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Analysing ratio-based controllers against motivational game theory in peer-to-peer renewable energy trading
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Abstract
The evolution of renewable energy (RE) production has ushered in an era of increased efficiency and accessibility. Yet, the transition from generation to utilization presents challenges, particularly in terms of tracking and matching energy supply with consumer demand. This inefficiency highlights the need for a sophisticated controller equipped with optimal algorithms. Thus, the aim of this research is to design proper models for peer-to-peer trading algorithms for RE to address these inefficiencies. Two controllers were used in this research work. The first controller uses an algorithm that distributes energy production based on the ratio of energy generated to energy demand, with the aim of minimizing wasted energy. A comparative analysis is conducted against a second controller employing a Motivational Game Theory (MGT) algorithm that incorporates prioritization of energy distribution based on price adjustments. The study evaluates the levels of unutilized energy and profit gains achieved by each controller. Results show that in scenarios where energy demand surpasses production, both the MGT-based and ratio-based controllers display similar levels of unutilized energy. However, the MGT - based controller proves higher profitability compared to its ratio-based counterpart. During peak hours, the MGT -based controller was able to record 9% more profit than ratio-based controller. Alternatively, in situations where production exceeds demand, the MGT-based controller records lower levels of unutilized energy while keeping superior financial performance. MGT- based controller can use 60% more energy produced than ratio- based controller. This study highlights that with suitable control algorithms such as ratio-based controller and the motivational game theory, the potential of peer-to-peer energy trading could be enhanced, by optimizing the utilities of renewable energy, minimize wastage, and boost profitability.

Author Keywords
energy trading; motivational game theory; optimal control; peer-to-peer; renewable energy

Index Keywords
Commerce; Energy, Energy demands, Energy productions, Energy trading, Matchings, Motivational game theory, Optimal controls, Peer to peer, Renewable energies, Unutilized energy; Profitability

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