INVESTIGATION OF SUN TRACKING SOLAR PHOTOVOLTAIC POWER PLANT FOR THE ANALYSIS OF IMPROVED EFFICIENCY WITH RESPECT TO STATIC SOLAR POWER PLANT

Pratibha Kasar[1], Akanksha Malhotra[2], Vishnu Mawandia[3]
[1]M.Tech Research Scholar, [2,3]AssistantProfessor,
[1, 2]Department of Electrical Engineering, [3]Department of Electronics and Communication,
Rajasthan College of Engineering for Women, Jaipur, Rajasthan.

Abstract: In this paper the results shown for tracking system developed and designed for the performance analysis of SPV power plants with tracking concept. The comparative results presented in the result section. In the result analysis it can be seen that the efficiency of solar photo voltaic generation can be increased by 35% in azimuthal tracking system. The data were collected from 8 am to 4:30 pm. In the developed tracking structure we used 4-tpi gear system for smooth tracking of the sun position. The voltage and current values are measured at by millimeter. These data were recorded at different time. The graph drawn can be seen in result analysis. Figure 10 shows the graphical representation of current and voltage values with respect to time. Red color line shows the data recorded from tracking system while green line presents the graph of static system.

Index Terms **- SPV system, Simulink based model, tracking system, Photovoltaic system.**

I. INTRODUCTION

In the present energy demand, conventional energy sources are imparting major role in pollution. Pollution is the major issues in the world. To resolve this issues every country moving towards the renewable energy sources. The best alternative is renewable energy sources the present renewable energy sources are solar energy, biogas energy power plant, wind energy etc. Solar power generation is most popular and pollution free. The main constraints related to solar power generation system is cost and efficiency. Many research scholar's claims about improved efficiency of solar cell but available solar cell in the market having 18 percent. The second constraint is initial installation cost. These two parameters can be optimized by introducing the sun tracking concept in the solar generation power plant. In literature survey, Sun tracking systems are well explained by the various research papers. Some papers presented the results by using micron roller based tracking system by using previous year's sun positions. They are using servo motors for tracking the sun positions. The different constraints related to SPV power plants, i.e. solar tracking are explained in the paper [1]-[2]. Optimization techniques and solar cell Configuration, Geometry [3]-[4], the new materials and technologies are presented [5]-[6]. The sun tracking hardwires are proposed by different research papers. On the basis of the presented sun tracking literature, tracking systems are broadly classified into two categories; Active and passive tracking system. Now a day's active tracking concept is superior due easy in implementation and accuracy in proposed output results. The maintenance cost of active tracking system is lower as compare to passive tracking system. The sun tracking system is also categorized in to two type's basis on rotation 1) Single axis tracking system. 2) Dual Axis tracking system. Dual axis tracking system have two degree of freedom means two axis of rotation of sun azimuthal means east to west and elevated specify the rotation from north to south or it is also known as tilted movement. It has been presented by researchers that dual axis tracking system can produced 43% more energy. The efficiency of static power plant can be improved with the use of dual axis tracking system. This 43 percent improved energy is calculated with respect to static or fix solar power plant. While by implementing the single axis tracking system (azimuthal tracking system) in the existing fix power plant the calculated improved efficiency is 38%.

II. SUN TRACKER

The figure-1 depicts the position of the sun with respect to time. The movement of the sun with respect to earth is east to west on daily basis while its tiltation position or motion on elevated tracking system is on monthly basis. All the research is focusing towards the tracking system because SPV power plants convert light energy into electrical energy. In the electrical energy there are two parameters voltage and current. The production of the current from solar cells depends on the intensity of light.

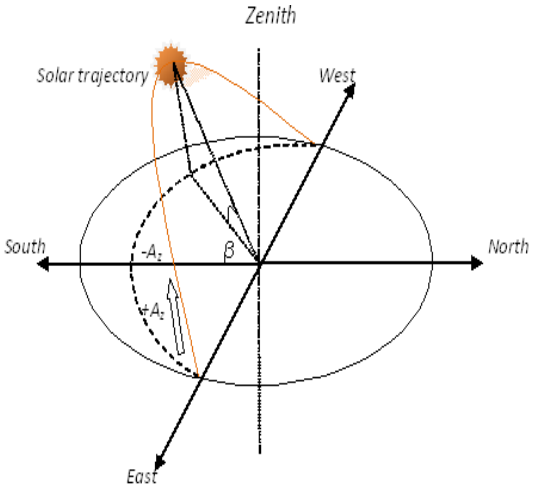

Figure 1: Solar Trajectory

As per position of sun with respect the earth the three solar events are described vernal equinox occurs on dated 21st march every year, Summer solstice occurs on 21st June and winter solstice on 21st December.

III. SOLAR TRACKING PV SYSTEM

The solar PV system connection is presented in the figure 2. Generally solar installation require following components SPV cells for converting the light energy into electrical energy, MPPT charge controller for extracting the maximum energy from SPV power plant to load, battery system for storing the electrical energy. In this figure first part is SPV generation system Panels are mounted on the sun tracking structure. The SPV system is connected to load for the experimental results. The results obtained are presented in result section. The second setup is static SPV generation system of same capacity.

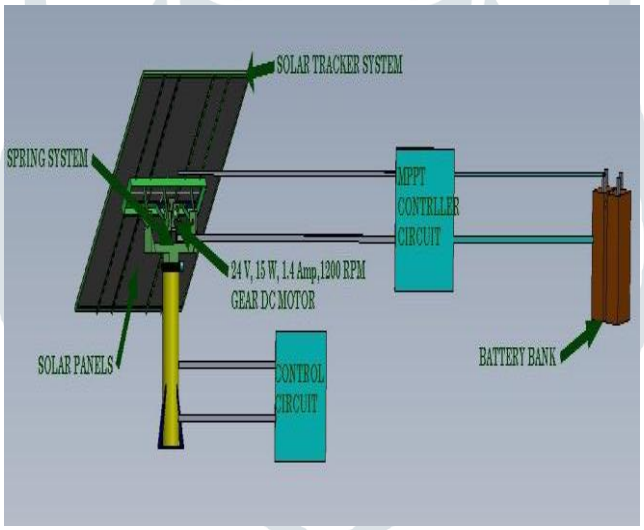

Figure 2: Block Diagram of Solar PV System

IV. SIMULINK MODEL

To study, effects of sun tracker implemented on SPV power generation system over static SPV power generation system. A Simulink model is developed for sun tracking SPV power plant and static SPV power plant as presented in figure-3 and 4. In this simulation processes discrete data are converted continuous data by implementing the curve fitting technique. This continuous data were used in the simulation results. The data recorded for temperature and light intensity were discrete in nature.

Static PV system:

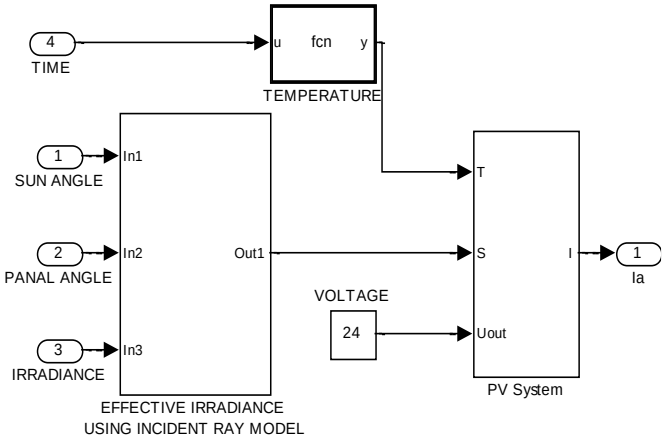

Figure 3: SIMULINK Model for Static PV System

Tracking PV system:

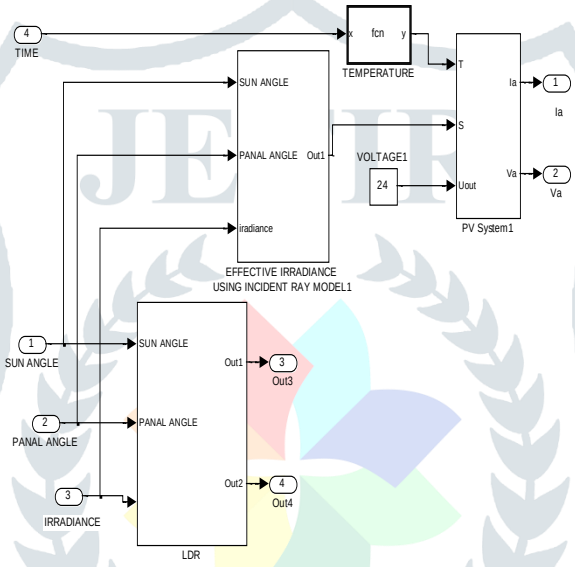

Figure 4: Tracking PV System Model

The temperature data were recorded with the use of temperature sensor on date 13-08-2019 is depicted in figure 5. The recorded data were discrete in nature but for simulation purpose this discrete data was first converted in to continuous form. The conversion of data from discrete to continuous form is done by curve fitting technique. The curve shown is continuous in nature with respect to time. Similarly irradiance curve with respect to time is shown in figure-6.

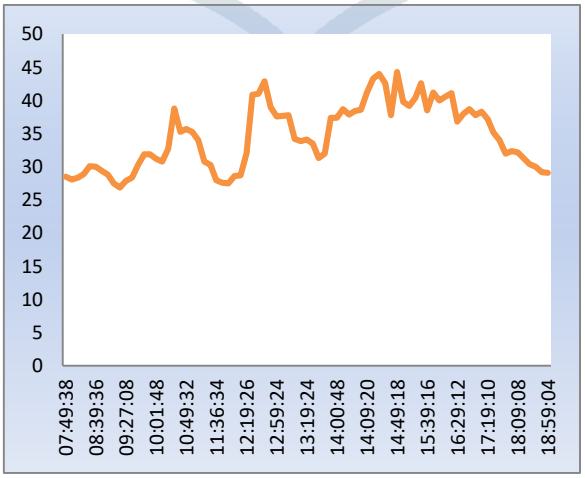

Figure 5: Temperature Recorded on date: 13-08-2019.

In the figure no 5, it can be seen that every instant of time the temperature value is varying. It is difficult to predict the temperature value in the next time instant. The variations in temperature data are collected on date 13-08-209; then cubic cure fitting was applied so that the collected discrete data can be converted into continuous form for simulation purpose.

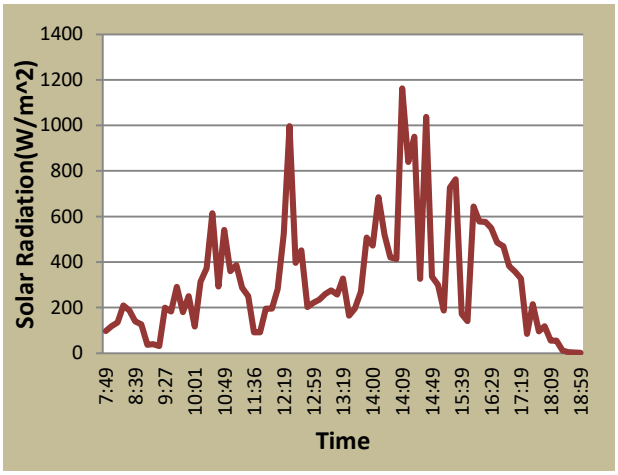

Figure 6: Solar Irradiance Recorded on 13-08-2019

Figure 6 shows the variation in irradiance value with respect to time. It can be seen that the irradiance value is also varying randomly. This data were measured on dated 13-08-2019. The irradiance data also converted into continuous form for the simulation purpose. The data collection was done from 7:49 AM to 6:59 PM.

V. SIMULATION RESULTS

To study the comparative study between the Static power plant and tracking SPV power plant. The simulation results are shown in figure 7. Both power plants are implemented on SIMILINK platform.

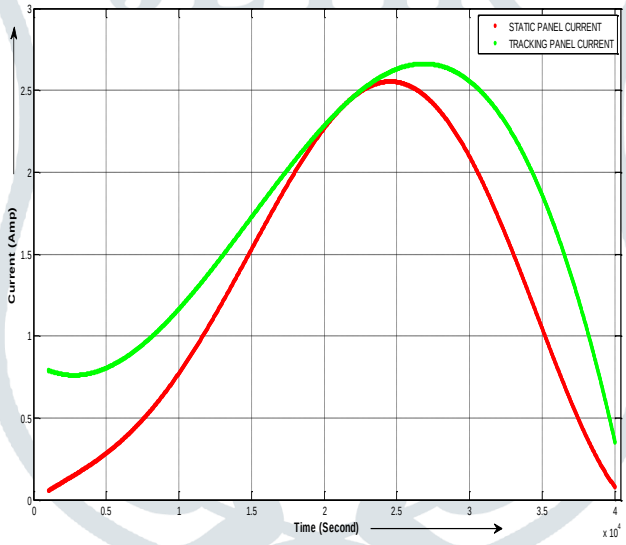

Figure 7: Simulation Result of SPV Power Plant

The curve has shown in green color present the value of current getting from sun tracking SPV power plants. While the current getting from fixed SPV system. In the graph shown in figure 7, the comparative analysis of current is presented. At 8 AM there is large difference in the current value between the SPV power plant with tracker and without tracker. At 2PM the current getting from both power plant are same. While if we see at 4PM the difference in current values are large.

Figure 8, shows the variation in the efficiency with respect to time. The difference in current in the 8 AM and 4:30PM is large while the difference is minimum at 2PM.

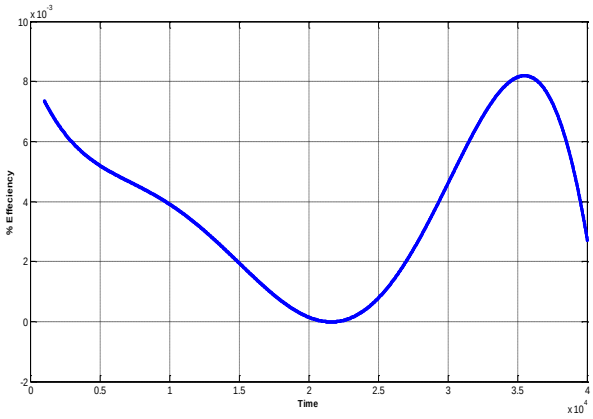

Figure 8: Simulation Result of Efficiency Vs Time

VI. EXPERIMENTAL RESULTS

Figure 9 shows the variation in power with respect to time, red line presents the variation in power when sun tracking system is implemented while blue line shows variation in power with respect to time. This experimental data collection was done from 8 AM to 4.30 PM on date 13-08-2019.

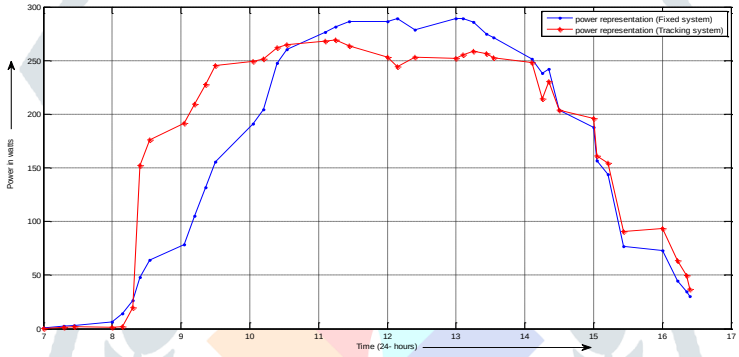

Figure 9: Variation in power Vs. Time

Figure 10 shows the variation in current with respect to time. The experimental data was collected on date 13-08-2019. Red line shows the variation in current of tracking SPV system when 100 watt load was connected to SPV system. Green line shows variation in current of static SPV power system.

It can be seen that current value getting from tracking SPV system is greater than the current value getting from static SPV system. Because the panel mounted on sun tracker are always towards the sun direction during the whole day. At 12 to 01 PM the current value of both system are approximately same because in this time interval, the sun light falls same.

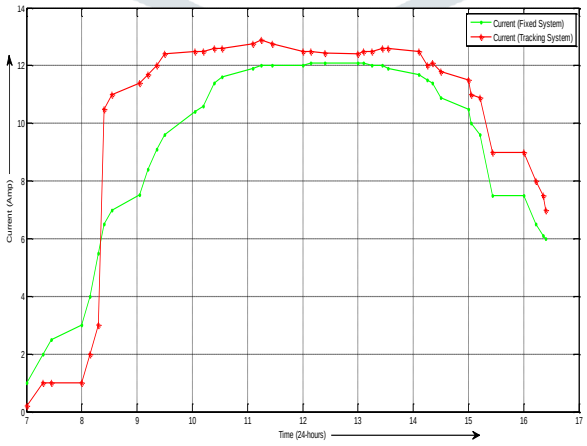

Figure 10: Variation in current vs. time

VII. CONCLUSION

In the above results presented in the paper, the calculated efficiency of SPV sun tracking system is greater than power generated from static SPV system by 38%. The results are shown in this paper are for single axis tracking system. Here single axis tracking means the sun tracker moves from east to west only.

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