

## ABSTRACT

Grid-connected renewable energy systems have advanced significantly in India recently. The most important renewable energy sources are solar and wind. Maximum power point tracking has a significant impact on the efficiency of PV and wind power systems. In this analysis, fuzzy logic is employed as an MPPT in a PV power system, and its effectiveness is compared to that of incremental conductance MPPT in terms of maximum power tracked, tracking time, and voltage quality. The TSR MPPT for wind energy conversion system with voltage regulation using fuzzy logic controller is compared PI controller and the fuzzy logic controller outperforms the PI controller in the aspects of steady state error, settling time and ripple in the voltage. The scheduling of power sources is critical to energy management and the system's economic benefit. The focus of this research is on the energy management strategies of a grid-connected residential PV-wind generation system with battery storage. Time of Use (TOU) pricing is a cost-reflective electricity tariff method that has proven to be a successful methodology for reducing peak power demand in the domestic sector around the world, particularly in developed countries.

In this research, novel Multitrial vector-based Differential Evolution algorithm (MTDE) is proposed as energy and cost management controller in grid connected residential PV-wind generation system coupled with battery storages. In the optimization, the fitness function is minimising the price of household electrical energy, and the optimisation variable is the dispatching ratio of electrical energy sold to the electrical network and consumed in the household. Using MATLAB, the performance of proposed

MTDE in the aspect of daily cost benefit and revenue growth rate are presented with the comparative analysis of whale optimisation algorithm, gravitational search algorithm and conventional self-made for self-consumed and rest for sale mode-based energy management controller.

In this research, one week's worth of data on PV power, wind power, and load power are analysed for economic benefit under the TOU tariff. The performance of the MTDE method is compared with that of the GSA, WOA, and conventional SFC and RFS mode-based energy management controllers in terms of daily cost benefit. Along with the daily cost benefit, the revenue growth rate of each optimization algorithm in comparison with conventional SFC and RFS modes is also presented to validate the economic benefit of energy and cost management systems. The daily cost benefit of the proposed system is INR 16.898 while it is INR 15.508 by WOA, INR 14.798 by GSA, and INR 12.183 by the SFC & RFS method. MTDE offers an improved cost benefit of 1.39 INR, 2.1 INR, and 4.715 INR compared to the WOA, GSA, and SFC & RFS methods, respectively.

In comparison with the existing SFC & RFS method, the GA analysed in the existing literature offered a revenue growth rate of 17.74%. While the GSA and WOA examined in this research improved it to 21.46% and 27.29%, respectively. The proposed MTDE revenue growth rate in comparison with the existing SFC & RFS method is 38.7% which is greater than both WOA and GSA. Compared with the government-advocated SFC & RFS mode, the proposed MTDE-based strategy can indeed obtain maximum benefits through optimization methodology. This means that the proposed system enhances both energy efficiency and economic benefits for the end user.