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Title: Agent-based Modeling of Energy Transactions within a Micro-grid Network Enhanced by Blockchain: Incorporating the Major Psychological Decision-making Theories

Abstract: An improved understanding of the behavior and preferences of individual energy users is key for policymakers to implement the appropriate strategies that can maximize the social benefits of energy transactions through new decentralized energy technologies. In particular, the emergence of blockchain technologies as a means to improve these transactions make the need of such understanding more significant, as the levels of effective human interaction with these innovative technologies is still under investigation. In view of the above, this work develops an agent-based simulation of the consumer/prosumer decisions that encompass energy transactions within a decentralized micro-grid network via blockchain. This model evaluates the effectiveness of different market and pricing mechanisms to benefit the electric grid and the energy users alike, by focusing on the social preferences, attitudes and values of the users. The unique feature of this modeling effort is that it incorporates well-established theories from psychology on how humans make decisions, recognizing that personal abilities, values, beliefs and judgment might lead to non-optimized decisions that are not always expected. Each agent represents the decision-maker of a household that is interconnected within a micro-grid network and able to perform energy transactions via a blockchain. Each one of these decision-makers is assumed to interact with the others by following one of the main decision theories such as rational choice, bounded rationality, theory of planned behavior and prospect theory. This setting is modeled after a real micro-grid community that is being established recently within the greater Tokyo metropolitan area in Japan, and it examines different scenarios representing different market designs and price mechanisms that are applicable to the community. In this way, the model examines prosumer-consumer interactions within a micro-grid community under more realistic parameters. Thus, and it can draw insights on the potential of each strategy to enhance the ability of blockchain-based decentralized micro-grids to i) reduce the overall peak/average ratio of the system, thus contributing to the overall resilience and flexibility of the grid and to; ii) reduce the overall cost of each decision-maker.