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"Review of Solar Tracking Device for Maximum Optimality"

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***Abstract:*-- A solar tracker is a device that orients a payload toward the Sun. Payloads are usually solar panels, parabolic troughs, Fresnel reflectors, mirrors or lenses. Although, Solar Energy is facilitating the power sector industry, the research and development in this area is yet to be satisfactory. Our contribution in this paper is an advanced survey focusing on solar tracking concept and most advanced research issues. This paper provides a better understanding of the solar tracking device and identifies important research issues in this burgeoning area of power generation.**

***Index Terms*:-- Azimuth angle, Efficiency, Single axis, Tracker.**

I. INTRODUCTION

Energy has become an important and one of the basic infrastructures required for the economic development of a country. Any physical activity in this world, whether by human beings or by nature is caused due to the flow of energy in one form or other. Energy is required to do any kind of work. The work output depends on the energy input. The capability to do work depends on the amount of energy one can control and utilize.

The increasing energy demand, continuous drawback of the existing sources of fossil fuels and increasing concern about environmental pollution pushed researchers to explore new technologies for the production of electricity from clean sources, renewable such as solar, wind etc.

The amount of electricity that is obtained in solar panel is directly proportional to the intensity of sunlight falling on the photovoltaic panel. To get a larger amount of solar energy the efficiency of photovoltaic systems have been studied by a large number of scientists and engineers. In general, there are three ways to increase the efficiency of photovoltaic systems. The first method is to increase the efficiency of power generation of the solar cells, the second is related to the efficiency of the control algorithms for the energy conversion, and the third approach is to adopt a tracking system to achieve maximum solar energy.

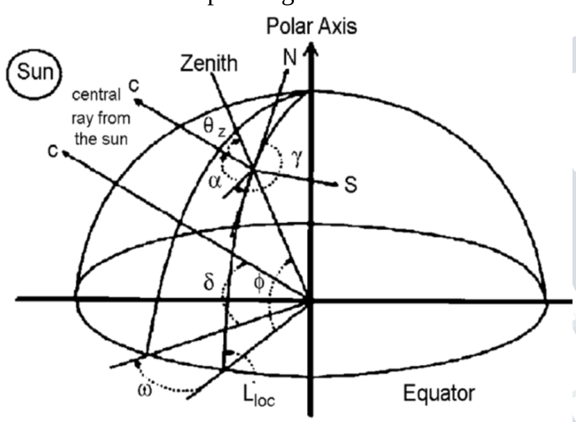
Present work in paperreviews the design and implementation of a single axis solar-tracking algorithm in order to improve the availability of solar energy and to improve the system's total efficiency. A solar tracker is used to track the orientation of the sun. Single axis trackers have one degree of freedom that acts as an axis of rotation. The axis of rotation of single axis trackers is typically aligned along a true North meridian. It is possible to align them in any cardinal direction with advanced tracking algorithms. In case of two-axis trackers the panel is positioned to track the orientation of the maximum sun light throughout the day by adjusting the tracker angles (both elevationand azimuth angles). The efficiency of solar energy absorptionusing one degree of freedom of solar tracking mechanism can be increased 27-32% rather than a fixed panel positionat the optimum angle, while the efficiency of solar energy absorption using two degrees of freedom of solar trackingmechanism are better 35-40% than a fixed panel position at the optimum angle, or increased about 6% from onedegrees of freedom of solar tracking mechanism. One of the main problems using mechanism of two degrees offreedom is the complexity and expensive cost.

II. LITERATURE SURVEY

Various authors have worked in this field to increase the efficiency of solar tracking device. Some of them have been elaborated trough studies and experimental setup as follows:

***RohitAgrawal*[1]*eta*l.** has discussed on the cost and ease of use of solar tracking system for maximum utilization of solar energy. According to the author Mechanical Solar tracking system is less costly when compared to Electro-mechanical solar tracking system. He further states that mechanical system uses zero energy from produced energy and thereby increasing the overall efficiency by 5-8%. Mechanical system also can be easy to maintain, and it requires unskilled worker and can be placed on hilly areas, remote or rusty or rainy place to develop electrical energy or to produce heat for different applications.

LuliaStamatescu[2]etal. have discussed solar tracking method design & implementation for experimental sun follower platform the presented control algorithm commands the movements of a photovoltaic module in order to follow the radiation & to maximize the obtained solar energy.In order to implement tracking algorithms, solar panel have to be placed on a structure that allows moving in a 2 axis. For this the equipments used is didactic miniature equipments which is equipped with a set of three photo voltaic cells that are placed on the same plane. Two motor are used to control the direction of panel, a DC supply of 24 volt, azimuthal angle and angle of inclination. The solar radiation sensitive cells are used to increase the power generation.



Z	Zenith angle (°)
α	elevation angle (°)
β	inclination angle (°)
Υ_c	surface azimuth angle (°)
Υ_s	solar azimuth (°)
δ	declination angle (°)
Ɵ	sun incidence angle (°)
Φ	geographical latitude
ω	hour angle (°)

Fig. 01- Schematic representation of solar angle.

Midriem[3] has found on the use of an astronomical algorithm for two degrees of freedom of solar tracking mechanism with the result that the expected solar thermal collector panel always leads to the sun & solar energy is absorbed optimally. The use of astronomy algorithms for solar tracking mechanisms two degrees of freedom based on the value of the azimuth & altitude resulting has been discussed. Inputs to the algorithm is latitude, longitude, time zone, date, month, year, hours, minutes & seconds.

Based on this research and findings it is known that the azimuth and elevation values was generated by these algorithms can be applied to two degrees of freedom of solar tracking mechanism because its accuracy is close to two other reference values.

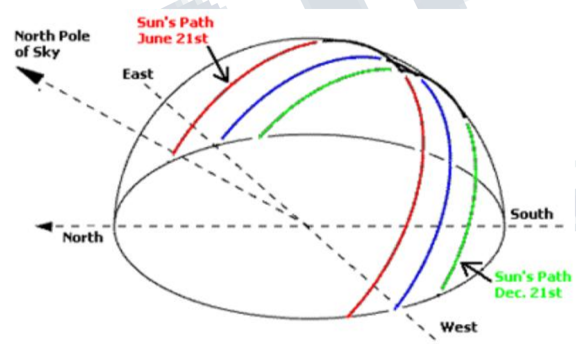


Fig. 02- The path of sun during the different seasons.

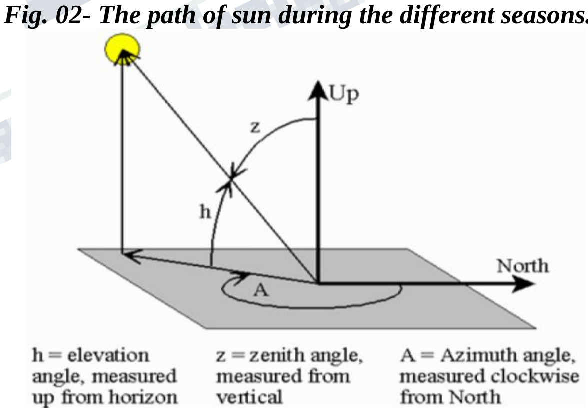


Fig. 03- Angles used in solar tracking.

Roberto Bruno[4]etal. have discussed on two different control strategies and system layout for energy optimization of a small size single axis solar trackers. According to the author mechanical movement systems are energy intensive and require costly periodic maintenance. In this paper author stresses on use of low power actuators. Author has investigated two different control strategies. The first one

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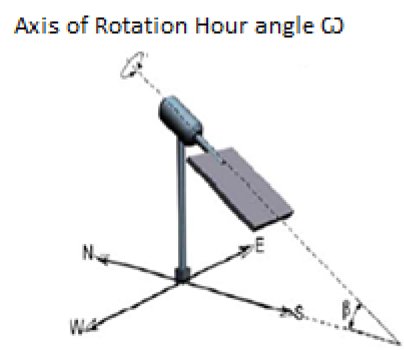
simply rotates the module of an angle equal to solar azimuth angle & adjusts it during the sunrise & sunset. In the second control strategy, rotation angle is chosen in order to minimize the incident angle during whole year. Author concludes that the first strategy has tracking efficiency of 91.4% and increase of 23.6% of annual solar collection while second has tracking efficiency of 96.4% and increase of 27.5%. Further he also stresses on having adequate distance between modules to avoid self-shading of the PV panel. The author has focused on the ratio of module spacing and the width change in η of 9% is observed. The weight of the module plays an important role since it is responsible for the power consumption and responsible for the overall η percentage of the system.

M Koussa*[5]*et al.have discussed on performance of different types of sun tracking mechanisms under different sky conditions namely dry and clear and cloudy sky. The different types of sun tracking mechanisms studied are dual axis sun tracker, single axis sun tracker (two kinds), and fixedpanel (two orientations). The author has also discussed on the effect of day length on the performance of the system, further he concludes that the efficiency of dual axis solar tracker is more than single axis since angle of incidence of sunlight is almost zero. Efficiency of single axis is more than fixed type. The efficiency of all types of solar tracker is almost same under cloudy sky and no appreciable change is seen. But under clear sky, the use of system is recommended as efficiency increases. The amount of energy received and used is directly proportional to amount of day light received. Therefore the amount of day length also affects the performance of system.

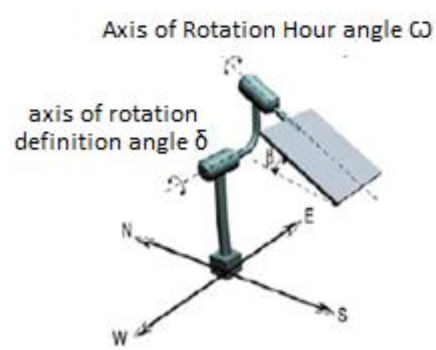
J. Rizk*[6]*etal. in this paper have proposed, designed and constructed a solar tracker, the final design of the tracker was successful, in that it achieved an overall power collection efficiency increased from only 39% for a fixed panel to over 70% for the same panel on the tracking device. In terms of real value, this means that the overall cost of a system can be reduced significantly, considering that much power can be supplied by the solar array coupled to a solar tracking device. By extracting more power from the same solar panel, the cost per watt is decreased, thereby rendering solar power much more cost-effective than previously achieved using fixed solar panels.

Also, the solar tracker designed employed the new principle of using small solar cells to function as self-adjusting light sensors, providing a variable indication of their relative angle to the sun by detecting their voltage output. By using this method, the solar tracker was successful in maintaining a solar array at a sufficiently perpendicular angle to the sun. The power increase gained over a fixed horizontal array was in excess of 30%.

MRI Sarker*[7]** ***etal. have discussed on the design, construction and also investigated an experimental study of a two-axis automatic control solar tracking system to track solar PV panel according to the direction of beam propagation of solar radiation. The aim of the paper is to design a microcontroller operated two-axis sun tracker which works efficiently in all weather conditions regardless of the presence of clouds and also investigate effect of using two-axis sun tracker on electrical generation of flat photovoltaic system.



(a)



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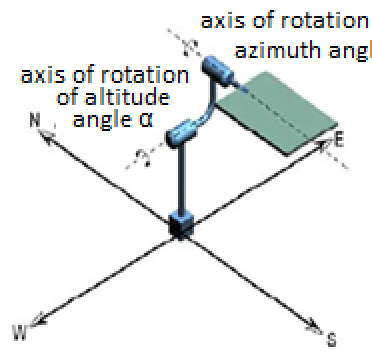

(c)

Fig. 04-(a) One-axis sun tracking system with tilt equal to latitude angle; (b) two axis equatorial sun tracking system with tilt angle equal to latitude angle; (c) two axis azimuth/elevation sun tracking system.

ShahriarBazyari[8] etal.have studied different systems with fixed panels and single and double axis solar tracker. Author elaborates on different parameters of solar radiation such as azimuth and zenith angle etc. The author has compared fixed single axis and double solar system for Qeshm Island. Result depicts that single axis system generates 1.35 times more than fixed solar panel and double axis system generates 1.04 times single axis system.

Miguel de Simón-Martín[9]etal. have discussed on different types of sun-trackingsystems that are classified according to the movement they perform (cinematic classification). Further,three real PV installations-fixed, horizontal-axis tracking and dual-axis mount tracking—locatedin the same geographical area in Spain (they are approximately under the same weather conditions) are analyzed. These installations have been studied in order to establish which one is themost efficient and affordable—Specific Energy Production (*SEP*) and Performance Ratio (*PR*) analysis. PVGIS solar radiation estimate tool has been used for comparing the theoretical radiationpotential on each plant. The land requirements have been considered in the analysis of theGround Cover Ratio (*GCR*) and the Surface Performance Ratio (*SPR*). Moreover, comparing threemain financial indicators let us carry out a financial study: Payback Time (*PBT*), Net Present Value (*NPV*) and Internal Rate of Return (*IRR*). In the case study, final annual energetic results demonstratethat the dual-axis plant shows a relevant *SEP* advantage, but if we take into account the landoccupied for this sort of devices we find much more profitable the horizontal-axis sun-trackingsystem, with a *SPR* value 4.24% higher than the fixed system we have studied. Its *PBT* is also a 22% lower than the dual-axis tracking installation.

HosseinMousazadeb[10] etal. have discussed that the solar radiation are usually given in the form of solar radiation on a horizontal surface and PV panels are usually positioned to an angle to the horizontal plane. The author has described different types of solar tracking devices such as active tracker, passive tracker, etc. Author has compared the increase in energy of all types of solar trackers. Author has finally classified solar tracking devices as shown in figure 05.

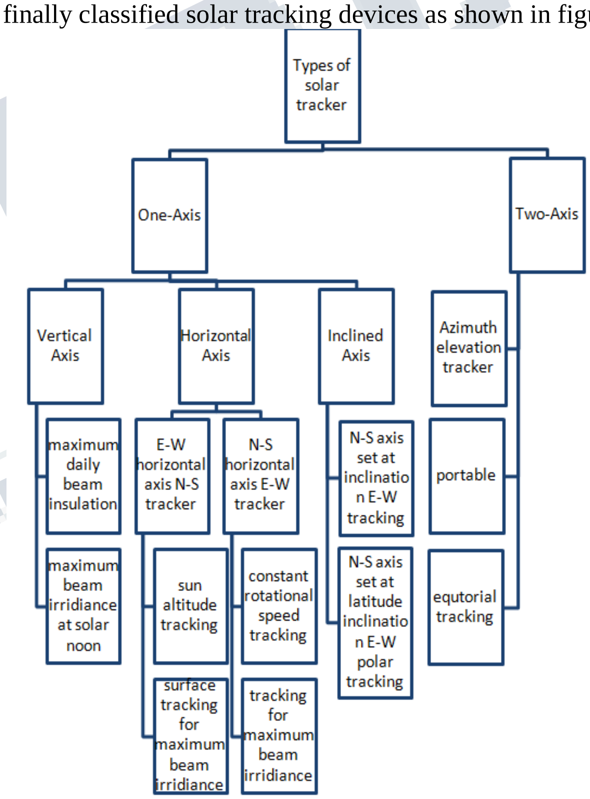

Fig 05- Classification of solar tracking device.

III. CONCLUSION

After studying the papers, we have come to a conclusion that single axis and dual axis are highly efficient in terms of the electrical energy output when compared to the fixed mount system. Dual axis tracking system works well even during cloudy days when compared with single axis tracker. Hence the efficiency of dual axis tracker system is higher when compared with single axis tracker system. But the hardware complexity and cost is higher in the dual axis tracker when compared with fixed and single tracker.

Solar trackers generate more electricity than their stationary counterparts due to an increased direct exposure to solar rays.Solar trackers generate more electricity in roughly the same amount of space needed for fixed tilt systems, making them ideal optimizing land usage.

IV. FUTURE SCOPE

In future this project can be implemented on large solar plants. This system is designed to operate continuously. But it can be also designed it to receive the inputs at fixed intervals of time (maybe 4 or 5 minutes). This will also result in reduced power consumption at a great level.

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