***dynamic participation in peer-to-peer electrictiy tradinG mechanisms in local communities***

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## Overview

Supporting the transition towards a decarbonized energy system, distributed on-site PV generation and battery energy storage systems (BESSs) became increasingly prevalent. Consumers can be producers at the same time, called *prosumers*, and they are enabled to become active participants in decentralized energy markets, e.g. by engaging in local energy communities and peer-to-peer trading mechanisms. Energy communities are independent of local microgrids and they are not necessarily site-dependent, which allows prosumers to participate on a voluntary basis.1 This creates a perfect environment for prosumers to participate with short-term contracts, e.g. on an annual basis, and thus evaluate dynamic phase-in and phase-out of prosumers in energy communities. Different market mechanisms are applicable within energy communities; the peer-to-peer trading mechanism introduced here is one example of many possibilities.

## Methods

The method of this work is based on the open-source model FRESH:COM (see [1] and [2]), which is implemented in Python using the Pyomo package. FRESH:COM is a linear optimization model that allocates electricity in local energy communities via peer-to-peer trading. The allocation mechanism considers (i) the minimization of grid purchases by the community (e.e. of an external supplier), and (ii) the willingness-to-pay of the individual prosumers and thus the maximization of the community’s social welfare over a whole year. The contribution of the present work is the extension of the model in order to find the optimum over a horizon of several years while the set of prosumers participating in the peer-to-peer trading is changing repeatedly. Figure 1 shows the schematics of the peer-to-peer trading concept including changes in the set of community members.

Figure 1: Schematic overview of peer-to-peer trading

Prosumers of the original community set-up exchange electricity with the other prosumers (Fig. 1 green) and with the public distribution grid. New prosumers can join (Fig. 1 orange) the community and start peer-to-peer trading with the other members, or existing prosumers can leave the community. On a yearly basis, the algorithm finds the optimal configuration of new members to join the existing community, respecting the objective of social welfare maximization as well as fairness indicators, which are included as benchmarks to evaluate the community’s performance from the perspective of the individual community member (see [3]).

## Results and Conclusions

The first set of results is generated to demonstrate the functionality of the proposed method. Then, sensitivity analyses are conducted with the purpose of finding key characteristics of potential new prosumers that improve the community’s overall performance. In another set of results, different settlement patterns are compared and their potential for peer-to-peer trading communities is evaluated. This work concludes with suggesting strategies for emerging peer-to-peer trading communities and advising respective policies.

## References

[1] [www.github.com/tperger/FRESH-COM](http://www.github.com/tperger/FRESH-COM)

[2] T. Perger, L. Wachter, A. Fleischhacker, H. Auer, PV sharing in local communities: Peer-to-peer trading under consideration of the prosumers’ willingness-to-pay, In: Sustainable Cities and Society (2021), DOI: <https://doi.org/10.1016/j.scs.2020.102634>

[3] F. Moret and P. Pinson, "Energy Collectives: A Community and Fairness Based Approach to Future Electricity Markets," in IEEE Transactions on Power Systems, vol. 34, no. 5, pp. 3994-4004, Sept. 2019, doi: 10.1109/TPWRS.2018.2808961.