Available online at www.sciencedirect.com

ScienceDirect

Energy Procedia 90 (2016) 191 – 199

Energy Procedia

5th International Conference on Advances in Energy Research, ICAER 2015, 15-17 December 2015, Mumbai, India

Design and feasibility studies of a small scale Grid Connected Solar PV Power Plant

Ratan Mandal[a*], Srinjoy Panja[b]

[a]*Faculty, School of Energy Studies, Jadavpur University, Kolkata – 700032.*

[b]*Post Graduate Student, School of Energy Studies, Jadavpur University, Kolkata – 700032.*

Abstract

The depletion of fossil fuel resources on a worldwide basis has necessitated an urgent search for alternative energy sources to meet up the present day demands. Solar energy is clean, inexhaustible and environment-friendly potential resource among renewable energy options. But neither a standalone solar photovoltaic system nor a wind energy system can provide a continuous supply of energy due to seasonal and periodic variations. Therefore, in order to satisfy the load demand, grid connected energy systems are now becomes promising options that combine solar and conventional energy systems to meet the future energy demand at reduces consumption of fossil fuels. In the present work it is tried to develop a small scale grid connected solar photovoltaic (SPV) system. The details of the grid connected solar photovoltaic system are studied first. Here, in this present work 1 kWp SPV system is considered for system design. Then it is installed on the roof top of our School of Energy Studies Building and successfully connected with the grid. We find that the system is feeding power to the grid successfully. From the performance analysis of the system we found that the power feeding to the grid maximum 814 W at the radiation of around 1003 W/m^2 and the overall system efficiencies are varying from 12.3% to 18.42% at different level of solar intensity. We also found the average energy generation from the present system is around 3 – 4 kWh/day in the last rainy seasons. These results are the evidence of reliability and feasibility of the present system. And it will help to reduce the electricity bill for the consumers who have maximum consumption in day hours i.e. School, College, Office, Commercial buildings, Shops etc. To best of our Knowledge this is the first time such type of small scale grid connected solar photo voltaic (SPV) system was reported.

Peer-review under responsibility of the organizing committee of ICAER 2015

Keywords: SPV system; Grid connected inverter; Synchronization; Frequency; etc.

* Corresponding author. Tel.: +91-9474608241
E-mail address: ratan_mandal99@yahoo.co.in

Peer-review under responsibility of the organizing committee of ICAER 2015
doi:10.1016/j.egypro.2016.11.185

1. Introduction

Energy plays a pivotal role in our daily activities. The degree of development and civilization of a country is measured by the amount of utilization of energy by human beings. Energy demand is increasing day by day due to increase in population, urbanization and industrialization. The world's fossil fuel supply viz. coal, petroleum and natural gas will thus be depleted in a few hundred years. The rate of energy consumption increasing, supply is depleting resulting in inflation and energy shortage. This is called energy crisis. Hence alternative or renewable sources of energy have to be developed to meet future energy requirement. In one minute, the sun may provide enough energy to supply the world's energy needs for one year. In one day, it provides more energy than the world's population could consume in 27years. The energy is free and the supply is unlimited. All we need to do is find a way to use it. The largest solar electric generating plant in the world produces a maximum of 354 Megawatts (MW) of electricity and is located at Kramer Junction, California. Since India has abundant sources of RE especially sunlight, it can cater to all the energy needs of the country. The country receives an average radiation of 5 kWh per square meter (m) per day and with 2300 to 3200 sunshine hours per year. The potential of solar photovoltaic has therefore been estimated at 20 MW per square km [1]. Grid interconnection of photovoltaic (PV) power generation system has the advantage of more effective utilization of generated power. However, the technical requirements from both the utility power system grid side and the PV system side need to be satisfied to ensure the safety of the PV installer and the reliability of the utility grid. Clarifying the technical requirements for grid interconnection and solving the problems are therefore very important issues for widespread application of PV systems. Grid interconnection of PV systems is accomplished through the inverter, which convert DC power generated from PV modules to AC power used for ordinary power supply for electrical equipment's [2].Studies from various research paper we understood that there may be some drawback in PV industry like failure of power generation in cloudy weather, high capital cost, lack of solar cell materials, complex module manufacturing process, a number components required, higher tariff, larger loss, proper architectural design etc. Output of the inverter does not give 100% sinusoidal wave; it creates harmonics in the output voltage and current wave [3].

Now Government of India has set a renewable energy capacity addition target of 29.8 GW for the twelfth TYP, taking the total renewable capacity to almost 55 GW by the end of TY17. This includes 15 GW from wind, 10 GW from solar and 2.7 GW from biomass and 2.1 GW from small hydro. Investment in renewable energy is expected to almost quadruple to Indian Rupee (INR) 3,186 billion in the 12th Ten Year Plan (TYP) from INR892 billion in the 11th TYP, implying average annual investments of nearly INR600 billion [1]. To achieve this target apart from large scale SPV power plant, the small scale grid connected SPV by individuals may add a great potential to the conventional grid system. Keeping mind the need and present problem associated with the grid connected SPV system; we have designed a small scale (1KW) grid connected SPV system. Now it is installed on the roof top of our School of Energy Studies Building and successfully connected with the grid. The design methodologies for the same and its feasibility study by performance analysis are described here.

Nomenclature

A	ampere
ac	alternating current
dc	direct current
GW	gigawatt
INR	Indian Rupee
JNNSM	Jawaharlal Nehru Solar Mission
kW	kilowatt
kWh	kilowatt hour
kWp	kilowatt peak
MW	megawatt
RE	renewable energy
sq. ft.	square foot