Adaptive robust strategy for energy and regulation Service Management in Local Energy Communities

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Full paper: https://www.sciencedirect.com/science/article/pii/S0306261924020312

Summary

Local energy communities (LECs) play a crucial role in enhancing energy self-sufficiency and sustainability by fostering local renewable generation and consumption. However, the inherent variability in renewable power generation and consumption presents challenges. This paper introduces a novel linear bi-level model designed to optimize resource scheduling within LECs, incorporating shared battery energy storage and hydrogen energy systems. Both systems are utilized for providing regulation services, including both generation and consumption modes. To account for uncertainties in demand and renewable power generation, we employ adaptive robust optimization (ARO), formulating the problem as a min-max-min framework. The outer and inner minimization sub-problems represent the optimal strategy of the LEC in the day-ahead energy and reserve markets, and real-time regulation markets, respectively. The worst-case realization of uncertain consumption and photovoltaics generation (PV) is addressed through middle maximization. The proposed model identifies the optimal energy trading strategy for LECs to ensure the provision of regulation services under these uncertainties, based on a defined budget of uncertainty. The application of bi-level optimization and decomposition techniques facilitates solving the min-max-min problem. Simulation results reveal that integrating hydrogen energy systems significantly enhances community flexibility and reduces overall energy supply costs.

Highlights

- Using ARO-based model to optimize LEC resources in energy and regulation.
- Integration shared battery and hydrogen systems to improve flexibility of LECs.
- Proposing bi-level optimization to solve min-max-min problem.

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Info

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.

Start date
1 February 2020

End date
30 November 2024

Overall budget: € 3 988 713,75

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864276