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Title: Risk Trading in Energy Communities

Abstract: Volatile local market-clearing prices and consequently volatile payoffs for energy community members give rise to risk-averse preferences of individual players. Risk-averse players take rather conservative forward market, i.e. day-ahead market, decisions to the costs of increased disbenefits, such as higher costs or lower revenues, in spot markets, i.e. real-time markets. Thereby, local market-clearing prices are altered, which effects the payoff of rival players. The case is most striking, if players are heterogeneously risk-averse and some players accept a greater payoff volatility than others. For this case, we propose risk trading in energy communities to outweigh welfare losses due to conservative long-term decisions of a few highly risk-averse players.

We consider the Conditional Value-at-Risk (CVaR) as our risk measure for players and study different degrees of risk market completeness, ranging from fully incomplete risk markets to a complete risk market. We define a risk-averse Nash game with risk trading. For incomplete risk markets we reformulate the game as a two-stage stochastic equilibrium problem, which potentially has multiple Nash equilibria. For the special case, where the market for risk is complete, we relay on optimization techniques to find a Nash equilibrium. Numerical findings indicate that significant system costs savings can be realized when players engage in risk trading and sufficient financial hedging products are available. Moreover, risk-trading efficiently protects less risk-averse players from highly risk-averse decision making of rival players.

Key words: Energy communities, CVaR, risk trading, Arrow-Debreu securities, two-stage stochastic equilibrium