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Resolving optimal power flow issue on IEEE 57 bus system having renewable energies by MMKE algorithm

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***Abstract*—In the current paper, optimal power flow (OPF) issue has been addressed using Multi-trial vector based monkey king evolution (MMKE). The test system is standard IEEE 57 bus network where renewable energy sources (RESs) like wind power (WP), solar photovoltaic power (PV) and plugin electric vehicle (PEV) are being incorporated with traditional units. Objective of the study includes minimization of overall generation cost and emission. To deal with stochastic RESs, appropriate probability density functions (PDF) are utilized. The test results are contrasted with contemporary study. One way ANOVA has been conducted on the sample results to statistically validate the superior performance of MMKE.**

***Index Terms*—OPF, MMKE, RESs, ANOVA.**

I. Introduction

Optimal Power Flow (OPF) optimizes the operation of power systems by minimizing costs, losses, or emissions while maintaining grid reliability. It ensures power balance and adheres to constraints like generator limits, voltage stability, and transmission capacity. OPF optimizes renewable energy use by prioritizing cleaner sources and reducing reliance on fossil fuels. It ensures grid stability despite variability, minimizes costs, and lowers emissions. OPF supports flexible, efficient, and sustainable power systems. OPF struggles with integrating intermittent renewable energy sources due to uncertainty in power output, potentially impacting grid stability and security.

This study [1] introduced a hybrid progressive particle swarm optimization and gravitational search algorithm for optimal power flow with wind and solar generators, validated on the IEEE 30-bus system and compared to 20 other methods. In this article [2] the applied method was the sunflower optimization algorithm to optimize OPF with and without distributed generation, outperforming the genetic algorithm on IEEE 14-bus and 30-bus networks. Conic optimization [3]enables efficient and reliable power system functioning and highlights key advantages. The work in [4], used graph neural networks to efficiently approximate OPF solutions, addressing non-convexity challenges in power grids. This work [5] introduced a machine learning method to optimize real-time grid operations by learning efficient OPF solutions, cutting down computational costs. This research [6] used machine learning for OPF, predicting optimal generator settings and active constraints, validated on two benchmark grids. In the paper [7] , a deep learning-based algorithm using a deep belief network to optimize transient stability and control costs in power systems. Pullaguram et al. [8] presented a small-signal stability-constrained optimal power flow for microgrids, using convex relaxation to solve stability constraints efficiently in real time. The artical [9]presented an adaptive constraint differential evolution algorithm for OPF, improving cost, emission, power losses, and voltage deviation in power systems. This paper [10]reviewed recent metaheuristic optimization techniques for solving the nonlinear OPF problem, including human-, evolutionary-, and physics-inspired algorithms. It reviewed [11] on emphasizes integrating detailed OPF constraints into distributed energy systems (DES) models for improved accuracy and recommends further research on high-fidelity DES-OPF models. It [12] based on a hybrid deep reinforcement learning method for fast, secure SCOPF solutions, combining primal-dual deep deterministic policy gradient and KKT conditions to satisfy power system security constraints. In this paper [13], reviewed the impact of distributed generators on OPF, exploring optimization techniques and future research for efficient power systems. The authors in [14] proposed an -constrained adaptive differential evolution algorithm for OPF, showing improvements over state-of-the-art methods in multiple test cases. Zadehbagheri et al. [15] optimized TCSC location and capacity in transmission networks to reduce