A Comparative Analysis Based on Energy Efficiency of Dual Axis Solar Tracker System and Fixed Mount Solar System

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Abstract: Solar energy is rapidly gaining more importance as an expanding source of renewable energy resources. As such, it is vital to understand the technologies associated with it. Now a days researchers are more interested to increase the overall efficiency of solar system by various means. This research work proposes dual axis solar tracking system to increase the overall efficiency of solar plate. The work is focused on design and implementation of dual axis solar tracker system to track the sun whole day. Dual axis solar tracker system allows more energy to be produced by solar plate because the solar array is able to remain aligned to sun. In this research work, a scaled down dual axis solar tracker is designed and its performance is compared with single axis solar tracker system. The comparative analysis of dual axis and fixed mount solar system on the basis of overall energy efficiency is discussed in detail. From results it is very clear that dual axis solar tracker system gives an overall energy efficiency of 48.98 % which is preferably more than fixed mount solar system.

Keywords: *Dual Axis Solar Tracker, Energy Efficiency, Fixed Mount Solar System, Renewable Energy Resource, Arduino*

1. Introduction

Day by day the demand of electrical energy is increasing, yet today there are so many resources found to generate electrical energy but all those resource are no more renewable [1]. Other than these resource electrical energy can also be generated from renewable sources to continuously generate energy without destroying source of energy generation any more. These renewable energy sources are limited to generate limited energy hence they are not efficient as compared to non-renewable sources [2]. To make them more efficient many observations are being taken in account. This research work is focused to enhance the overall efficiency of a solar plate. For this purpose, the solar plate is mounted on dual axis solar tracker in order to get more sunlight directed to it so it can generate more energy. Dual axis solar tracker tracks the sun which will help solar panel to get more amount of sunlight [3].

To track the sun's movement accurately dual axis tracking system is necessary. The active/continuous tracking system tracks the sun for light intensity variation with precision. Hence, the power gain from this system is very high. To achieve this power gain the system uses two different motors continuously for two different axes. As a result it always consumes a certain amount of extra power compared to time-based tracking system[4,5,6]. Therefore to reduce this power loss a combination of active and time-based tracking could be the suitable alternative to this system. Finally the motivation of this research work is to design and implement a hybrid dual axis solar tracking system which reduces the motor power consumption while tracking accurately [7,8].

2. Research Model and Methodology

This research work is focused on implementation of a solar tracker model which is power efficient as well as cost efficient. Hence solar tracker has been designed to cover the total motion of sun in order to get more energy from it with help of sensors, motors and a flexible stand.

Solar tracking is an advanced technology to track the motion of sun and receive maximum amount of energy. For a high accuracy of solar tracker a closed loop solar tracking system has been used. The solar movement models are used to track the azimuth and elevation angles of sun. For this purpose a proper geographical location has been selected with a given date and time. The control functions are performed using arduino. In the closed loop system various sensors i.e. light dependent resistors (LDRs) are used to sense the position of sun. This in turn produces a feedback single to control unit of PV cell which rotates the solar plate to ensure maximum solar radiation at PV cell. Two servo motors are used to rotate the solar plate. Two motors are mounted directly with the solar panel and one motor is connected with the base to control the horizontal direction.

In this research work, the closed loop control structure has been adopted using five LDRs that give the feedback to the arduino to properly track the sun. LDRs sense the light and compare the intensity of light if the light intensity between them is different than maximum current would flow through the greater light intensity and gives input to arduino that would cause the tracker to turn to that position. The block diagram of project is shown in Figure 1.

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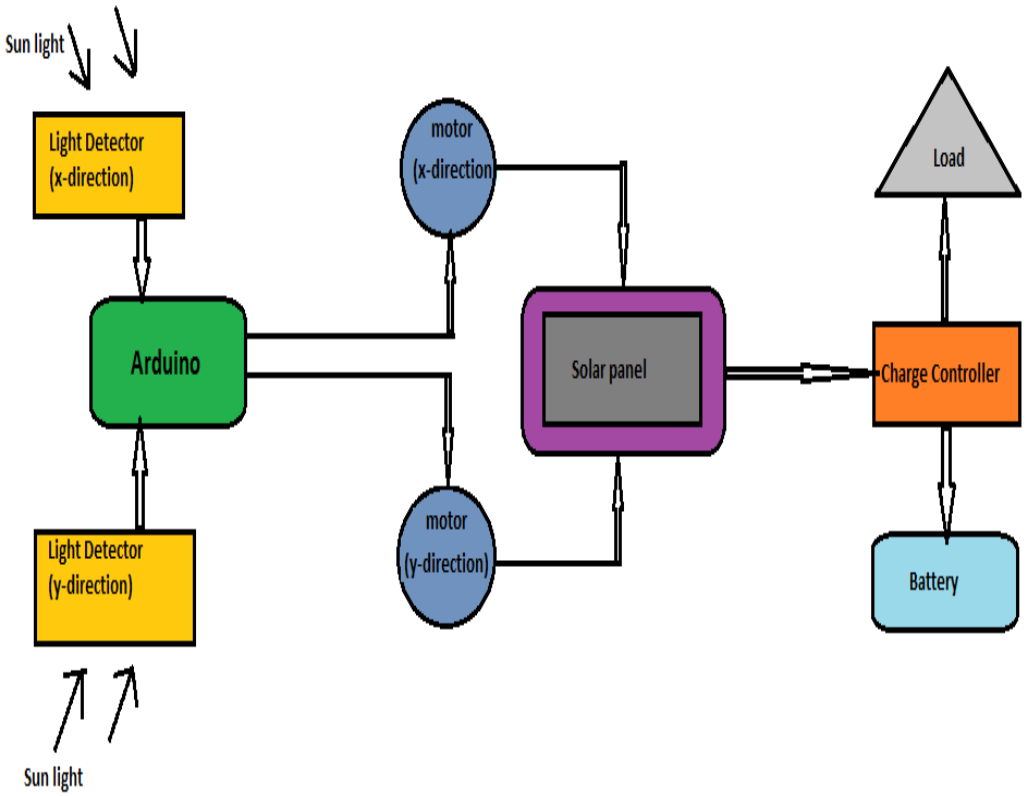

Figure 1: Block Diagram of Project

3. Simulation Results

Moreover for the virtual realization of the solar tracker system, it is best realized by software known as PVSyst 6.4.2 where all the aspects are watched properly to enhance its efficiency.

Figure 2 shows the geographical units of Sukkur city. Basically this software is connected to map of the world so where ever one is going to set his system all the units will be provided by software itself.

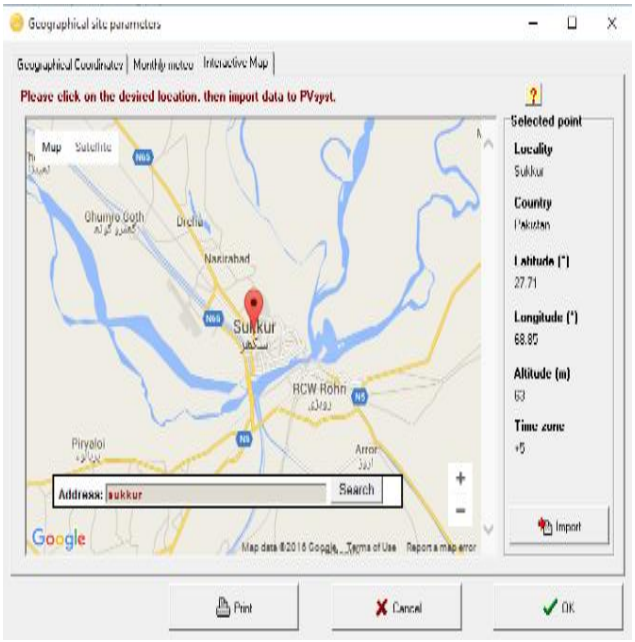

Figure 2: Geographical Site Parameters

Figure 3 shows the settings. After selecting two axes we need to set the tilt and azimuth angle which depend upon the site. Backtracking means to track again to its original position relative to sun. Sometimes due to external forces tracker lost it position so it can easily trace itself to be set on real and actual position.

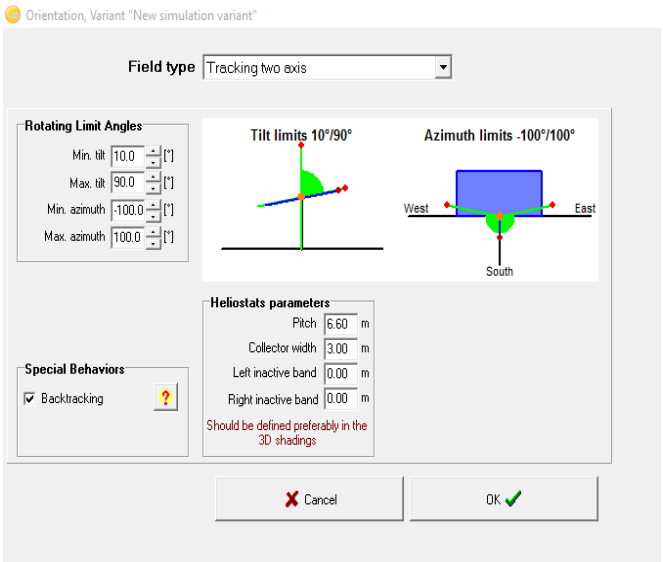

Figure 3: Orientation Process

After setting up all defined values the simulation is to be done in order to find the virtual results of the project. The simulation parameters are shown in Figure. 4.

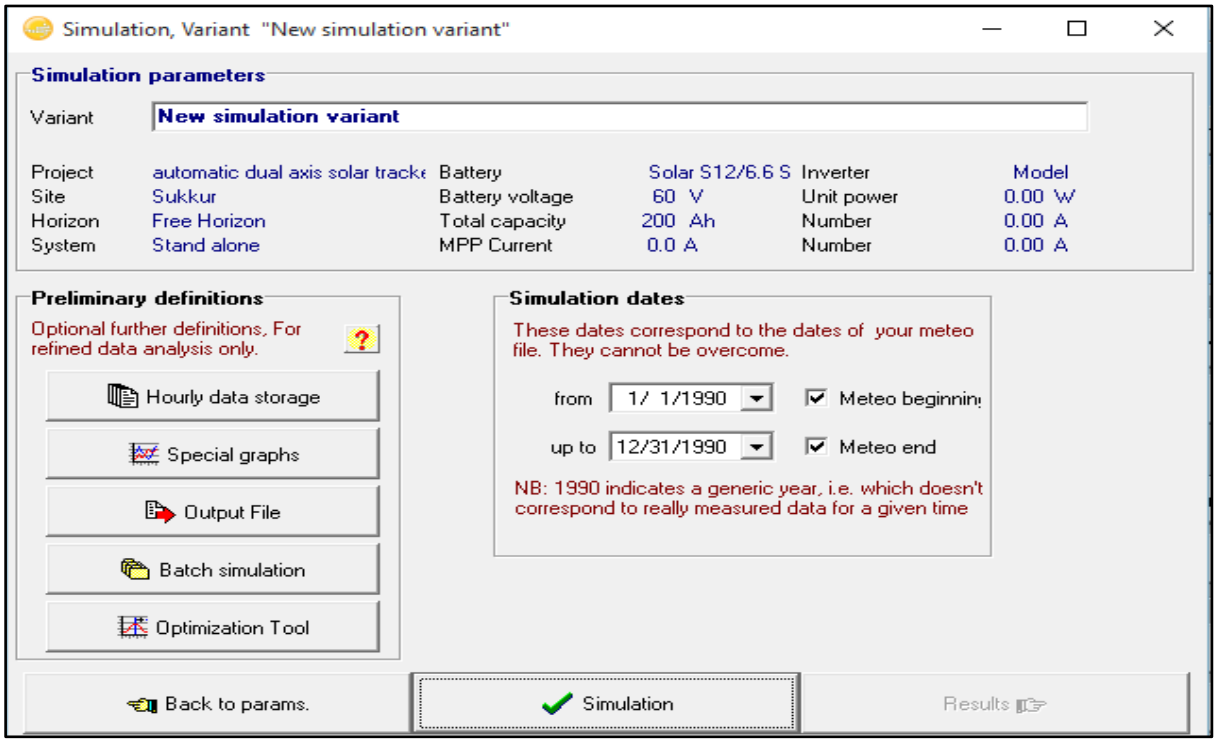

Figure. 4. Simulation Parameters

Figure 5 shows the performance ratio of different types of loads following the annual needs in all months. It also depicts sunlight intensity and its variance in different months.

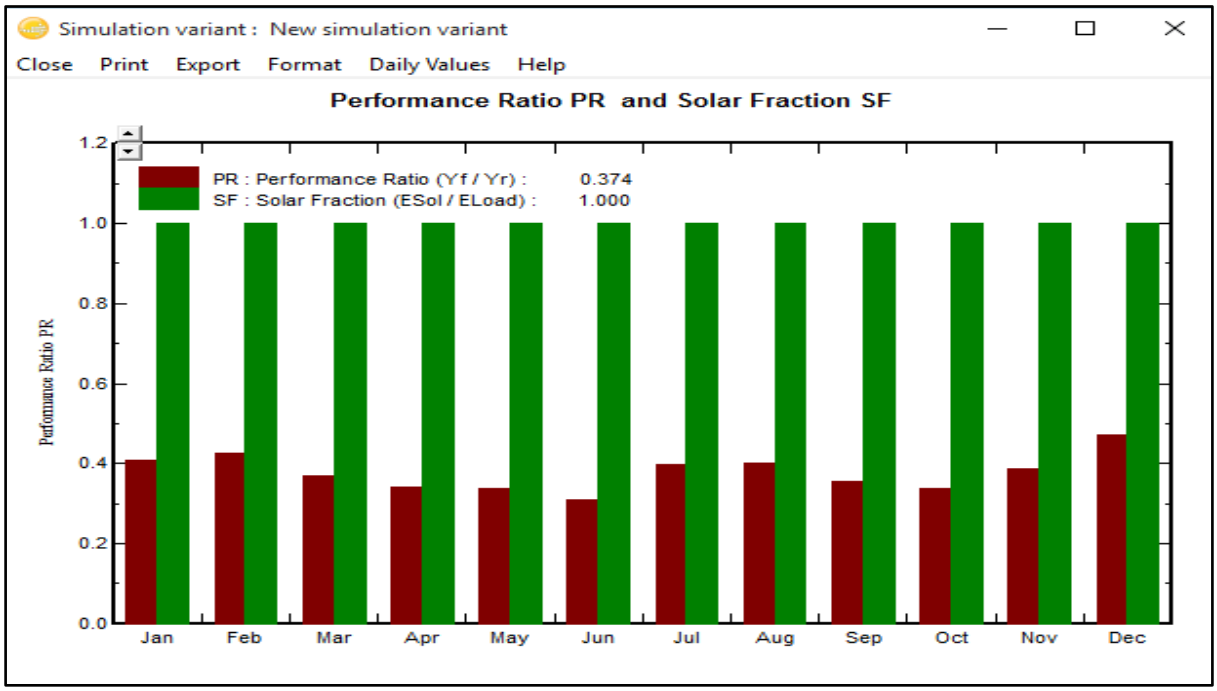

Figure 5: Performance Ratios

Table 1 shows the simulation of energy use. Due to seasonal effect different months give different output. Their energy use and energy generation values differ from each other due to seasonal change. The table clear depicts the difference in outputs.

Table 1: Amount Energy Usage in Different Months

Month	Array (kWh)	Energy (Load) kWh	Energy (User) kWh	Solar Fraction
January	89.98	79.15	79.15	1.000
February	77.41	71.49	71.49	1.000
March	79.03	72.64	72.64	1.000
April	76.00	70.30	70.30	1.000
May	78.53	72.64	72.64	1.000
June	66.05	60.25	60.25	1.000
July	68.45	62.26	62.26	1.000
August	67.33	62.26	62.26	1.000
September	76.85	70.64	70.64	1.000
November	76.38	70.30	70.30	1.000
December	85.43	79.15	79.15	1.000
Year	919.85	843.36	843.36	1.000

3.1 Energy Efficiency Analysis

A detailed comparative analysis of energy efficiency of fixed mount solar tracker system and dual axis solar tracker system is given in Table.2 which clearly states the applicability and suitability of dual axis solar tracker system.

Simulation results for both static panel and dual-axis tracker are taken for different hours and are depicted in table 2 which shows applicability and suitability of dual axis solar tracker system.

Table 2: Power of Fixed Versus Dual Axis Solar Tracker

Time	Output Power of Fixed Mount Solar System (W)	Output Power of Dual Axis Solar Tracker System (W)
7:00 A.M	14.57	38
8:00 A.M	23.98	49.72
9:00 A.M	43.87	52.70
10:00 A.M	47.94	54.95
11:00 A.M	52	52.97
12:00 Noon	57.66	59.61
13:00 P.M	57.96	58.04
14:00 P.M	56.41	56.56
15:00 P.M	54.68	55.31
16:00 P.M	48.17	54.85
17:00 P.M	36.96	52.36
18:00 P.M	27.72	52.66
19:00 P.M	12.69	33.22

Figure.6 shows the daily array output energy graph. The proper setting of panels on roof really matters a lot. If its arrangement becomes a bit change then yesterday will show difference in output.

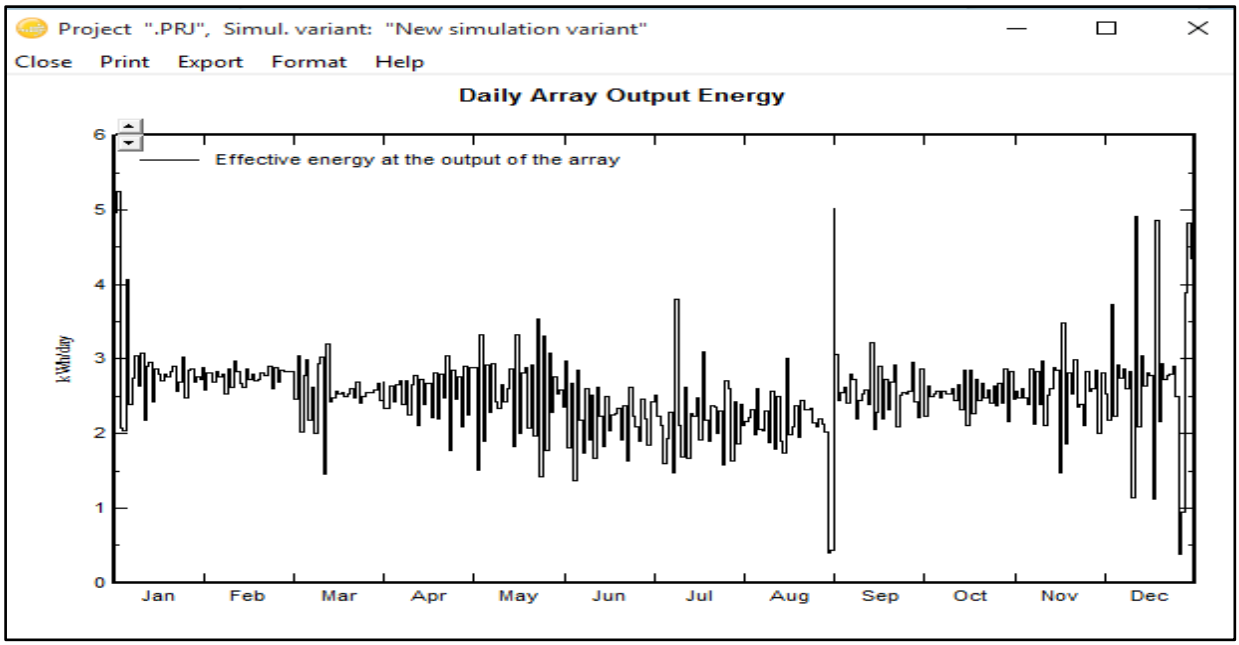

Figure 6: Daily Array Output Energy

4. Conclusion

Renewable energy is the ultimate solution of current energy crisis. Solar energy is one of best example of renewable energy. To achieve maximum amount of energy from sun, its necessary to track the sun whole day. In this research work a dual axis solar tracker has been designed and implemented. A comparative analysis based on energy efficiency of dual axis solar tracker system vs fixed mount solar system has been done. The simulation results clearly show that dual axis solar tracker system is more efficient as compared to fixed mount solar system. This proves its applicability and suitability as an energy efficient technique for solar system.

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