Using the quasi-oppositional artificial hummingbird algorithm, a probabilistic optimal power flow for an integrated renewable power system comprising wind and solar

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Abstract:
Optimal Power Flow (OPF) is crucial for efficient and sustainable power system management, aiming to minimize operational costs and emissions while meeting system constraints. This paper introduces the artificial hummingbird algorithm (AHA) to solve the OPF problem, enhanced with Quasi-Oppositional Based Learning (QOBL) for improved convergence and solution accuracy. The proposed QOAHA is validated on the IEEE 57-bus system, demonstrating superior performance compared to existing optimization techniques in cost and emission reduction. By combining the exploration capability of AHA with QOBL's accelerated search, the algorithm achieves robust and efficient results. This hybrid approach offers a promising direction for addressing complex power system challenges.

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I. Introduction

Wind and solar energy are emerging as major sources of electricity as the globe transitions to cleaner, more

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***Index Terms*—probabilistic optimal power flow (POPF), trans-**

posing significant issues for power system operators presented in [1].

The optimal power flow (OPF) is a critical tool used by power system operators to optimize electricity generation and distribution. OPF models enforce technical restrictions, such as transmission capacity, voltage limits, and generation bounds, to minimize operating costs while maintaining system reliability. Traditional OPF models, as presented in [2], assume that conventional power plants produce electricity in a steady and predictable manner. However, integrating renewable energy sources, such as wind and solar, introduces substantial challenges due to their intermittent and variable nature, reducing