Analytical Investigation And Effect of Optimum Tilt And Azimuth Angle on DC Production For Sikar, India

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Abstract- *Solar energy is largest alternate source of energy on the earth. Among all other renewable energy, solar energy has been an important as it has many features like minimum maintenance, easy use and small payback etc. The major and important issue is to produce more electricity through solar. For solar energy we depend on PV cell; efficiency of solar panel depends on solar radiation which falls on panel. One of the important factors for the output of a solar panel depends on the tilt and azimuth angle of the panel. This paper presents optimum value of tilt angle and azimuth angle for sikar, Helioscope software has used for analysis the effect of tilt angle and azimuth angle on solar output. Value of optimum tilt and azimuth angle has been calculated & is given for particular area. In this paper DC outcome through panel has been calculated for fixed solar panel when panel installed at optimum tilt angle and optimum azimuth angle. Apart this effect of tilt angle and azimuth angle on dc generation in single axis tracker and dual axis tracker also calculated and optimum tilt angle and azimuth angle is given, to increase overall distilled output of the solar. Analytical results were carried out between the hours of 8:00 am to 6:00 pm for a 125w Si-poly solar panel for period of year 2019. The result clearly shows that the DC generation is grater at optimum tilt and azimuth angle. These angles play an important role in the efficiency of the solar plant.*

Keywords- Solar energy, solar tracker, renewable energy, SPV (Solar Photovoltaic), Solar panel

I. INTRODUCTION

Energy is the main key driver of India's economic process with the main focus being on primary source like coal, oil gas, hydro, nuclear wind and Biomass used for industrial purpose. Coal however is the ministry of our energy scene. India is the sixth largest country in terms of the power generation [1]. Today, in the power Sector we are totally dependent on fossil fuels but fossil fuels are non-renewable and limited in sources they will be exhausted one day. Solar energy is largest alternate source of energy on the earth. Tilt and azimuth angle are factors that significantly influences the performance that affects the efficiency of the panel [2][3]. It is why several solar angles are analyzed and utilized in PV power calculations. It is very important for a researcher to know whether the sun light will be available or not throughout the year so that PV panels can be installed at the ideal angle to absorb the most quantity of sunlight throughout the year [4]. To improve PV panel efficiency, one needs to design and analyses solar panels in different ways, therefore more sunlight hits the surface of the panel [5][6]. The analysis are tried to achieve the maximum DC generation from the sun using optimum tilt angle optimum azimuth angle.

II. EFFECT OF TILT ANGLE AND AZIMUTH ANGLE

The default value of tilt angle is equal to the station's latitude plus 15 degrees in winter or minus 15 degrees in summer. During the winter we increasing the tilt angle to favors energy production, while in summer we decrease the tilt angle to favors energy production [7]. In the summer sun is high then facing to sun minimum tilt angle required for solar panel but in winter when sun is low maximum tilt angle required. This normally maximizes annual energy production. A flat roof includes a 0-degree tilt angle and a vertical wall mount includes a 90-degree tilt angle [8].

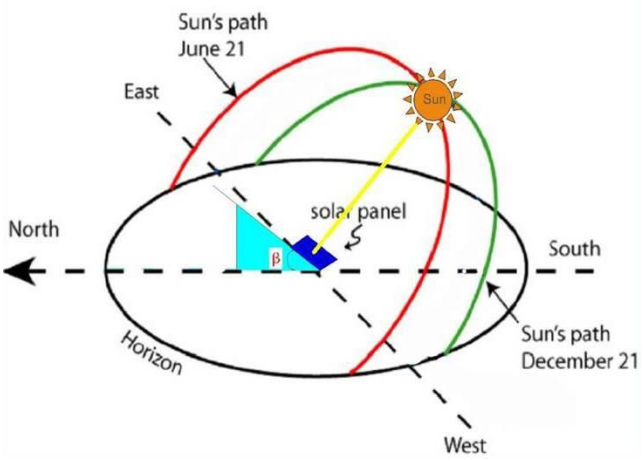

Fig.1 Minimum tilt angle (β) when sun is high (summer season)

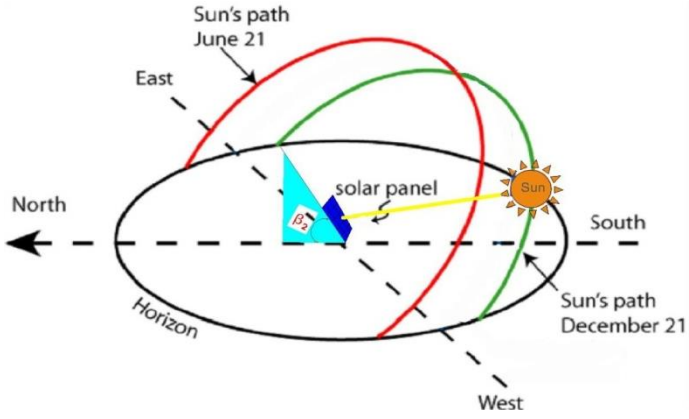

Fig.2 Maximum tilt angle (β_2) when sun is low (winter season)

Every day the sun rises in the east and set in the west thus value of azimuth angle has changed every minutes, track to path of sun from east to west needs to calculate proper azimuth angle [9][10]. The best output is given by the parallel rays of the sun and hence the panel must be directly faced to the sun for the entire the day for maximum efficiency [11]. Value of azimuth angle is zero in the true north, 90° in the East and 180° in true south.

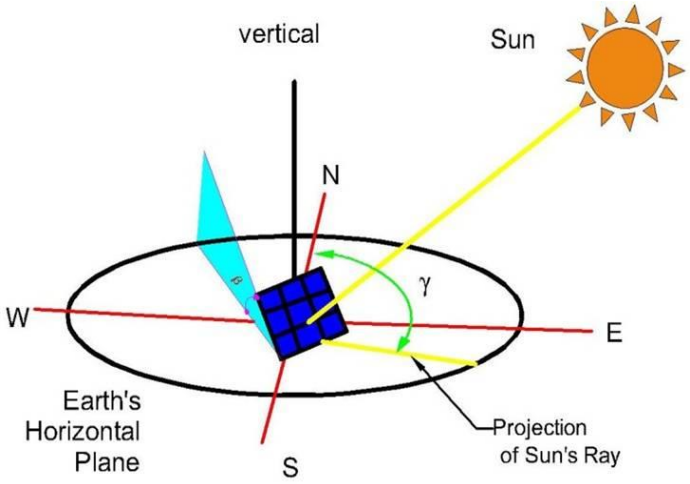

Fig.3 Azimuth angle (γ) at the morning time

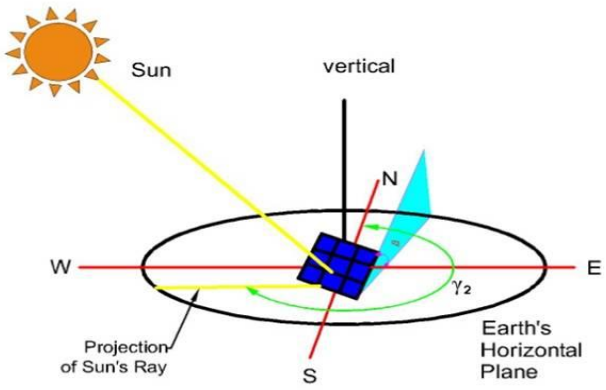

Fig.4 Azimuth angle (γ_2) at the Evening time

III. HELIOSCOPE SOFTWARE

Helioscope is an internet application for analysis to solar panel designed by Folsom Labs, Calif. in The United States of America. Helioscope is time saviour for energy modeling as a result, it provides automation. HelioScope, is modified the method of designing and simulating a solar array.

This is a user friend software package. By exploitation Helioscope we are able to produce design of solar array, and that we can simulate to get the results. Using Helioscope we are able to resolve optimum angle and energy production at explicit location exploitation local atmospheric condition. We are able to get annual and monthly information of production and radiation that falls on panel. Its simplest method attract to United States of America to design a solar array and installation of it. To make a project and obtaining data from this tool it is very easy to do it in four or five steps [12][13].

Benefits of Helioscope

The key benefits of Helioscope are as follows:

1. Quickly evaluate potential sites.
2. Analyse design decisions.
3. Simplify the workflow.

IV. METHODOLOGY

First of all make a project file and outline a solar panel using field geometry in helioscope (software). after creation a new project next step is outline solar panel's position like what's tilled angle what's azimuth angle of panel in mechanical tab. Numbers of panels depends on filed segment, therefore, we are defining field segment for single panel (According to space occupied by a

panel). After then next steps is select time period for the Electricity generation, defining Eclectic connections. Finally, a report file (analysis) is formed, that is imported in to urge total irradiation fall on the panel and the way a lot of electricity is generated throughout the month on particular position. Similarly, get respectful report file using angle variation in helioscope, helioscope has capability to change the physical angle of panel in line with need to do analysis on panel with that angle. Using these files we get an optimum tilt angle and azimuth angle for panel installation for Sikar (Raj.)

The methodology to find out optimum tilt angle and azimuth angle is given below

Step-1:- Take 125W Si-poly solar panel and Keep it to true South. Vary tilt angle starting from 0 degrees to 90 degrees in steps of 5 degree. Determine and tabulate DC generation at each tilt angle. Calculate maximum DC production monthly as well as annually and find out optimum tilt angle.

Step-2:- Take 125W Si-poly solar panel and Keep it to optimum tilt angle. Start varying azimuth angle starting from 90 degrees (true East) to 270 degrees in steps of 10 degree s (180 is true South). Determine and tabulate DC generation at each azimuth angle. Calculate maximum DC production monthly as well as annually and find out optimum azimuth angle according to DC production monthly as well as annually.

Step-3:- Take 125W Si-poly solar panel. Keep it to at annually optimum tilt angle and Start to varying solar panel at monthly optimum azimuth angle (Single axis Tracking). Calculate DC out comes from solar panel monthly as well as annually.

Step-4:- Take 125W Si-poly solar panel. Start to varying solar panel at monthly optimum tilt angle and optimum azimuth angle (Dual axis Tracking). Calculate DC out comes from solar panel monthly as well as annually.

V. ANALYSIS AND RESULTS

For the analysis, Sikar has used as location. First of all, the project name and its location are provided manually then the software automatically takes up the longitude and latitude according to given address. Sikar's longitude is 75.125885 degrees and latitude is 27.615406 degrees. PV module used for the analysis (Si-poly 36 cells).

Analysis of effect of tilt angle on dc generation

In the simulation of tilt angle variation has given from 0 degrees to 90 degrees in steps of 5 degrees. At the various value of tilt angles note and the effect of tilt angle is compared. Then following inputs are provided:

a. PV module watts = 125Wp
b. Azimuth angle = 180 degree (true South)
c. Tilt angle variation 0 degrees to 90 degrees (in steps of 5 degrees)
d. Horizontal (landscape) orientation
e. Fixed tilt racking; condition set for year-2017-18

Analysis of effect of Azimuth angle on dc generation

Azimuth angle is varied 90 degrees to east and west from true south in steps of 10 degrees. Take variation of Azimuth angle from 90 degrees to 270 degrees to east and west from true south in steps of 10 degrees as a calculating variation effect. Note down the solar output at different azimuth angle by fixing the tilt angle at optimum angle and thus the effect of azimuth angle is studied. Then following inputs are provided for study of effect of azimuth angle:

a. PV module watts= 240Wp
b. Azimuth angle variation = from 90 degrees to 270 degrees (in steps of 10 degrees)
c. Tilt angle = 32 degree
d. Horizontal (landscape) orientation
e. Fixed tilt racking,

Analysis Step-1:- After analysis getting that optimum tilt angle is 32° for Sikar.
Analysis Step-2:- After analysis getting that optimum Azimuth angle is 150° for Sikar.
Analysis Step-3:- In this step, Tilt angle is set as 32° and at various optimum azimuth angle DC outcomes has calculated and result has tabulated
Analysis Step-4:- In this step, determined optimum tilt and azimuth for all months and at these angle Dc outcomes has calculated and tabulated

Comparative study of solar outcomes through various tilt and azimuth are shown in graphical from fig. 5, 6 and 7 respectively.

TABLE 1
RESULT ANALYSIS ON OPTIMUM AZIMUTH (150º) AND OPTIMUM TILT (32º) ANGLE

S. No.	Months year 2018	Tilt Angle in degree	Azimuth angle in degree	DC Generation (kwh)
1	January	32	150	19.0
2	February	32	150	21.6
3	March	32	150	26.6
4	April	32	150	26.2
5	May	32	150	26.8
6	June	32	150	25.8
7	July	32	150	22.0
8	August	32	150	19.7
9	September	32	150	23.9
10	October	32	150	24.5
11	November	32	150	22.0
12	December	32	150	20.5
Annual Dc generation, kwh				**278.6**

TABLE 2
RESULT ANALYSIS ON MONTHLY OPTIMUM AZIMUTH AND FIXED OPTIMUM (32°) TILT ANGLE

S. No.	Months year 2018	Tilt Angle in degree	Azimuth angle in degree	DC Generation (kwh)
1	Jan	32	160	21.1
2	Feb	32	160	22.6
3	Mar	32	150	26.7
4	Apr	32	130	26.4
5	May	32	100	27.4
6	Jun	32	90	26.4
7	Jul	32	90	22.6
8	Aug	32	110	21.9
9	Sep	32	140	24.2
10	Oct	32	160	25.0
11	Nov	32	170	23.1
12	Dec	32	170	21.2
Annual Dc generation				**288.6**

TABLE 3
RESULT ANALYSIS ON MONTHLY OPTIMUM AZIMUTH AND OPTIMUM TILT ANGLE

S. No.	Months	Tilt angle in degree	Azimuth angle in degree	DC Generation (kwh)
1	Jan	55	160	24.3
2	Feb	45	160	25.5
3	Mar	30	150	28.8
4	Apr	20	130	28.1
5	May	15	100	29.2
6	Jun	10	90	27.1
7	Jul	10	90	26.2
8	Aug	20	110	23.8
9	Sep	25	140	25.0
10	Oct	40	160	27.4
11	Nov	50	170	26.6
12	Dec	55	170	23.7
13	Annual	32	150	315.7

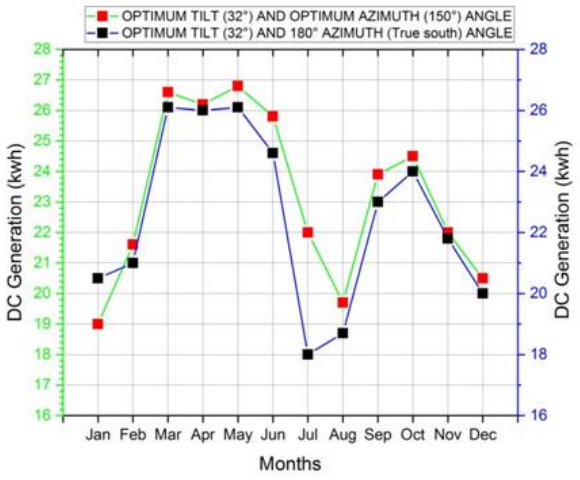

Fig.5 Comparative DC generation for optimum tilt & optimum azimuth angle with optimum tilt and true south (180º)

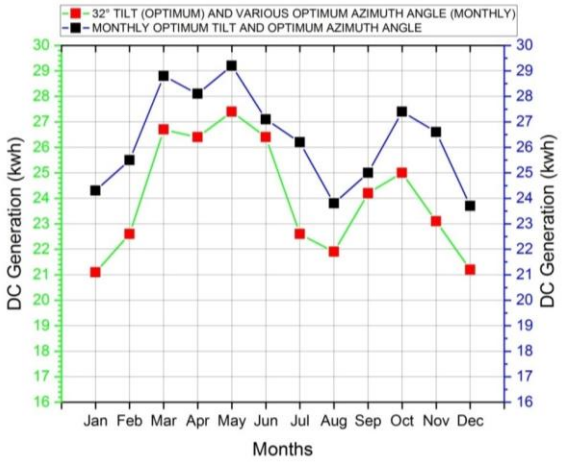

Fig.6 Comparative DC generation for fixed optimum tilt & various optimum azimuth angle with monthly optimum tilt and azimuth angle

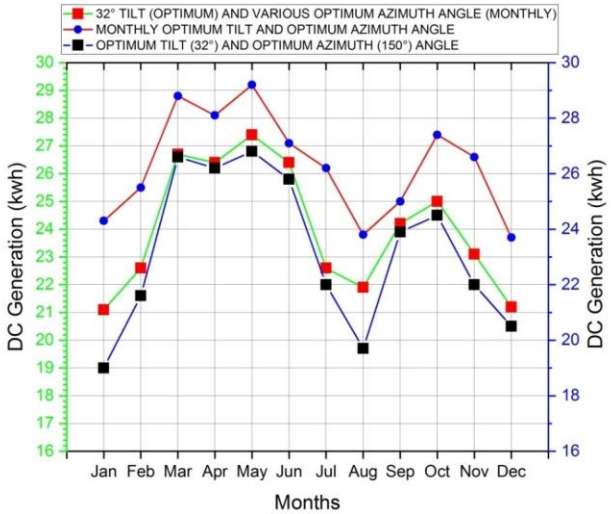

Fig.7 Comparative DC generation for fixed solar panel, Single Axis and dual axis solar panel tracking system based on optimum tilt and azimuth angle

IV. CONCLUSION

The effect of tilt and azimuth angle was studied using simulation report. A number of simulation reports were generated to determine tilt angle and azimuth angle for particular region as well as DC generation from solar panel. The optimum azimuth angle for Sikar (Raj.) is 150° and optimum tilt angle is 32° as annual maximum DC generation. Using analysis and Simulation report monthly optimum tilt and optimum azimuth angle has calculated as well as DC generation. It was observed that if panel is installed at optimum tilt and optimum azimuth angle DC generation has increases. Apart from this it is also observed that if single axis and dual axis tracking system will designed as a optimum tilt and azimuth angle then solar panel gives more DC production. After analysis it was observed that using dual axis solar tracking system (monthly optimum tilt and optimum azimuth angle) we can get more DC outcomes through panel as a compare to fixed solar panel. It was observed that the DC generation through dual axis tracker (optimum tilt and azimuth angle based) is 17% higher as compared to fixed (45° tilt angle and 180° azimuth) solar panel.

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