A. Heidari, R.C. Bansal and R. Bo, 2026, Applying two-stage risk-based market structures for energy hub-based plug-in electric vehicles using information decision gap theory and a hybrid recurrent convolutional network, *Sustainable Energy, Grids and Networks,* Volume 45, March 2026, 102085.

Abstract This paper investigates the optimal operation of an energy hub engaged in both day-ahead and real-time trading. A two-stage optimization framework Information Gap Decision Theory (IGDT) for day-ahead bidding and stochastic programming with Monte Carlo scenarios for real-time recourse is applied. Risk-neutral, risk-averse, and risk-taking strategies are considered to capture different risk preferences. The hub integrates combined heat and power, renewable energy, plug-in electric vehicles, and vehicle-to-grid and grid-to-vehicle technologies. Price and load forecasts are generated using a hybrid recurrent convolutional network (HRCN). Results highlight the trade-off between risk management and economic performance: costs are 16.5% higher in the risk-averse mode than in the risk-neutral mode, and 55.6% higher than in the risk-taking mode. Natural gas accounts for the most in the risk-taking case, at $\sim$33% of the total cost. Under the tested conditions, the proposed IGDT–stochastic–HRCN framework improves expected costs relative to baselines, though outcomes may vary under different market rules, fuel prices, or volatility regimes.

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