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| **Abstract:** |  |
| The growing adoption of rooftop solar photovoltaic (PV) systems, coupled with the ability to sell surplus energy back to the national grid, presents a promising opportunity for residential energy management. This research introduces an innovative Advanced Energy Management System (AEMS) that integrates rooftop solar PV with energy-efficient appliances, offering a transformative approach to optimizing household energy consumption. By leveraging advanced demand-side management (DSM) techniques, the AEMS enables users to strategically shift energy usage away from peak hours, thereby reducing reliance on grid energy and minimizing costs. Empirical evaluations reveal that the AEMS significantly outperforms conventional energy management systems, achieving cost reductions of 28.59–35.48 %. The user-friendly interface and robust optimization strategies of the proposed model ensure operational efficiency, making it a valuable tool for maximizing energy savings and enhancing grid stability. Focusing on the specific context of Bangladesh, this study provides a comprehensive techno-economic analysis, demonstrating the practical applicability and long-term sustainability of suggested AEMS. The findings underscore the potential of the proposed model to revolutionize residential energy management, positioning it as a key enabler of both economic and environmental benefits for prosumers in emerging markets. | |