by using thermal masses. In this paper analysis is carried out using mono crystalline cells for being most efficient and modeling and simulation results are presented and discussed.

2. Tracking System Modeling

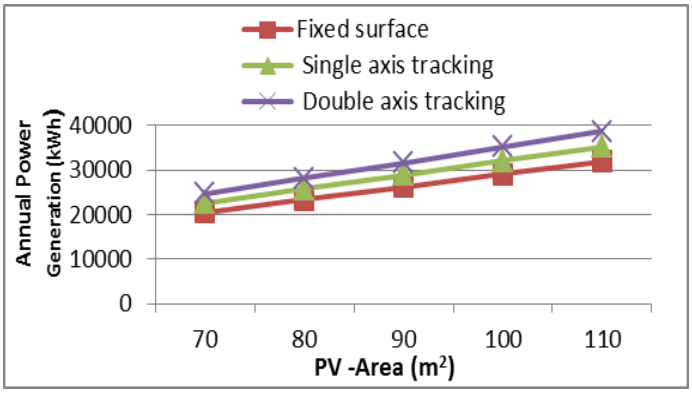
Tracking systems that adjust the position of PV modules in the direction of the sun can boost yields from solar installations by 40% or more. Two basic configurations for tracker systems are available. Single-axis trackers rotate about one axis, azimuthally orienting the panels to track the sun's movements over the course of a day. Dual axis trackers provide both azimuth rotation for daily tracking and tilt rotation for seasonal tracking the movement of the sun. Nordic (India) offers standard single and dual axis tracking products for commercial applications (kW scale). These trackers are mounted on a galvanized steel pole structure and use PLC driven linear actuators/worm gears to orient the PV panels and track the sun. The trackers are built in such manner to protect the panels if the wind speed is too high. The trackers can accommodate solar PV modules upto 25 sq. m [26].

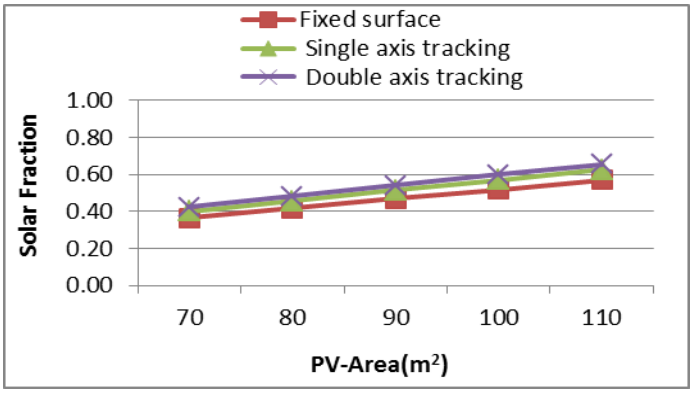
3. Performance analysis of PV cooling system with tracking

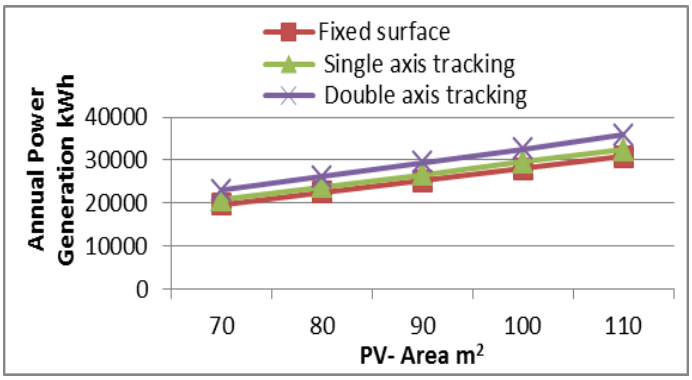
In the TRNSYS model of solar photovoltaic cooling system, the tracking system is enabled in the weather file Type 15.3 parameter 7 that allows the model to track the sun. Fig 5.1 shows the annual power generation for the four climates with three options fixed, single axis tracking and double axis tracking systems. It has been observed from the graph that the annual power generation increases about 10-20% using single axis tracking and further 5-15% using double axis tracking mechanism.

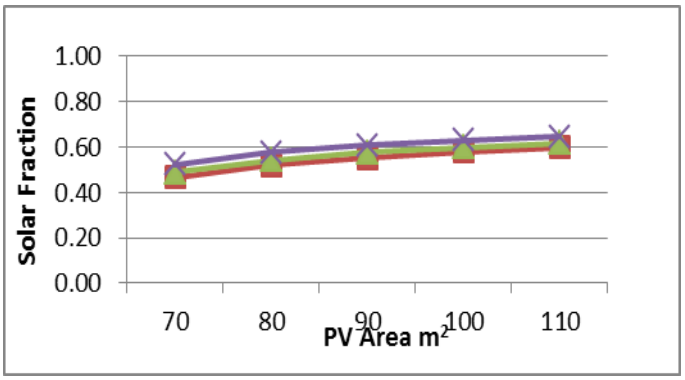
Solar fraction

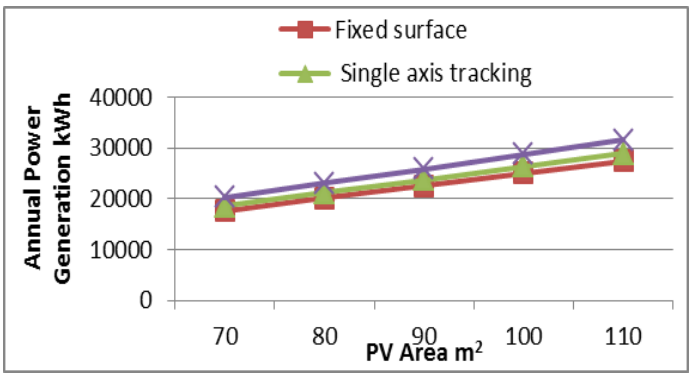
Fig 2 shows the solar fraction for the four different climates with the three options fixed, single and double axis tracking. It is clear from the fig 2 that the solar fraction increases because the power generation increases while the energy consumption is same in all the three case i.e fixed, single and double axis tracking. So there is more matching between generation of PV and consumption of air conditioner.

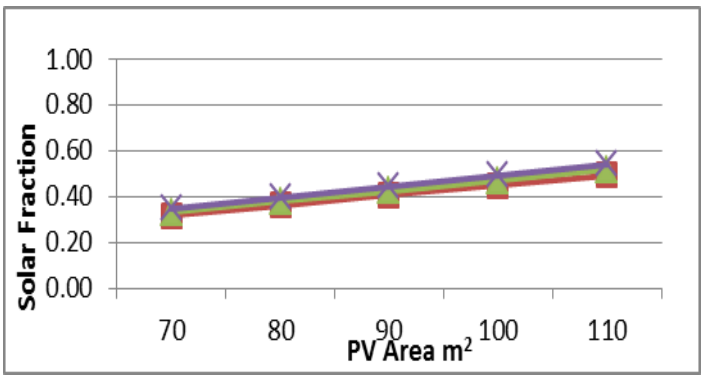


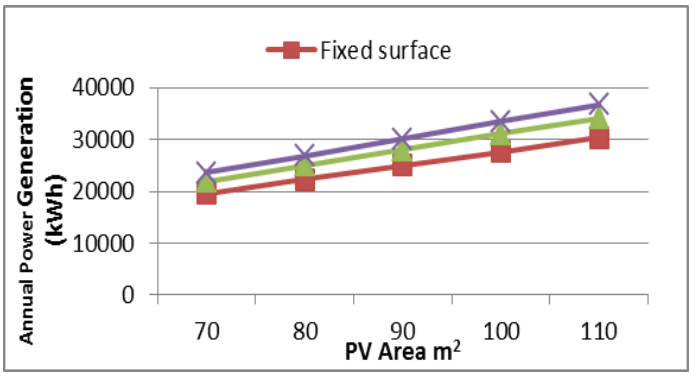












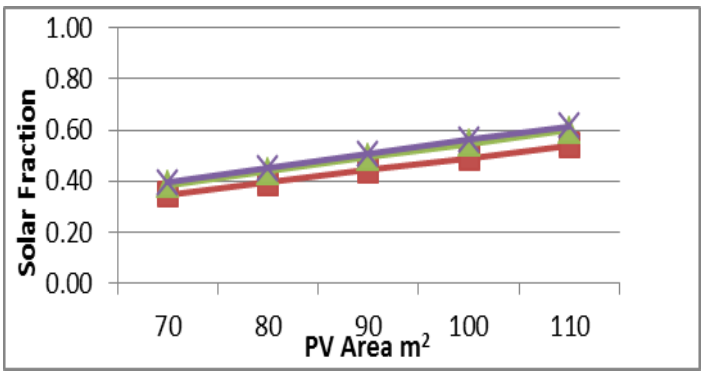


Fig.1Annual power generation with PV area (a) Hot and dry (Ahemdabad) (b) Moderate (Bangalore) (c) Warm and humid (Chennai) (d) Composite (Delhi)

Fig.2 Annual Solar Fraction with PV area (a) Hot and dry (Ahemdabad) (b) Moderate (Bangalore) (c) Warm and humid (Chennai) (d) Composite (Delhi)

Payback Time

Fig.3 shows the comparison of payback time for the fixed, single axis and double axis tracking mechanism with respect to the different climates. It has been observed from the fig 3that the payback time is very high in the tracking systems because the cost of tracking is very high Rs. 8370/m^2 of PV area [139]. The annual power generation increases about 15-35% while the cost of tracking system increases very high (Rs.8370/m^2). The highest payback time is for the moderate climate because of the low cooling demand.

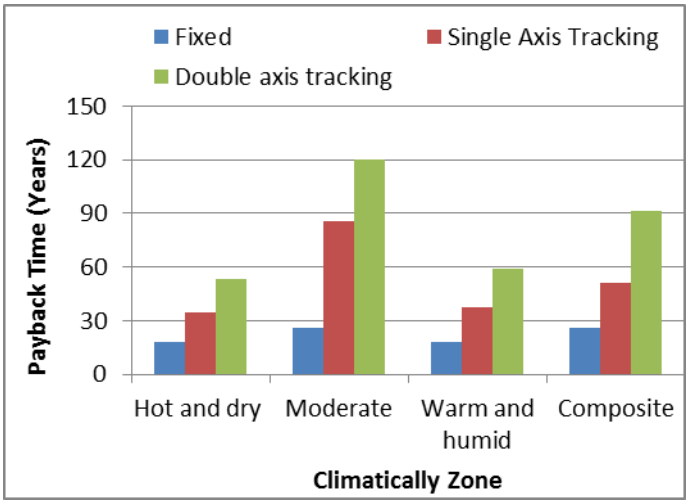


Fig .3 Comparison of Payback time (PV area90 m^2)

4. Conclusion:

It has been observed that the annual power generation increases about 10-20% using single axis tracking and further 5-15% using double axis tracking mechanism. As the annual power generation is increase the solar fraction also gets increase. But due to high cost of tracking mechanism payback time also increase.

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