

Investigate of Solar PV Rooftop Energy with Various of Tile and Angel in Winter Season at the Northern Thailand

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ABSTRACT

This paper describes the study on solar energy of various tilt and direction. The test rig with various eight directions and seven angles was applied to experimental. The simplify equation of Solar energy has been applied to examine the experimental. The test condition had implemented at Pasang Technical college Lamphun province on 18° 31' 34" N / 98° 56' 22" E. The result shown that the maximum total solar energy at tile and direct is 50 degree, south face respectively. This practical experiment can be applied to find out not only the maximum energy out on title and angle but also economic decision.

1. Introduction

An immense boost from the policy of the present government by 2013, Thailand has had plan to installation Solar Photovoltaic Roof Top around 1,000 MW that divided in 3 parts such as (1) village or community 800 MW, (2) household 100 MW and (3) business park or industrial 100 MW [1]. Generally, the roof of household and industrial was designed within factor of comfortable living, function, modern and etc., which means the angle and title of abode had be out of keeping with solar energy system. Normally, the maximum irradiance has received by the tilt angle equal to the latitude of a location. However, the pattern of weather has difference in winter summer and rainy season respectively.

In this paper, the test rig with various eight directions and seven angles was applied to experimental. The simplify equation of Solar energy has been applied to examine the experimental.

2. Theoretical investigation of the energy at various tilt and angle

2.1 Solar Irradiance

The global solar irradiance incident with a tilted surface I_G comprises three components, as shown in Fig.1: (i) direct or beam, I_b (ii) diffuse, I_d and (iii) reflected, $I_{reflected}$ solar irradiance component.

$$I_G = I_b + I_d + I_{reflected} \quad (1)$$

2.2 Direct of beam radiation

The geometric relationships of a plane with any particular orientation relative to the earth at any time and incoming beam solar radiation can be describe in terms of several angles. The figure 1 shows the angle and set of consistent sign conventions are as follows: [2]

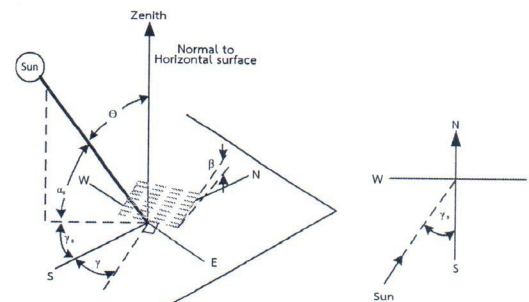


Fig. 1 Angle for the tiled surface.

$$\begin{aligned} \cos \theta = & \sin \delta \sin \phi \cos \beta - \sin \delta \cos \phi \sin \beta \cos \gamma \\ & + \cos \delta \cos \phi \cos \beta \cos \omega + \cos \delta \sin \phi \sin \beta \cos \gamma \cos \omega \\ & + \cos \delta \sin \beta \sin \gamma \sin \omega \end{aligned} \quad (2)$$

Following, solar declination “ δ ” is given by equation (2), where “ D ” is the Julian day of the year.

$$\delta = 23.45 \sin \left[\frac{360(D + 284)}{365} \right] \quad (3)$$

2.3 Simplify model for calculated the energy at various title and angle

This experiment proposed the simplify model to calculate the energy for comparison between the total irradiance at various tile and angle by calculated, $I_{mea@ \beta, \gamma}$ with total irradiance at slope of surface is zero, $I_{mea@ \beta=0}$ multiplied by the angle of incidence of beam radiation on a surface as following:

$$I_{mea@β,γ} = I_{mea@β=0} \cos \theta \quad (4)$$

3. Experiment setup

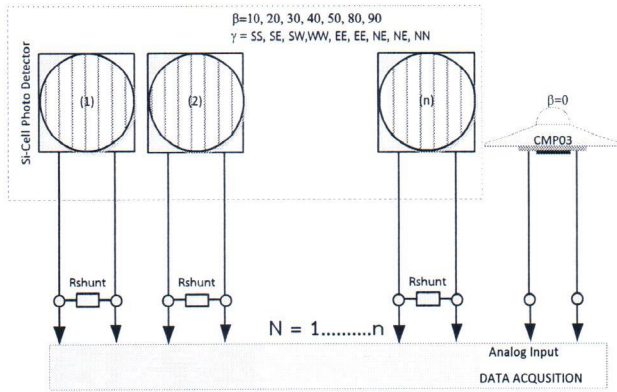


Fig. 2 Schematic diagram of the system measurement.

To confirm the simplify model results, an experimental system had implemented for determining the highest irradiance with tile and angle. The solar irradiance test rig was constructed with 8 directions and each direction had 7 angles such as 10, 20, 30, 40, 50, 80 and 90 degree respectively. The two type of solar irradiance instrument was set up to collected the data to data acquisition system. The global irradiance was measurement by KIPP&ZONEN CMP03 pyranormeter that fix at slope of surface is zero and the other was fix with title and angle. The Si-cell photo detector was chose to measure the solar irradiance with various tile and angle amount 42 components. The entire Si photo detector was calibrated with CMP03 pyranormeter. The test site was located at Pasang Technical college Lamphun province on 18° 31' 34" N / 98° 56' 22" E in the winter season of Thailand on January and the most clearly sky of solar radiation was selected to represent the data.

4. Results

The total solar energy at the site test had 5.16 kWh-day or 18.57 MJ-day with clear sky as shown in Fig.3.

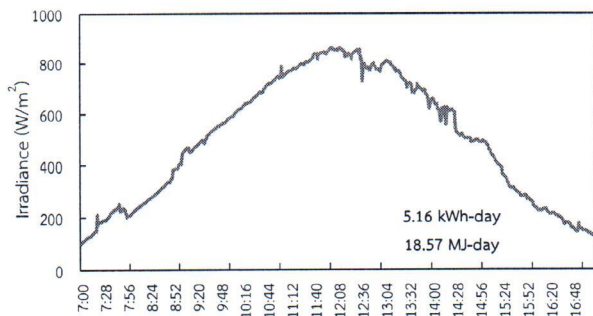


Fig. 3 Irradiance of experiment day on winter season.

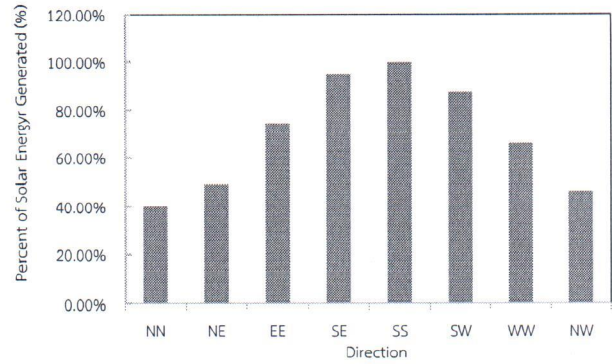


Fig. 4 Percentage of solar energy at various directions

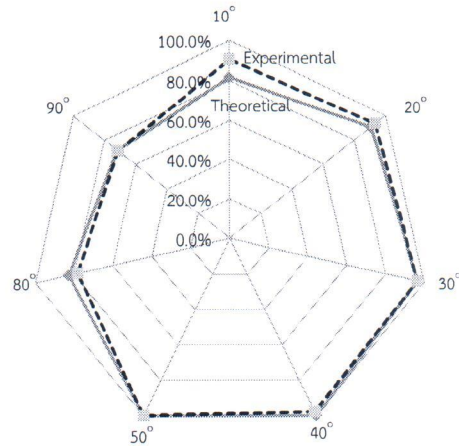


Fig. 5 Investigate the experimental and theoretical at various angle on south face.

The result shown that the maximum total solar energy at tile and direct is 50 degree, south face respectively.

5. Conclusion

The simplify model have had confirm the experiment represent in the winter season at northern data as well and possible to applied the other season for prediction. It experiments can be applied to find out not only the maximum energy out on title and angle but also economic decision of the installation the PV solar rooftop.

REFERENCES

- [1] Energy Regulatory Commission available on: <http://www.erc.or.th/ERCWeb2/default.aspx>
- [2] J.A.Duffie and W.A.Beckman. Solar Engineering of Thermal Processes., NewYork, John Wiley&Sons, INC. 1980, pp.10-21.