Abstract

This research work is proposed to study the effects of different electrical components in enhancing the sustainability of electric distribution networks (DNs) based on technical, economic, and environmental benefits. It explores the impact of optimal allocation of different combinations of photovoltaic (PV) and wind distributed generator (DGs) on the sustainability of different standard IEEE bus networks/ practical test networks. The potential effects of battery energy storage systems (BESS) and Static Var Compensators (SVCs) in maximizing the sustainability indices of the DNs are elaborately explained in this work. The role of different electric vehicles (EVs) in enhancing the sustainability indices of the network with different penetration levels are analyzed and illustrated. The uncertainty associated with PV and wind power generation due to intermittent nature of wind, solar irradiation and their effects on the system parameters are explored. This work also provides an estimation of the optimal number of PV modules required for DG installation considering seasonal variations. A detailed analysis of the impact of a demand response (DR) program on the load-curtailment/shifting patterns and network performance indices is performed. The process of determining the optimal locations, capacities, and number of multiple DGs/BESS/SVCs/EV charging stations in different DNs with different optimization techniques to minimize the active power losses and enhance the sustainability indices of the network are investigated and presented. Statistical analyses of the performance parameters of different evolutionary computational algorithms considered in this work are provided for different case-studies.