

A techno-economic centric integrated decision-making planning approach for optimal assets placement in meshed distribution network across the load growth

Abstract

The modern distribution networks under the smart grid paradigm have been considered both interconnected and reliable. In grid modernization concepts, the optimal asset optimization across a certain planning horizon is of core importance. Modern planning problems are more inclined towards a feasible solution amongst conflicting criteria. In this paper, an integrated decision-making planning (IDMP) approach is proposed. The proposed methodology includes voltage stability assessment indices linked with loss minimization condition-based approach, and is integrated with different multi-criteria decision-making methodologies (MCDM), followed by unanimous decision making (UDM). The proposed IDMP approach aims at optimal assets sitting and sizing in a meshed distribution network to find a trade-off solution with various asset types across normal and load growth horizons. An initial evaluation is carried out with assets such as distributed generation (DG), photovoltaic (PV)-based renewable DG, and distributed static compensator (D-STATCOM) units. The solutions for various cases of asset optimization and respective alternatives focusing on technical only, economic only, and techno-economic objectives across the planning horizon have been evaluated. Later, various prominent MCDM methodologies are applied to find a trade-off solution across different cases and scenarios of assets optimization. Finally, UDM is applied to find trade-off solutions amongst various MCDM methodologies across normal and load growth levels. The proposed approach is carried out across a 33-bus meshed configured distribution network. Findings from the proposed IDMP approach are compared with available works reported in the literature. The numerical results achieved have validated the effectiveness of the proposed planning approach in terms of better performance and an effective trade-off solution across various asset types.

Keywords

Distributed generation; Distributed static compensator; Distribution network; Distribution network planning; Losses minimizations; Mesh distribution network; Multi-criteria decision making; Unanimous decision making; Voltage stability assessment index