



## OPEN Electric vehicle integrated tidal-solar-wind-hydro-thermal systems for strengthening the microgrid and environment sustainability

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Incorporating electric vehicles (EVs) into the power grid significantly impacts its safe and reliable operation, while the unpredictable nature of wind power adds further complications. Solar power, though less efficient in converting sunlight to electricity compared to wind power, remains a popular renewable energy source. Combining wind and solar energy is advantageous because wind energy can be harnessed both day and night, unlike solar energy. Tidal energy also offers a reliable renewable option, although it has its own set of challenges. Consequently, the utilization of renewable energy sources (RESs) have become increasingly complex. Fossil fuels, on the other hand, are a major cause of severe pollution. This study addresses integration of wind, solar, tidal, and electric vehicles, using a unique moth-flame optimization technique, to solve the challenge of hydrothermal scheduling (HTS). The primary objective is to reduce power generation costs while adhering to various limitations, including transmission losses, thermal unit valve point effects, and RESs variability. In order to maximize energy management, several EVs are currently being built as virtual power plants (VPPs), utilizing sustainable energy sources. So, VPPs and combined renewable energy sources make the micro-grid more rigid. The objective is to minimize fuel expenditures by balancing load demand and transmission losses while satisfying all conditions. By evaluating the generation costs with MFO, this study demonstrates the effectiveness of the method and compares it with other advanced optimization techniques, highlighting its superior efficiency, utility and reliability. When the performance of normal HTS system, RES and EV based HTS system are observed, it is clearly observed that RESs based system has improved the results by 5.49% as compared to the conventional system using the suggested COMFO approach. The findings also show that EVs can effectively contribute to a hydro-thermal scheduling system with integrated renewable energy by using grid power.

**Keywords** Tidal, Wind, Solar, Electric vehicles (EVs), Hydro-thermal scheduling (HTS), Advanced optimization technique

### Abbreviations

AHA	Artificial hummingbird algorithm
CBL	Chaotic based learning
COMFO	Chaotic oppositional moth flame optimization
CQOWOA	Chaotic quasi-oppositional whale optimization algorithm
CSMA	Chaotic slime mould algorithm
CWOA	Chaotic whale optimization algorithm
CO	Cheetah optimization
CRO	Chemical reaction optimization
CSA	Clonal selection algorithm

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