Abstract

The suitability of photovoltaic (PV) technology for a particular site depends on five major factors like annual solar insolation distribution, efficiency of PV module with intensity, annual ambient temperature profile and module temperature coefficients, solar spectrum distribution and power degradation of PV modules with time. In this study, NASA satellite data have used for solar insolation analysis and India is divided into 12 climatic zones on the basis of temperature variations and annual average insolation. The output of PV module provided by manufacturer is rated at standard test condition (STC). The actual output from the module in the field varies from its rated output due to change in environmental parameters from the STC conditions. The loss of power due to temperature is determined by temperature co-efficient which varies with different types of solar cell technologies. In this study temperature co-efficient of different types of commercially available solar modules are evaluated. The testing has been carried out at PV test facility of Solar Energy Centre, New Delhi. Mono-crystalline, multi-crystalline, amorphous silicon and CdTe based solar modules are tested for temperature co-efficient evaluation. The modules are selected randomly from various manufactures. It is found that the average temperature co-efficient of power for mono-crystalline, multi-crystalline and CdTe based modules are -0.446 %/°C, -0.387 %/°C and -0.172 %/°C respectively. In case of amorphous silicon module, only one sample is measured and the temperature coefficient is -0.234 %/°C. The temperature co-efficient and Nominal Operating Cell Temperature (NOCT) data for different cell technology shows the variation in energy output is 7.74% with reference to 25°C ambient temperature.

The energy output from a 1 kW plant of different technologies (mono crystalline, multi crystalline, amorphous silicon and CdTe) in different climatic zones has been calculated. It is found that the CdTe based solar module provides better performance in almost all climatic zones of India except very low temperature zones (temperature below 0°C) irrespective of insolation. In this study, the calculated energy output is compared with the 19 field installation (amorphous silicon module) output. It is found that 48 % places the actual energy output is within the range of prediction. However, 42% places the energy output varies in the range of ±7.8%, and in rest 10% places the variation is higher. The predicted energy output is higher by 8.55% than the actual energy output (multi-crystalline) at SEC outdoor test bed. It is found from the analysis that the performance of CdTe modules is better than mono crystalline or multi crystalline modules at lower irradiance. This study provides an understanding on the variation in energy generation in various climatic zones and concludes which type of PV technology is suitable for a particular climatic zone for optimum energy output.