TRADING MODELS FOR ENERGY COMMUNITIES: AN ECONOMIC ASSESSMENT OF THE FULL P2P SCHEME

Laura Wangen, Univ. Grenoble Alpes, CNRS, INRAE, Grenoble INP, GAEL, 38000 Grenoble, France, +352661507498, laura.wangen@univ-grenoble-alpes.fr

Overview

With the integration of Energy Communities (ECs) into the European electricity system, the development of customised trading models and pricing strategies is essential to address their operational and economic needs. The growing role of ECs underscores the critical challenge of optimising trading mechanisms and the need for stable economic frameworks for prosumers. However, the impacts of various trading models on the financial and operational outcomes for EC members remain insufficiently explored.

To address this gap, this paper analyses the Full P2P scheme from an economic point of view. This scheme serves as a standard model for local energy transactions, based on bilateral negotiations to establish agreements between prosumers on energy amounts and prices. With this framework, prosumers in the community are still connected to the grid to sell their surplus energy and to purchase energy to cover any deficits as needed.

Methods

This paper integrates a linear programming model that allocates energy optimally among members while maximising the community's overall revenue. Building on the Full P2P optimisation framework proposed by Perger et al. (2021), the model is generalised and evaluated under three configurations: (1) a baseline scenario reflecting standard trading mechanisms with different priorities on self-consumption practices; (2) a scenario incorporating the member's willingness-to-pay (WTP); and (3) a scenario integrating battery energy storage systems into the community. To validate the methodology, a European case study of an Energy Community with 250 members and primarily based on Portuguese data, is used. To support this analysis, members are grouped into quartiles by their load and production profiles to examine the evolution of trading behaviours across prosumer groups, with a particular focus on the trade-offs between intra-community and grid exchanges.

Results

The clustering approach reveales significant differences in energy-sharing dynamics among prosumer profiles, providing insights into how these profiles influence self-consumption, grid reliance, and overall energy distribution within the community. Load- and production-based clusters exhibit trends toward increased self-sufficiency and enhance energy management as the trading models become more advanced. Notably, the WTP-based model encourages self-consumption among high-consumption and high-production prosumers while it also reduces community trades. Conversely, battery integration reduces both self-consumption and reliance on the community and the grid, illustrating the critical role of storage technologies in shaping energy-sharing behaviours.

Conclusions

These findings emphasise the importance of tailored strategies for different prosumer groups, investments in energy storage, and economic incentives to enhance energy independence while reducing grid interactions. They also underscore the potential for P2P trading models to promote cost efficiency and local energy use in large ECs.

Future research should extend these insights by comparing the presented configurations with alternative trading models, including those involving a community manager. As no comprehensive comparison of such trading models currently exists, this paper highlights the need to evaluate the relative benefits and challenges of distinct P2P mechanisms. Such comparisons will provide a pathway toward optimised energy distribution and maximised financial outcomes in decentralised energy markets, ultimately strengthening the role of ECs in the European electricity market.

References

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