Optimum design of a standalone photovoltaic system based on integration of iterative-PESA-II and AHP-VICKOR methods

ABSTRACT

Solar energy is considered one of the most important renewable energy resources, and can be used to power a stand-alone photovoltaic (SAPV) system for supplying electricity in a remote area. However, inconstancy and unpredictable amounts of solar radiation are considered major obstacles in designing SAPV systems. Therefore, an accurate sizing method is necessary to apply in order to find an optimal configuration and fulfil the required load demand. In this study, a novel hybrid sizing approach was developed on the basis of techno-economic objectives to optimally size the SAPV system. The proposed hybrid method consisted of an intuitive method to estimate initial numbers of PV modules and storage battery, an iterative approach to accurately generate a set of wide ranges of optimal configurations, and a Pareto envelope-based selection algorithm (PESA-II) to reduce large configuration by efficacy obtaining a set of Pareto front (PF) solutions. Subsequently, the optimal configurations were ranked by using an integrated analytic hierarchy process (AHP) and vlsekeriterijumskaoptimizacija i kompromisonoresenje (VIKOR). The techno-economic objectives were loss of load probability, life cycle cost, and levelized cost of energy. The performance analysis results demonstrated that the lead–acid battery was reliable and more cost-effective than the other types of storage battery.

Keyword: Standalone PV system; Optimal sizing; Numerical method; PESA-II; AHP; Storage battery