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RESEARCH ARTICLE

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Implementation of multi-objective chaotic mayfly optimisation for hydro-thermal- solar-wind scheduling based on available transfer capability problem

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Summary

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 minimisation of power generation cost of the thermal power units is achieved by incorporating renewable sources, says hydro, winds, and solar plants for 24 hours scheduled, and ATC calculation is the prime objective. In recent literature, the Mayfly algorithm (MA) optimisation approach, which combines the advantages of evolutionary algorithms and swarms intelligence to attend better results, is successfully implemented. In this article, optimum power flow (OPF) based ATC is enforced under various conditions with hydro-thermal-solar-wind scheduling concept on the IEEE 9, IEEE 39, and IEEE 118 test bus systems to check the performance of the proposed chaotic MA. The chaotic MA is a hybridised format of the MA and chaotic map (C-MAP) method with opposition based learning. It is noted from the simulation study that the suggested hybrid C-MAP approach has a dominant nature over other well-established optimisation algorithms. In case of single objective function, the optimum value of the cost function is better than 13% to its

List of Symbols and Abbreviations: $CH_{1,1t}$, $CH_{2,1t}$, $CH_{3,1t}$, $CH_{4,1t}$, $CH_{5,1t}$, $CH_{6,1t}$, co-efficient of power generations of *1t*th hydro unit; $disq_{i,1t}$, water discharge rate at *1t*th interval for *i*th hydro unit; T_{1ref}, reference temperature; T_{1amb}, ambient temperature; P_{wnd}, wind power; SI_1s, solar radiation; SP_{1solar}, solar power generation; subscript i, *i*th unit; subscript 1t, *t*th interval; Vol, volume of the water; a_s, temperature coefficient; SP_{1solar}, solar power generation; PD_t, power demand at *t*th interval; S_{1tot}, total solar share power; wnd_1R, rated wind power of turbine; $E_{dr,1Z,1T}$, direct cost of wind power; $E_{UN,1Z,1T}$, under estimated cost of wind power; $E_{OVR,1Z,1T}$, over estimated cost of wind power; S_f, S_h, scale and shape factor respectively; g_Z, direct cost coefficient of *z*th unit wind generator; vl, current wind speed; Vl_{out}, Vl_{in}, cut-out and cut-in velocity of wind respectively; Vl_R, rated speed of the wind; cfw, random variable of wind; P_{wnd}, wind power; ATC, available transfer capability; cdf, cumulative density function; cdf, cumulative density function; C-MAP, hybrid chaotic Mayfly algorithm; DGs, distributed/distribution generation; FERC, federal energy regulatory commission; GWO, grey wolf optimizer; HTSW, hydro-thermal-solar-wind; MA, mayfly algorithm; NERC, North American electric reliability council; OASIS, open access same-time information system; OPF, optimal power flow; pdw, probability density function; PHY, hydro power generation; PSO, particle swarm optimization.

