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Performance Analysis of Monocrystalline, Polycrystalline and Thin Film Type PV Module Technologies

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ABSTRACT: Photovoltaic PV, system is a green power source, which can convert sunlight to electricity. It requires no fuel, produces no emissions, and involves no moving parts. There are two modes of PV system operation. Stand-alone PV system with battery storage and PV system connected to electric utility, EU with or without battery storage.

I. INTRODUCTION

Harnessing the solar energy for the use of mankind is gaining momentum these days. As the decentralized power sources, Solar Photovoltaic (SPV) system is a promising alternative, because of its numerous advantages like modular structure, decreasing cost, government policies, maintenance and pollution freeness etc. Application of SPV systems has great potential to meet energy needs in a cost effective way by using an optimal design strategy. In order to generate the power from SPV sources continuously, there is also need for backup systems such as battery storage.

Photovoltaic (PV) system installation is playing significant role all over world because of the fact that PV system is clean, environment affable, and secure source of energy. Nevertheless, the negative aspect of PV system is the elevated investment expenditure to match up to the conventional sources of energy. Presently, various research works are being carried out centring on optimization of PV systems so that the number of optimal number PV modules, optimal capability of storage battery, optimal capability of inverter, and optimal PV array tilt angle can be obtained. To assist the determination of optimal sizing of PV systems, user-friendly software tools are required [1]. A few of the softwares which are developed for optimal design of PV systems can be found in [2–5]. In [2], a software tool named "PHOTOV-III" has been developed to determine the number of PV modules and capacity of battery based on load demand for optimal sizing of PV systems in Greece. In the optimization procedure, the number of PV modules is initially fixed while the battery capacity value is kept changing based on load demand until zero load rejection. After that, the number of PV modules is increased, and the simulation is repeated. During each simulation, PV sizing curves are generated at zero load rejection condition. However, this software only generates the sizing curves without calculating the actual sizes of the PV system, and it does not take into account the optimal inverter size and PV module tilt angle. In [3], a software program has been developed in the FORTRAN language for calculating the minimum PV array area based on a welldefined weather profile and the minimum number of storage days for the purpose of optimal sizing of PV systems. The limitation of the program is that it is not user friendly and it does not calculate the inverter size and the PV module tilt angle. Another PV software tool has been developed to monitor the performance of a small PV system in a remote area [4]. The software is used to monitor PV system but does not calculate optimal size of PV systems. Several commercially available software tools for simulating standalone and hybrid PV systems can be found in [5]. These commercial software tools are named RETScreen, PV F-Chart, SolarDesignTool, INSEL, TRNSYS, NREL etc.

PVSYST is a computer software package for study, sizing, simulation and data analysis of complete PV systems. PVSYST, designed by energy institute of Geneva, which contains all the subprograms for design, optimization and simulation of PV systems, grid connected, isolated and pumping applications.

This work makes use of PVSYST for performing a comparative analysis on PV cells performance for three different PV technologies for actual operating conditions. The result shows significant benefit of using grid connected PV, penetrating the existing network.

II. PVSYST

PVSYST is a computer software package for study, sizing, simulation and data analysis of complete PV systems. PVSYST, designed by energy institute of Geneva, which contains all the subprograms for design, optimization and simulation of PV systems, grid connected, isolated and pumping applications.

The program includes a separate database for about 7200 models of PV modules and 2000 models of inverters.

It is a tool that allows to analyze precisely different configurations and its outcome can be estimated in order to identify best technical and economical solutions and closely compare the performance of different technological alternatives for any explicit PV project [8]. Project design part, performing detailed simulation in hourly values, including an easy to use expert system, which helps user to define PV-field and to select the correct components.

PVSYST also gives assess in to meteorological sources available on internet. Shadow Consideration: Spacing of PV array is also very important after the PV panels are selected and installed at a certain angle

A. Comparison of proposed PV technologies

For proposing a 100kW PV system, we made analysis using PVSYST software tool for three different PV module types chosen, flat PV panels are chosen. After giving required input details, we chose SMA inverter model sunny central 100, 450-820V, 50Hz, 100 kWac

B. Use of single CENTRAL inverter

Compared with multiple inverters a single central inverter is less complex, economic, more efficient, avoids problems due to mismatch and also central inverter is better when working at higher voltages, so that no further amplification is needed like multi inverter. Mismatch is intrinsic in PV modules due to cell dissimilarity but can also be formed by exterior reasons that may affect output of a PV array such as shading. For a judiciously positioned PV array, mismatch is usually considered to lead to 1-3% reduction in dc power

C. Mismatch

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III. RESULTS AND DISCUSSION

Space has no objects that could cause shadows. We want to propose installation of PV panels, and for choice of panels we made a comparative study of outcomes taking different types of manufacturing technologies. Specifications of panels and inverter are chosen from those available in library of PVSYST.

Table 1. shows that using thin film PV will give highest Performance Ratio (PR) and highest produced energy per year. In comparing PV generation technologies conversion efficiency is the most important parameter to be determined, Array efficiency and system efficiency of poly and mono crystalline are comparable, whereas that of thin film is much lower. Poly Si requires minimum number of modules and minimum area. So it is suggested to go for poly crystalline technology.

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Here PV modules chosen are BP Solar Si poly model 4165N, SunTech Solar Si mono XTP 165-34, NexPower a.Si:H NH100AT 5A.

Table 1. Simulation results.

System summery	Poly Si	Mono Si	Thin film
No. of modules	608	612	960
Module area(m^2)	765	784	1512
No. of inverters	01	01	01
Nominal PV power(kW_p)	100	101	101
Max PV power(kWdc)	93.8	96.9	104
Array loss%at STC	15.3	16.8	9.1
System losses%T STC	13.6	13.8	15.1
Mismatch loss(%at mpp)	2.1	2	1
No. of modules in series	19	18	16
No. of parallel strings	32	34	60
Performance ratio%	69.7	70	75.8
Produced energy(MWh/year)	142.6	144	156
Array efficiency	10.54	10.42	5.91
System efficiency	9.14	9.02	5.05

IV. CONCLUSION & FUTURE SCOPE

Photovoltaic energy sources with their complete related limitations are found to be one of the most hopeful solutions for the energy demand of the forthcoming years. Latest initiatives by Indian government for promotion of instalments and proposals of solar PV power and favourable climatic conditions of India. It provides a substantial reason for proposing installation of solar PV systems.

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