Trading between households in smart energy communities

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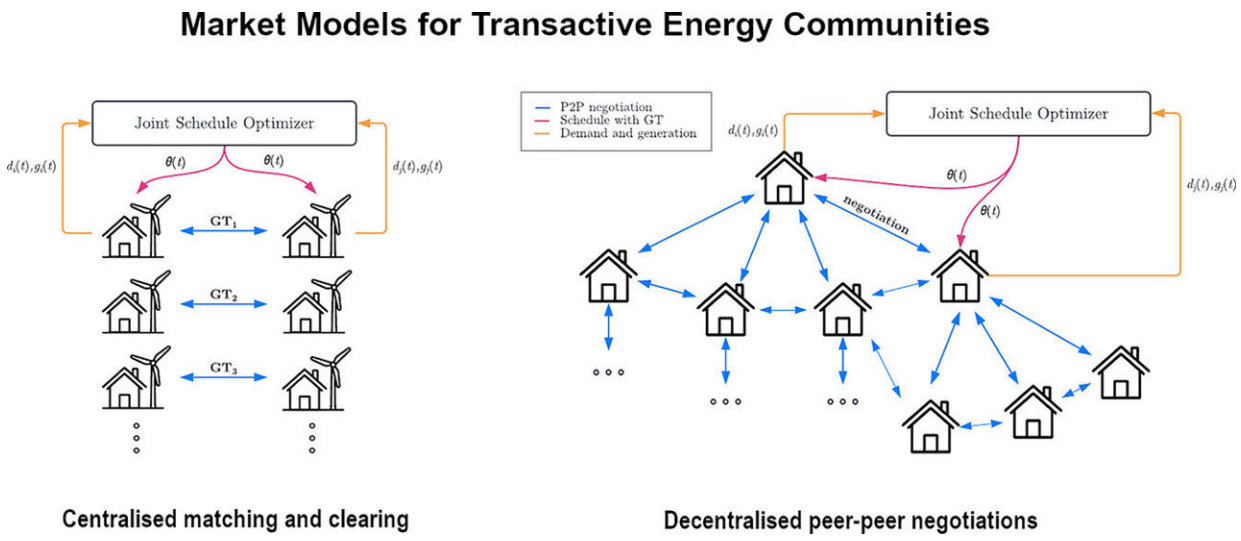

Graphical abstract. Credit: *Applied Energy* (2023). DOI: 10.1016/j.apenergy.2023.122173

Our energy systems are undergoing rapid change. Many households are generating electricity with solar panels, and there are new sources of demand and storage, such as charging electric vehicles and home batteries. Local prosumers (energy consumers who also generate and store energy) are taking control of their own energy supply. This development is prompting the creation of energy communities and micro-grids, such as the SchoonSchip community in the north of Amsterdam.

Energy communities allow consumers to generate, use and trade energy locally. In this way, they are no longer dependent on large energy suppliers. By bringing energy generation closer to where it is needed, these communities also help to alleviate grid congestion, which is a growing challenge for grid operators.

Unanswered questions

There are two main models for energy communities. In the first, prosumers individually control their own energy resources and then trade with each other. In the other model, multiple prosumers share and jointly control energy resources, such as wind turbines, solar panels or community-owned batteries. In both models, distributed AI techniques are often used to automate and optimize peer-to-peer (P2P) exchanges.

Yet these models raise many unanswered questions: how do you honestly share the costs and benefits of generating energy from shared assets? Other important questions are: how many prosumers need to be involved to make P2P trading economically viable, and what are the various reasons for people with different energy consumption needs to participate in such projects?

Large-scale real data

A study, published in *Applied Energy*, aims to shed light on some of these key questions. The researchers used large-scale real data from the UK.

Co-author Valentin Robu, a researcher at CWI and TU Eindhoven, explains, "The focus of our study was on the marginal benefits of peer-to-peer energy exchange contracts, using a method of measurement known as 'Gains from Trade.' We found that as the number of peer-to-peer

energy contracts increases and more prosumers enter the market, diversity in consumption profiles quickly decreases, leading to significantly diminishing returns."

"This means that most of the Gains from Trade from an energy community can be achieved if only a fraction of the community members participate. Especially those members with the most different demand profiles from other community members."

"Our study also explores how an AI technique called multi-agent systems can be used to automate and optimize P2P negotiations so that both parties benefit from the energy exchange."

The study was the result of a collaboration between researchers at CWI (the National Research Institute for Mathematics & Computer Science in Amsterdam), Delft University of Technology & Eindhoven University of Technology in the Netherlands, together with researchers at University of Glasgow (UK) and Princeton University (U.S.). It was part of the Marie Curie TESTBED-2 project.

More information: Ying Zhang et al, Modelling the formation of peer-to-peer trading coalitions and prosumer participation incentives in transactive energy communities, *Applied Energy* (2023). DOI: 10.1016/j.apenergy.2023.122173

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