Comparison of Amorphous and Single Crystal Silicon Based Residential Grid Connected PV Systems: Case of Thailand

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ABSTRACT

Grid connected photovoltaic systems are an important electrification option especially in urban areas. Thailand has started the second phase of the residential grid connected PV system after five years completion of the first phase program. This paper compares the performance of amorphous silicon and single crystalline based household grid connected PV systems installed at Bangkok during the first phase program. Data collected over a year has been used to estimate the yields (reference yield, array yield and final yield), inverter efficiency, system efficiency, and performance ratio (PR). The variations of these parameters over the months indicate that the yields are high during June and July. The annual final yield and the average PR were found to be 1166 kWh/kW$_p$ and 0.73 respectively in case of amorphous system. The annual final yield and the average PR were found to be 960 kWh/kW$_p$ and 0.58 respectively in case of single crystalline system. The PR is always found to be higher in amorphous system than the single crystalline system. The result of the study indicates that the system installed in Bangkok performed satisfactory.

1. Introduction

The market penetration of photovoltaic (PV) has been increased significantly during the last decade of the 20th century worldwide. During 1990, there were mainly stand-alone systems in the remote areas and the application for the communication and consumer products were common. At the end of the decade, small decentralized grid connected PV system became dominant [1]. The grid connected PV systems in residential and commercial sector grew to 270 MW in 2002 from 199 MW in 2001 [2]. This development was brought about by means of a wide variety of promotion strategies and dissemination programs. These initiatives were launched by government institutions, electric utilities and NGOs [1]. In Thailand, household based roof top PV grid connected demonstration projects were initiated in 1997 with subsidy from the National Energy Policy Office (NEPO- now Energy Policy and Planning Office) with the objective to promote activities towards self-generated and clean electricity, and to contribute to the growth of domestic

result. The data were screened for obvious errors and mismatch. Some recorded data were unrealistic and those data were neglected before proceeding further [5].

4. Results and Discussion

The final yield (energy output per kW$_p$ from inverter) from the amorphous silicon system is always higher than the single crystalline solar cells except December 1998.In

PV cell manufacturers [3]. In the first phase, ten residential homes project (total capacity 23.76 kWp), city halls and government offices project (total capacity 25.20 kWp) and royal development study centers project (total capacity 14.7 kWp) were initiated [4]. In the second phase (initiated in 2003), 50 households are to be provided with grid connected PV systems within Bangkok city and other provinces (capacity 3.15 kW$_p$ each).
This paper presents the results of a study on the performance of two different PV grid based systems installed in households at Bangkok during the first phase program of roof top grid connected PV system.

2. System Description

During the first phase among the ten systems installed at Bangkok of which eight are of 2.25 kW$_p$ (single crystalline) capacity each and the others two systems are of 2.88 kW$_p$ capacity each and the PV cells used were amorphous silicon. Amorphous silicon system has 45 modules and they are arranged in four arrays (eleven modules in three arrays and twelve modules in another array). The total area of the panel is 45.5 m^2 and four arrays are connected in parallel to provide 2.88 kW$_p$. The modules used are UNI-SOLAR/US-64. Single crystalline system has 30 modules and they are arranged in two arrays (15 modules in each array). The total area of the panels is 19 m^2. Two arrays are connected in parallel to provide 2.25 kW$_p$. The modules used are Siemens SP75. The current controlled voltage fed inverter is used in the all systems and its capacity is 5kW.

3. Data Collection

For the study of household systems: solar radiation, ambient temperature, module temperature, output from the PV arrays and the inverter were measured every second and averaged for an hour. The data were collected from 7AM to 6PM daily for a period of thirteen months (May 1998- May 1999). However, the analysis has been presented from June 1998 to May 1999 to make the annual

December 1998, the amorphous system was stopped for one week and results lower final yield. Figure 1 shows the trend of the final yield over a year in two different systems. In amorphous system, the final yield varies from 129 kWh/kW$_p$/month to 61 kWh/kW$_p$/month and for single crystalline system, it varies 92 kWh/kW$_p$/month to 68 kWh/kW$_p$/month. The annual final yield of the amorphous

system is 1166 kWh/kW_p and single crystalline is 960 kWh/kW_p.

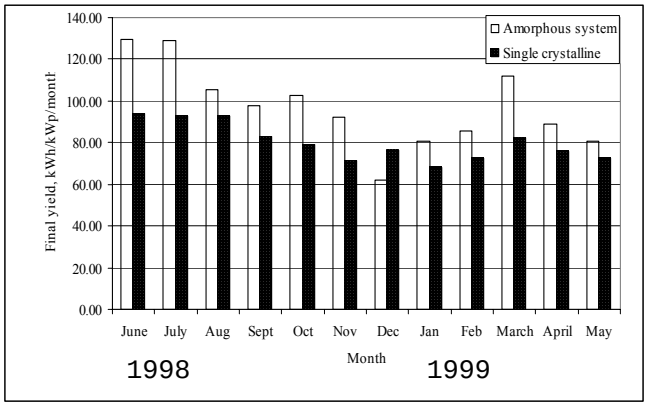

Figure 1: Monthly final yield trend over a year of the two systems.

The average module efficiency (ratio of the PV array output to the solar radiation falling on the plane of PV arrays) of single crystalline varies from 7.1 to 10.1% where as in the case of amorphous silicon it varies from 4.9 to 6.7%. The system efficiency (ratio of the output energy from the inverter to the available solar energy falling on the PV arrays) of single crystalline system is always higher than the amorphous system. This is basically due to the higher module efficiency used in the system. The system efficiency varies from 5.96 to 7.66% (in case of single crystalline) and 4.01 to 5.52% (in case of amorphous). The inverter efficiency (ratio between the daily active energy at the output of the inverter to the daily input of the inverter) ranges from 75 to 89 % in case of single crystalline whereas it remains always higher than 80% (82 – 90%) in the case of amorphous system. Performance ratio (PR) defined as the ratio of final yield to the reference yield. PR of the amorphous system is always higher than the single crystalline system except in the month December. In December this was due to the malfunction of the amorphous system for a week. The annual average PR in case of the basis of rated or measured power. In this study, the PR is calculated on the basis of the power rated by the manufacturer. amorphous system is 0.73 and single crystalline system is 0.58. The value of PR depends on whether it is estimated on

5. Conclusion

The performance parameters of the systems of capacity 2.88 kW_p and 2.25 kW_p are estimated. The annual final yield is higher (1166 kWh/kW_p) in case of amorphous than that of single crystalline (960 kWh/kW_p). No problems were noticed in single crystalline system during the study period. However, the amorphous system was stopped for one week in December due to the failure of the inverter. The average PRs are 0.58 (single crystalline) and 0.73 (amorphous silicon).

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