Meng Song, Ciwei Gao, Mingyu Yan, Yunting Yao and Tao Chen, 2025, Chapter 10: Robust peer-to-peer multi-energy trading considering carbon emission, in Meng Song, Ciwei Gao, Mingyu Yan, Yunting Yao and Tao Chen, *Local Energy Markets: Paving the Path Toward the Low-Carbon Digital Power Distribution System*, Springer.

**Abstract** In the context of decarbonization, the rise in renewable energy (RE) resources and gas-fired power plants has significantly increased the interdependence between electricity and gas markets. However, centralized market clearing under third-party management raises concerns about data privacy. We propose a peer-to-peer (P2P) multi-energy trading mechanism for integrated electricity and gas distribution systems that incorporates carbon emission limits via a nodal carbon intensity (NCI) model to mitigate this issue. Additionally, we utilize information gap decision theory (IGDT) to build a robust optimization framework that accounts for various uncertainties. The normal boundary intersection (NBI) method is employed to solve the multi-objective optimization problem, ensuring social welfare (SW). This approach considers the impact of uncertainties in RE generation and load demand on decentralized market trading. The model's effectiveness is validated through numerical simulations on a modified IEEE 33-buspower system and a 27-node gas network.

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