Calculation of Available Transfer Capability using Hybrid Chaotic Selfish Herd Optimizer and 24 Hours RES-thermal Scheduling

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Abstract: As fossil fuel stocks are being depleted, alternative sources of energy must be explored. Consequently, traditional thermal power plants must coexist with renewable resources, such as wind, solar, and hydro units, and all-day planning and operation techniques are necessary to safeguard nature while meeting the current demand. The fundamental components of contemporary power systems are the simultaneous decrease in generation costs and increase in the available transfer capacity (ATC) of current systems. Thermal units are linked to sources of renewable energy such as hydro, wind, and solar power, and are set up to run for 24 h. By contrast, new research reports that various chaotic maps are merged with various existing optimization methodologies to obtain better results than those without the inclusion of chaos. Chaos seems to increase the performance and convergence properties of existing optimization approaches. In this study, selfish animal tendencies, mathematically represented as selfish herd optimizers, were hybridized with chaotic phenomena and used to improve ATC and/or reduce generation costs, creating a multi-objective optimization problem. To evaluate the performance of the proposed hybridized optimization technique, an optimal power flow-based ATC was enforced under various hydro-thermal-solar-wind conditions, that is, the renewable energy source-thermal scheduling concept, on IEEE 9-bus, IEEE 39-bus, and Indian Northern Region Power Grid 246-bus test systems. The findings show that the proposed technique outperforms existing well-established optimization strategies.

Keywords: Available transfer capability (ATC), biogeography-based optimization (BBO), chaotic map, chaotic selfish herd optimizer (CSHO), grey wolf optimizer (GWO), optimum power flow (OPF), power generation cost (PGC), renewable energy sources (RES), selfish herd optimizer (SHO)

1 Introduction

According to the North American Electric Reliability Council (NERC), the definition of "available transfer capability" (ATC) is the amount of additional power that can be moved over the lines that are already in place without infringing on the power systems' limits. The hourly and daily ATC data must be openly accessible as per the guidelines of the Federal Energy Regulatory Commission (FERC). Presently, the complexity of power systems is very high because the modern frameworks and distributed generators (DGs) are connected to the grid.

The system operator must provide ATC in an open-access, publicly assessable domain on an hourly and daily basis [1]. According to the World Bank and Central Electricity Authority (CEA) India [2-3], the world's power demand is increasing rapidly. Constructing a new transmission line for highly populated countries such as India and China is almost impossible. An ATC assessment provides appropriate information to ensure that these types of power transactions continue to take place over the current transmission lines without infringing on the limits of the power system [1, 4-5].

Therefore, the real-time calculation of ATC always adds an extra burden to the optimization process. The benefit of real-time ATC assessment is that assessment occurs during the actual operation of power networks

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