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THE ROLE OF THE USER IN PEER-TO-PEER ENERGY COMMUNITIES

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1. MOTIVATION

The depletion of natural resources and increasing energy demand [1] highlight the need for innovative approaches that tackle issues of energy security, uncertainties of energy prices, and environmental sustainability – the so-called energy trilemma [2]. With decreasing costs and technological progress, decentral energy resources (DER) increasingly become a promising renewable alternative to fossil fuels and are considered a backbone of future power systems (e.g. 'Energiestrategie 2050' in Switzerland [3], 'Renewable Energy Directive' in the European Union [4]). Yet, DER like wind and solar power cannot follow a demand-sided production plan. In fact, the future power system in many countries is facing a rather asynchronous production and demand pattern, with DERs producing energy during the day while peak demand occurs in the mornings and evenings and storing energy is still expensive. These developments have caused a paradigm shift, granting once passive consumers a new role as potentially more active market participants: in particular, they may become 'prosumers' by investing in DER and storage technologies. In many regions, prosumers can feed excess energy into the grid in exchange of a monetary compensation. Yet, while electricity retail prices are rising, prosumers are increasingly facing falling feed-in tariffs in many countries. These developments make solutions more and more attractive that allow local trading of electricity among prosumers and consumers without intermediaries – so-called peer-to-peer (P2P) networks. In practice, such P2P networks are still in their infancy. Aside from technical and regulatory challenges, the key challenge is yet to engage consumers in this transformation, as electricity is a low-involvement commodity which is invisible and taken for granted by most consumers [5].

2. BUILDING A PROTOTYPE OF A PEER-TO-PEER ELECTRICITY NETWORK

To investigate the feasibility and real-world challenges of such a P2P system, we are currently building a real-world prototype of a P2P electricity network, which allows prosumers to market the electricity produced by their PV system to their community peers. The project has been approved for funding as a lighthouse project by the Swiss Federal Office of Energy and will be implemented in the town of Walenstadt (SG) in collaboration with the local utility company and several other partners from industry and academia. In this project, a minimum of 20 households will have the possibility to produce, consume and exchange locally generated electricity on a local market in their neighborhood. Energy exchange with the higher grid levels only occurs during times when the community is not self-sufficient or is producing more energy than consumed. Each household will be equipped with a smart meter that tracks electricity consumption and production. A virtual trading agent matches demand and supply, calculates the current market prices and stores the transactions in the blockchain. In addition, we develop a user interface in which the participants can set their trading preferences and monitor the status of their electricity supply (and, in the case of prosumers, of their electricity sales). Developing that user interface is a key component in this project. In fact, user engagement has revealed itself as more difficult and critical to the success or failure of many demand side management programs in the past few years than technical aspects [6]. Therefore, we carefully evaluate different content and design alternatives in a structured and iterative process.

3. IMPORTANCE OF USER INTERACTION

By design, consumers and prosumers play a central role in our prototype: they ensure the direct consumption of locally produced electricity within the community. Both, consumers and prosumers, can contribute to the self-sufficiency of the community by buying or selling local electricity. Prosumers may increase the profitability of their investments into PV systems or batteries by selling electricity at a higher price within the community than they might expect from feed-in tariffs in the future. Thus, P2P networks can make investments into additional DER more economically attractive, helping to increase the share of DER in the long term. Community members may also invest jointly in local infrastructure like a communal battery storage with associated dividends for the investors (crowdfunding). Examples like the success of Zurich utility company's product 'Lettenstrom' reveal that a considerable share of consumers has a higher willingness to pay for clean, locally produced energy. To what extent this can be leveraged on a larger scale in P2P networks and what kind of user interface facilitates the increase of local investments needs to be investigated. In our project, participants will have access to two user interfaces that enable an active participation in the project: a webapp and a message bot. The webapp features five functionalities: (1) community: statistics about the community's autarky, community building, (2) market: option to set buy and sell prices for local electricity, (3) transparency: production and consumption values in real-time and historic, (4) electricity billing: overview about financial transactions, and (5) investments: customer- and community-specific profitability estimations of installing solar panels or batteries. Given the relatively low engagement of end consumers with such technologies on the long-term in many previous projects [7], we provide the users with additional feedback on community statistics and individual market activity via a Whatsapp message bot and remind them to return to the webapp occasionally. Both user interfaces are developed in an iterative process following a product development framework from Human-Computer-Interaction research [8]. This includes frequent user feedback in early stages which we obtain by interviewing potential users in a first step, by conducting focus groups to get user feedback on following wireframes and by intensive usability testing while implementing the application.

4. CONCLUSION

In this project, we build a prototype of a P2P energy market in which participants can trade electricity locally. A central component of the project is the development of the user interface. To that end, we will investigate to what extent different kinds of content motivate consumers and prosumers to engage with the platform and local community.

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