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Abstract This paper proposes a robust optimization framework for the operation of a combined heat and power (CHP)-based microgrid (MG) under renewable energy source (RES) uncertainties, using risk-averse information gap decision theory (RA-IGDT). Unlike traditional uncertainty methods, IGDT facilitates decision-making without requiring probabilistic distributions, making it economically feasible even under RES fluctuations. A novel demand response (DR) model is integrated to optimize load shifting, reducing operational costs and boosting profitability. The MG model includes DER such as wind turbines, solar farms, fuel cells, energy storage, and thermal units. It is evaluated in four scenarios: islanded mode without DR, grid-connected mode without DR, grid-connected mode with DR, and grid-connected mode with RA-IGDT-based uncertainty management. Solar radiation, wind speed, and ambient temperature variations are modeled using Beta, Weibull, and Normal PDFs, respectively. Monte Carlo simulations with 1000 iterations validate the RA-IGDT approach, demonstrating operational resilience and profitability. Results show a 9% profit increase with DR, and RA-IGDT ensures economic feasibility even with a 34.4% RES generation reduction, though profitability decreases by 40% under extreme uncertainty. These findings underscore the practicality and robustness of the proposed MG strategy for real-world applications.

Keywords microgrid, risk averse, information gap decision theory, renewable energies, combined heat and power, energy storage device.

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