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ABSTRACT

The development of renewable energy sources (RES) is necessary for the sustainable development of any country due to depleting fossil fuel level, climbing fossil fuel prices across the world and more recently pressure for reduction CO_2 emission level. Among various renewable energy sources based technologies, the photovoltaic technology for power generation is considered well-suited technology particularly for distributed power generation

Solar irradiance data is a prerequisite for the designing and sizing of solar energy systems and site selection of solar power plants. Unfortunately it is not available for most of the Indian locations. Therefore regression models have been developed in this work with one or more of the following metrological parameter: such as mean sunshine duration per hour, temperature, relative humidity, wind speed and rainfall. The performance of the model is determined on the basis of statistical indicators like correlation coefficient(r), coefficient of determination (R^2), root mean square error (RMSE), mean percentage error (MPE), and mean bias error (MBE). The correlation using five different variables as given above for estimating global solar radiation incident on horizontal surface incorporating all the above mentioned parameters is found accurate and the data can also be used in the design and estimation of performance of solar applications system.

The proposed work also presents a study on a stand-alone photovoltaic system (SPV) to provide the required electricity for a single residential household in India. The complete design of the suggested system is carried out, such that the site radiation data and the electrical load data of a typical household in the considered site are taken into account during the design steps. Also, the life cycle cost (LCC) analysis is conducted to assess the economic viability of the system. It is found that the SPV power generation will be economically comparable to the grid connected power supply in near future in India. Therefore, the results of the study encouraged the use of the SPV systems to electrify the residential households India.

The proposed work also presents a case study on techno-economic comparison of electrifying a remote village with three different energy-supplying options, namely the SPV system, diesel generator sets and an extension of the conventional grid line. The results of the study encourage the use of SPV power based upon various economic indicators like unit cost of electricity, NPV and payback period for remote area electrification as compared with extending the grid connection or using diesel generators because remote area electrification requires long transmission and distribution lines that have heavy initial investments and suffer from huge transmission and distribution losses. Low load factors and low load densities also makes rural electrification economically unattractive.

The appropriate location of distributed generation (DG) is very important for loss reduction in radial distribution systems. The proposed work presents two different methodologies for optimal location and sizing of SPV based DG system in radial distribution systems based on fuzzy expert system (FES) approach and heuristic search based approach, so that the electrical power losses in the system can be minimized while maintaining the voltage profile in the system within the specified limits. Voltage along with active power loss reduction index of each node is fed into FES whose output is DG placement suitability. DG is then placed at the node with the highest suitability provided voltage constraints are not violated. In heuristic approach, a critical node, called sensitive node is selected based upon maximum power losses caused for installing DG system. Test results have been tested on IEEE-33 bus system and presented and it is concluded that FES based approach is better than heuristic based approach.

In the light of the above, this work proposes the promotion of SPV power as decentralized power units for rural remote places as the most cost-effective solution. The SPV system electric power is of particular value because it coincides with the peak demand specially during the summer afternoon. In addition to this, SPV systems can also increase the reliability of the system to which they are connected, can also reduce transmission and distribution losses as they generate the electricity close to the point where it is consumed. The large introduction of SPV systems may replace or postpone the extension of conventional central stations of electricity production and the investment in grid reinforcement having a positive overall economic impact. This would also result in accelerating the overall development of the under developed areas with a number of programmes like providing electricity, entrepreneurship development and employment generation opportunities.