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A modified and extended genetic algorithm for optimal distributed generation grid-integration solutions in direct current power grids

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Abstract-

The integration of distributed generation into direct current power grids presents a critical challenge in modern energy systems, as it directly impacts grid reliability, efficiency, and the successful transition to renewable energy. This study addresses the problem of optimizing distributed generation placement and sizing in direct current grids, a key issue for reducing power losses and improving energy distribution. To tackle this, a modified and extended genetic algorithm was developed, capable of handling both continuous and discrete variables simultaneously. The algorithm was tested on two standard direct current grid systems, a 21-bus microgrid and a 69-bus network. The results demonstrated significant improvements over existing methods, reducing power losses by 84.5% in the 21-bus microgrid and by 95% in the 69-bus direct current network, with notably reduced computation times. These findings indicate that the proposed algorithm not only optimizes distributed generation integration effectively but also offers superior performance compared to traditional approaches, without the need for additional methods or software. The novelty of this work lies in its ability to handle complex, nonlinear optimization problems within direct current grids using a single, efficient approach, advancing beyond previous efforts by achieving better results with fewer computational resources.

Index Terms- Direct current grids; Genetic algorithms; Meta-heuristic optimization methods; Mixed-integer nonlinear programming

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