



## Coordination for Multi-Energy Microgrids Using Multi-Agent Reinforcement Learning

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### Summary

Multi-energy microgrids (MEMGs) have significant potential to offer high energy utilization efficiency and system flexibility. The coordination of these MEMGs poses challenges due to the various system dynamics and uncertainties and the need to preserve privacy. This paper proposes a double auction (DA) market-based coordination framework. As such, MEMGs can not only schedule their own energy components but also trade energy with others in DA market. After that, we formulate this problem as Markov games and propose a multi-agent reinforcement learning method by making use of the DA market public information to enhance the stability with privacy perseverance. Case studies involving a real-world scenario validate the superior performance of the proposed method in reducing both energy costs and carbon emissions.

### Highlights

- The flexibility due to the local electricity trading among different MEMGs and the coupled energy conversions in each MEMG is explored. The examined problem is complex because of various system dynamics and uncertainties.
- A DA market-based coordination framework among multiple MEMGs has been proposed to obtain good performance with privacy preservation.
- A novel DA-MATD3 method is proposed, which inherits the ability of the MATD3 to perform well in a multi-agent environment with various system dynamics and uncertainties and addresses privacy concerns using a DA market framework.
- The DA-MATD3 method integrates the key information of the DA market into the state-of-the-art MATD3 algorithm by connecting the critic networks of the agents with the DA market order books.



The TradeRES project will develop and test innovative electricity market designs that can meet society's needs of a (near) 100% renewable power system. The market design will be tested in a sophisticated simulation environment in which real-world characteristics such as actors' limited foresight into the future and risk aversion are included.



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