

Abstract

We study decentralized decisions among resiliency investors for hardening electric distribution systems with governance, which could coordinate the achievement of social optimums.

Significant investments are being made to build resilient infrastructure for society well-being by hardening electric distribution networks. However, whether independent investment decisions can reach social optimums is not well studied. Previous research has focused on optimization of system designs to improve resiliency with limited modeling efforts on the interactions of decentralized decision making. Within regulatory governance, we investigate interactions between two independent resiliency investors with a game-theoretic model incorporating detailed payoff functions. Moreover, we demonstrate the framework with typical data and sensitivity analyses. We find that the decentralized optimal solution is not a social optimum without governance and the government could subsidize grid hardening to achieve the social optimum. Additionally, we conduct Monte Carlo simulations by varying key parameters and find that a socially undesirable outcome could occur with the highest frequency. Therefore, it is important to narrow the uncertain ranges for particular benefits/costs and use policy instruments to induce the socially desired outcomes. These results yield important insights into the role of regulatory governance in supervising resiliency investors and highlight the significance of studying the interactions between independent investors.

Citation

Shan, X., F. A. Felder, and D. W. Coit, "Game-theoretic Model for Electric Distribution Resiliency/Reliability from a Multiple Stakeholder Perspective", IIE Transactions, 49(2): 159-177, 2017.