Abstract

The integration of Renewable Energy Sources (RES) such as solar and wind into hybrid power grids introduces significant variability and uncertainty, which can challenge grid stability and reliability. This research investigates the application of robust optimization techniques to manage these uncertainties in the hybrid power grid network of Bangladesh. Using real-world solar and wind data, we model the fluctuations caused by climatic variations and assess their impact on grid operations. The IEEE 16-bus network is employed as the test system for this analysis. Our methodology includes data collection, reprocessing, and the development of a robust optimization model to minimize worst-case deviations in power supply while ensuring grid stability. The results, presented through comprehensive graphs and tables, demonstrate the effectiveness of the proposed approachin optimizing power dispatch, reducing costs, and enhancing reliability metrics. Comparative analysis reveals that robust optimization outperforms traditional methods, offering superior grid stability and cost-efficiency under uncertain conditions. This study provides a robust framework for managing RES variability in Bangladesh's hybrid power grid, contributing tothe development of resilient and sustainable energy systems