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Study and Analysis of Various Solar Tracking Systems

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Abstract – Energy requirement continues to increase with the growth in population. The fossil fuel based conventional sources of energy are widely used but they are polluting and depleting fast. Whether it is the conventional or non-conventional source, solar energy is the mother of all these forms of energy. It gives light and heat energy in such a manner that doesn't harm the environment. Power obtained from the fixed solar mounting system due to its fixed arrangement is very little. The power generation from solar panels can be increased with the help of tracking systems in such a manner that panels face the sun during the day in all the seasons. A comparative analysis and study of various solar tracking systems are presented in this paper.

Keywords- Solar Tracker, Photovoltaic System, Sensor, Solar Energy, Renewable Energy.

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1. INTRODUCTION

In the modern era, energy is needed in different forms for day to day activities. The fossil fuel reserves are depleting fast and also, they are primarily responsible for climate change which has emerged as the biggest challenge of 21st century. In the modern lifestyle, energy consumption is increasing rapidly and hence the situation compels to minimize dependence on fossil fuel-based power generation and adopt renewable sources of energy. The fossil fuels emit greenhouse gases that are responsible for global warming which has been established as the main cause of climate change. Sun is a free source of other renewable energies sources such as wind, water, biomass etc.

Solar energy reaches earth in the form of light and heat. Solar cell itself does not produce much power when used alone. The cells are assembled and interconnected to form panels. The main drawback in the use of solar energy is that energy density and efficiency of solar PV cell are low. The solar panel of fixed mounting structure cannot be facing towards the sun all the time. The power generation from solar panels can be enhanced if the panels track to face the sun. In a dual axis tracking system, the enhanced power generation of 30 to 40% can be obtained in a year.

The initial cost of fixed type solar panels is very less but on the other hand, generated power is also very less.

In view of this, tracking systems may offer a way to enhance power generation. A solar PV panel facing the sun in the morning, noon and, evening is shown in Figure-1.

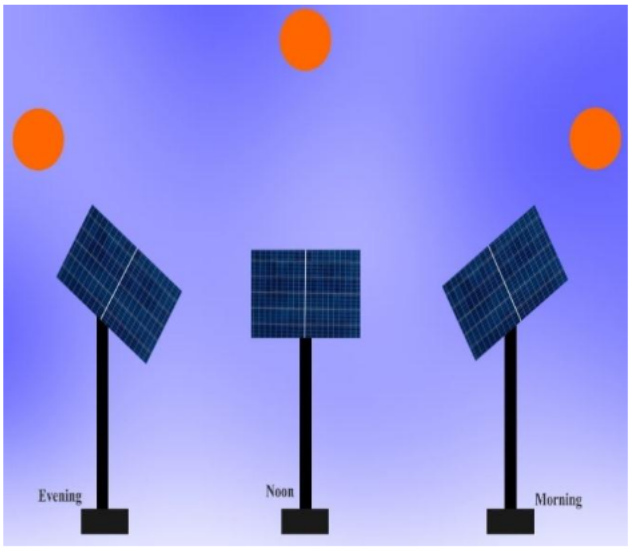

Fig.1 Solar Tracking System

2. TYPES OF SOLAR TRACKING SYSTEM

For several years, developments are taking place in the field of tracking systems and the process continues with innovative ideas. The classification of solar trackers on the basis of axis, feedback, and energy are given in Figure-2.

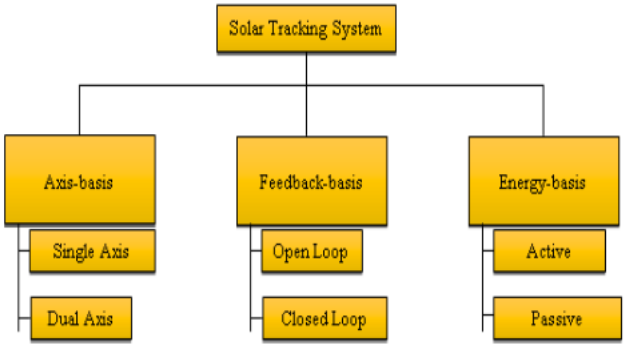

Fig.2 Classification of Solar Tracking System

(i) Axis basis: The solar tracker are single or dual axis type.Single axis tracking system moves only in one direction (x or y-axis).It is simple, cheap, easy to install and has less number of moving or electronic parts to control and handle the tracking. The dual axis tracker moves both in vertical and horizontal directions (x and y-axis). It is complex, difficult to install, costlier and has a larger number of moving parts to control and handle the tracking.The condition where generation is of prime importance, dual axis tracking system is prefered due to its higher generation capability.

Both the single and dual axis can be astronomical or sensor based.

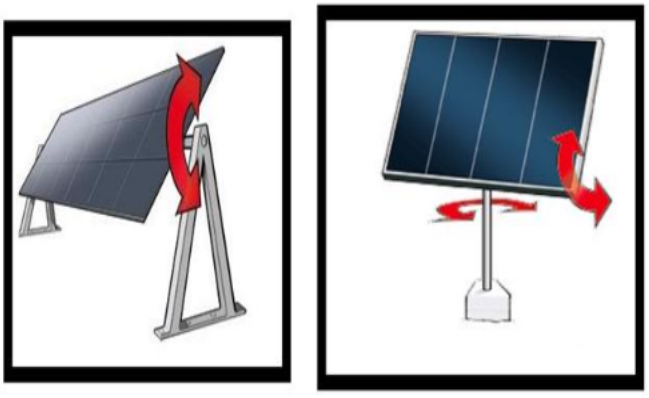

Fig 3 Single and Dual Axis Solar Trackers

(ii) Feedback-basis: It may be possible that the type of solar tracker can be open loop or closed loop. An open loop tracking system is one in which controller doesn't receive any information related to the output and proper working as there is no feedback system. While the closed-loop system is one in which output is connected to the input and this time each and every information related to output is in the knowledge of the controller.Thus the closed-loop system is recommended in every case.The sensor-based tracking system is a good example of the closed loop tracking system.

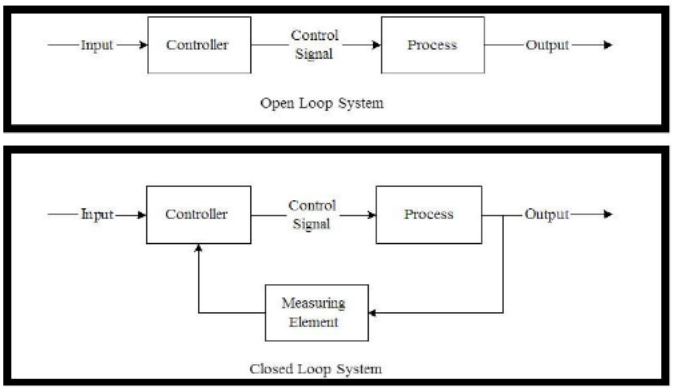

Fig 4 Open and Closed Loop Solar Tracker

(iii) Energy-basis: the solar trackers are active or passive types.An active solar tracker is one that needs electrical energy (AC or DC) to move solar panels. The passive solar tracker is not dependent on electrical energy. It makes use of solar heat to increase the pressure of gas with a low boiling point. The movement of solar panels towards the sun depends on the pressure of gas.For higher reliability, active system is preferred. The reliability of active system is lower due to several electrical and mechanical components.

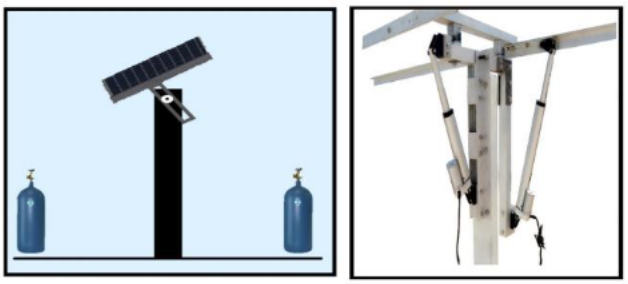

Fig 5 Passive and Active Solar Tracker

A comparison of different types of solar tracking systems is given in Table-1.

Table 1 Comparison of Different Tracking Systems

Parameters	Axis		Feedback		Energy	
	Single Axis Tracker	Dual Axis Tracker	Open loop Tracker	Closed Loop Tracker	Passive Tracker	Active Tracker
Reliability	High due toless number of moving parts	Low due to large number of moving parts	Depends on the mechanical support structure	Depends on the mechanical support structure	Unreliable	Depends on mechanical Support structure
Tracking method	Either astronomical or sensor based	Either astronomical or sensor based	Astronomical	Sensor based	Either astronomical or sensor based	Either astronomical or sensor based
Tracking Accuracy	Depends on the selection of tracking method	Depends on the selection of tracking method	Lower but higher than passive tracker	High	Low	Highest
Cost	High but lower than dual axis	Highest	Medium	High	High	Low
Power Consumption	Low	High	Depends on number of motors	Depends on number of motors	Highest	High
Availability	Easily available	Easily available	Easily available	Easily available	Difficult	Easily Available
Feedback	Depends on the selection of tracking method	Depends on the selection of tracking method	No	Yes	Depends on the selection of tracking method	Yes
Tracker Driving Device	Actuator or drives	Actuator or drives	Actuator or drives	Actuator or drives	Gas cylinder	Actuator or drives
Electronics Part Count	Small number	Large number	Small number	Large number	Little or none	Large number
Generation	High but lesser than dual axis	Highest	Depends on the number of axes adopted	Depends on the number of axes adopted	Lowest	Depends on the number of axes adopted
Driving Energy	Electric energy	Electric energy	Electric energy	Electric energy	Mechanical energy(gas driven)	Electric energy

3. CONCLUSION

After study and analysis of various tracking systems. It has been observed that there is no single tracker to suit all the situations. Hence, an appropriate decision needs to be taken on the project to project basis.

Small-scale rooftop installations for local use may not be provided with any tracking system to minimize capital investment. This system is totally stationary and hence more sturdy and reliable.

While selecting the tracker, extreme climatic conditions at the site must be taken into consideration. To obtain higher generation, the options of the single axis, as well as double axis tracking are available. With some extra coast, the single axis tracking system may be considered to enhance generation. Dual axis tracking system increases the cost but is desirable to maximize generation at a site with land constraint. A quality work in tracking and support systems and their O&M is necessary to ensure smooth functioning of tracking systems to improve reliability.

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