International Journal of Power and Energy Systems, Vol. 42, No. 10, 2022
An Open Access Paper

MULTI-OBJECTIVE CHAOTIC MAYFLY OPTIMIZATION FOR SOLAR-WIND-HYDROTHERMAL SCHEDULING BASED ON ATC PROBLEM

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Abstract

The electrical power generation from conventional thermal power plants needs to be interconnected with natural resources like solar, wind, hydro units with all-day planning and operation strategies to save mother nature and meet the current electricity demand. The complexity and size of the power network are increasing rapidly day by day. The enhanced power transfer from one section to another section in the existing grid system is the subject of available transfer capability (ATC), which is the modern power system's critical factor. In this paper, the minimization of power generation cost of the thermal power units is achieved by incorporating renewable sources, says hydro, winds, and solar plants for 24 h scheduled, and ATC calculation is the prime objective. In recent literature, the Mayfly algorithm (MA) optimization approach, which combines the advantages of evolutionary algorithms and swarms intelligence to attend better results, is successfully implemented. In this article, optimum power flow-based ATC is enforced under various conditions with hydro-thermal-solar-wind scheduling concept on the IEEE 9 test bus system to check the performance of the proposed chaotic MA. The chaotic MA is a hybridized format of the MA and chaotic map (CHMA) method. It is noted from the simulation study that the suggested CHMA approach has a dominant nature over other well-established optimization algorithms. In case of single objective function, the value of the cost function is improved by 14% and that of for multi-objective, it is improved by more than 20% and ATC value is enhanced by near about 55% and more.

Key Words

Available transfer capability (ATC), chaotic Mayfly algorithm (CHMA), hydro-thermal-solar-wind scheduling (HTSW), Mayfly algorithm (MA), optimum power flow (OPF), and particle swarm optimization (PSO)

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Recommended by Prof. Ikhlaq Hussain
(DOI: 10.2316/J.2022.203-0382)

1. Introduction

In the present era, to save mother nature and reduce the thermal power plant's generation cost, natural resources are involved. In this paper, solar, hydro, and wind power plants are incorporated with conventional thermal units to achieve the goal. The authors have also done 24 h load scheduling and proper coordination of all the said natural resources with thermal units to match the load demand. The North American Electric Reliability Council (NAERC) defines available transfer capability (ATC) as the amount of extra transportable power through the existing transmission system without violating power system constraints. As per the guideline of Federal Energy Regulatory Commission (FERC), the basic ATC data must be available on an hourly basis in an open−access market. The distribution generations (DGs) add up to the complexity of the modern power system framework. It is to enhance the capacity of transferring electrical power in the existing network for future transaction to deal with contingencies and uncertainties of the power system [1]. In the present era, with the rising economy, power transfers have been enhancing at a much higher rate than transmission capacity, which abbreviated reliability and system security. ATC assessment is the window to provide adequate knowledge in advance on these types of power transactions through the existing electrical power network without violating the power system constraints [1]–[3].

Estimating any parameter in real-time adds an extra huddle to its evaluation process like ATC calculation. This real-time ATC evaluation gives ample benefits in financial and engineering aspects as follows:

1. If the ATC knowledge is known in advance, more operating windows will be opened for the operator to run the power system in ten times or more power transaction conditions.

from Table 2, in the case of CHMA, the ATC is enhanced by 55.36% compared to PSO. The simulation results reveal the computational efficiency of the proposed CHMA approach.

5. Conclusion

This paper introduces a recent methodology for enhancing ATC and generation of cost optimization incorporating renewable sources, *i.e.*, hydro, solar, and wind [20]. The proposed method, *i.e.,* CHMA method, has been verified by examining its superior convergence characteristics and higher efficiency with other meta-heuristic optimizations. The uncertainties of wind power and load requirement are taken into consideration in this article. The incorporation of solar, wind, and hydro units to the traditional thermal generating units to minimize the overall active power generation cost is another objective of this paper. The results executed by the projected approach are correlated through the results established by the similar heuristic methods, say SCA, PSO, GWO, MA, revealed in the current literature. The efficiency of the proposed method is substantiated by using IEEE 9-bus test system for two different cases. In each case, the proposed method shows that convergence characteristics and computational efficiency of CHMA are superior to that of the other methods. This article handles the problems regarding ATC with hydro-thermal and solar and wind scheduling for 24 h [21], which is the uniqueness of this paper.

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Biographies

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