SMART ENERGY SERVICES FOR ENERGY COMMUNITIES - BUSINESS MODELS AND USER EXPERIENCE ANALYSIS FROM THE SERVE-U FIELD TRIAL

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Introduction

The European energy sector is firmly set on a path of transformation for an achievement of net-zero emissions target by 2050. This path has further opened up several smaller transformations in the country and regional level, mainly in the form of renewable energy communities [1].

The project Serve-U [2] aims at the development and validation of an energy use optimization platform (EOP), which supports energy communities (EC) in terms of energy flow visualization and communication [3] and enables EC members to optimally control the utilization of their renewable energy sources, in a manner that accentuates flexibility and demand optimization, albeit with minimal technical and financial effort. To achieve this, generation estimates based on high-resolution meteorological data, exchange-based price data and self-learning consumption forecasts are effectively integrated into an energy optimization model. A high degree of scalability is achieved by focusing on available generation, load (smart meter and inverter data) and market data, some of which is based on open standards.

On side of the EC members, the idea is to learn new habits in the use of electricity by adapting electricity consumption to generation, all the while using weather forecasts and data to estimate the energy production within the community. Serve-U application uses community member data to create individualized actions and tips on how the community's electricity balance can be improved through manual DSM activities, i.e. shifting the use of domestic appliances.

The overall aim of the project is to determine the economic and ecological potential of such a low-cost optimization approach for energy communities, taking user-specific aspects as pre-condition for acceptance and market uptake into account. In this conference contribution, we will focus on two selected results from the project Serve-U; (1.) results from the development of business models for smart energy services and (2.) results from users' experience analysis on the acceptance of the EOP through app interaction, response to time-sensitive and motivational actions and feedback within the functional validation phase.

Methods

For the development of business models that allow scalability and integrate individuals behaviour patterns thereby ensuring acceptance of the platform, a literature research has been conducted in order to identify the different tools already available on the market. Furthermore, gain a deeper understanding on the functionalities offered by these tools and acquire an overview on the market situation. Secondly, two workshops with in total 12 private persons that are interested in using and interacting with the elaborated prototype by the Serve-U project (pre-informed, energy community members or in closer affiliation with project partners' customer basis) has been conducted in order to identify pre-conditions and perspectives that business-model development can be based upon. The first part of the conference contribution will elaborate on results of these business models.

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As a primary project milestone, we successfully developed a functional prototype of an application integrating smart energy services and a day-ahead optimization model. The prototype underwent validation in a real-world context through three distinct phases. Participants were integrated with their household data, encompassing consumption, generation, information on applicable technologies for demand-side management (DSM) measures, and individual preferences. All participants were aggregated to a hypothetical energy community. During the functional validation, which spanned several weeks, participants received visualizations, energy community information, and specific DSM instructions via push notifications through the application. The application facilitated user interaction with project personnel, progress tracking of fellow members, and feedback provision regarding the intention to implement suggested measures in household practices.

Concurrently, the social-empirical research component aimed to identify criteria for framework conditions, incentives, and motivators influencing user adoption of the Energy Optimization Platform (EOP) in their energy practices. We developed and implemented potential framework conditions into the app as motivational texts, drawing on insights from previous studies and preliminary projects. The functional validation phase had multiple objectives, including validating the effectiveness of time-sensitive DSM actions, testing the motivation concept, evaluating and enhancing app attractiveness through ratings and feedback, and assessing the long-term impact of application interaction on household practices and willingness to adopt behavioral changes. To that end, each validation phase included two online workshops to gather qualitative insights into users' expectations before and experiences after the validation phase. A pre-post survey setup accompanied the functional validation, yielding longitudinal data for comparing users' acceptance, perspectives on DSM measures, willingness to adopt such actions, insights into household energy practices, and attitudes. The second part of this conference contribution focuses on results from the analysis of users' experiences during the validation phase.

Expected results

The specification of general service business models with regard to the requirements of energy service platforms made it possible to define three interaction models, namely (i) analogue energy community, (ii) user-induced behavioural adaptation, and (iii) automated system optimisation based on modelling algorithms. Analyzing these afore mentioned interaction models provided valuable insights into the nature and structures of these business models, along with their corresponding benefits in achieving objectives such as (i) increasing the share of renewable energy sources, (ii) fostering decentralized production and consumption patterns, and (iii) enhancing resilience and grid serviceability.

The social-empirical analysis of the pre-post survey results shed light on users’ expectations and their fulfillment on interactions through the platform app, their potential motivations within ECs and willingness to adopt new energy practices and shifting their household behavior towards manual DSM. Throughout the validation period, user interactions with the app and their expressed willingness to act on suggested measures were tracked through activity reports, yielding insights into the actual commitment to implement actions in their households. The results and analysis informed the development and refinement of criteria determining the successful adoption and acceptance of behavioral adjustments.

In conclusion, empirical findings suggest that platforms like Serve-U contribute to the optimal utilization of renewable energy sources within energy communities. They facilitate demand optimization with minimal technical and financial effort for the energy community, promoting self-sufficiency and increasing awareness of energy use among community members.

References

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