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ABSTRACT

Over the past few decades, the demand for renewable energy is monotonically increasing and still continuing to grow exponentially across the world. Due to decrement in non-renewable energy resources (coal, water, nuclear etc.), renewable energies (solar, wind, biomass etc.) can be seen as a best alternative source of energy. Among those sources of energy, solar energy is widely accepted, as it is hazard & pollution free, abundant in nature etc. Developing countries like India require a huge amount of energy for sustainable development. For harnessing the solar energy, the government launches a variety of scheme like Jawaharlal Nehru National Solar Mission (JNNSM) in 2010 to fulfil India's clean energy dreams.

In spite of having these figures of merit, it creates a big challenge to analyse and quantification of the performance of solar photovoltaic (SPV) systems. A typical SPV system comprises many vulnerable components such as PV module, inverter, battery, charge controller, cable etc., whose performance depends on loads and environmental conditions. Reliability assessment methods can be generally utilized to gauge the performance of SPV system. The main aim of these methods is to find out the critical components, which are responsible for performance degradation, so that corrective maintenance measure can be taken to improve the overall effectiveness of the system. The SPV power system can be large with a complex network. For such cases, reliability evaluation of the entire power system becomes complicated. Hence, to analyse the reliability of the SPV system, it is divided into their subsystem. This thesis focuses on reliability analysis of solar photovoltaic (SPV) power system. For reliability analysis of the system, a quantitative and qualitative analysis approach is used. Two main methods are currently implemented: Failure Modes Effects and Critical Analysis (FMECA) and Fault Tree Analysis (FTA).

Failure mode effect and criticality analysis (FMECA) can gauge the possible failure modes, in order to rank the critical failure modes of the system. Ranking of all failure modes associated with the SPV system is done on the basis of fuzzy RPN, which is calculated by weighted Euclidean distance formula and centroid defuzzification method.

Fault tree analysis (FTA) is an another powerful reliability assessment method, which is based on deductive logic (bottom–up), by considering all basic events, leads to the occurrence of a Top event. Thus, Conventional FTA integrated with fuzzy linguistic scale is introduced to rectify drawback, mentioned above, in which failure possibilities in term of a linguistic variable of unknown failure data for all basic events of the SPV system are assigned. For Aggregated fuzzy number, a consistency agreement method is introduced. Ranking of all basic events is done on the basis of Fussell-Vesely (F-V) importance measure, which is performed to apportion the most critical basic event.

Another way to make the system reliable by allocating failure rate to each component of the system, in order to achieve the decided reliability goals, reliability allocation method is introduced.

Evaluation of reliability indicators in terms of performance indicator for solar photovoltaic power systems is done here, which is another important aspect to assess the reliability of SPV power systems.

The main aim of reliability analysis of the SPV system is to find out the critical components, which are responsible for performance degradation, so that corrective maintenance measure can be taken to improve the overall effectiveness of the system.