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REINFORCEMENT LEARNING FOR COORDINATED BATTERY TRADING ACROSS DAY-AHEAD AND INTRADAY MARKETS

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Extended Abstract

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Abstract Summary

Battery energy storage systems (BESS) are expected to play a key role in electricity markets with increasing shares of renewable generation. While current projects often rely on stacked revenues from ancillary services and wholesale markets, increasing competition and the expected saturation of flexibility products are projected to shift revenues toward wholesale arbitrage. This motivates the analysis of merchant trading strategies based on coordinated participation in day-ahead and continuous intraday markets.

This paper presents a data-driven framework for cross-market battery trading that combines deep reinforcement learning (DRL) with optimization. A Proximal Policy Optimization (PPO) agent determines day-ahead trading decisions, while a Rolling Intrinsic (RI) optimization model approximates continuous intraday trading by re-optimizing positions under updated market conditions. The framework is evaluated on historical German market data from 2019 to 2025.

The proposed approach addresses two key challenges. First, it relaxes the assumption of neutral positions between markets, allowing for anticipatory strategies that link day-ahead and intraday decisions. Second, it tackles the temporal credit assignment problem arising from delayed intraday outcomes using reward shaping based on counterfactual rewards.

Preliminary results show that the DRL agent deviates from myopic day-ahead arbitrage strategies and instead adopts trading patterns that implicitly account for intraday adjustment opportunities. However, the resulting profit improvements remain limited. In addition, the results indicate that learning coordinated strategies becomes more difficult in recent market environments, where increased intraday liquidity reduces performance differences between alternative strategies.

Overall, the findings highlight both the potential and the limitations of DRL for cross-market battery trading and emphasize the importance of realistic intraday market modeling in learning-based approaches.