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Abstract With increasing concerns about climate change and the need for cleaner energy sources, the integration of different energy resources and sectors is a key driver in transitioning towards more sustainable and flexible future multi-energy systems. Their integration not only enables whole power system cost-efficiency, flexibility and resiliency but also empowers consumers to optimize energy consumption, encouraging a more flexible and customer-centric energy landscape. To enhance the economic performance of distributed energy systems, this paper focuses on studying a multi-energy system with the integration of electricity, gas and heating/cooling sectors. This research aims to address demand uncertainty, a critical parameter influencing economic feasibility. To achieve this, the information-gap decision method is adopted, enabling effective management and mitigation of potential risks associated with volatile electrical and thermal demands. This approach seeks to ensure the optimal economic performance of the multi-energy system under varying market conditions for decision-makers with various risk attitudes. The robustness of decisions against worst-case scenarios is evaluated using a robustness model, analyzing various risk levels to provide a comprehensive view for decision-makers. On the other side, an opportunity function is utilized to address the risk-seeker point of view. As part of this optimization approach, we thoroughly analyze the role of electrical energy storage as a buffer to facilitate efficient energy utilization in the studied multi-energy system. This integration aims to optimize energy supply and demand, analyzing the economic benefits of a multi-energy system when considering different risk attitudes.

Keywords electricity; multi-energy system; optimization; risk management; uncertainty