DEMAND-SIDE FLEXIBILITY IN THE RESIDENTIAL HEATING SECTOR – A STATED CHOICE EXPERIMENT IN GERMANY

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Overview

The growing share of renewables and electrification of the transport and heating sectors is increasingly leading to an imbalance of energy supply and demand in the distribution grids at the regional and local level. While the supply side is becoming increasingly flexible and volatile, the demand side is largely rigid and inflexible, especially at the household level. However, households have great potential to provide demand-side flexibility for grid stability by matching their energy demand to supply.

While a balancing energy market with ancillary services providing flexibility to the transmission grids is already well established in Germany, regional flexibility markets (RFMs) involving residential households are still in a research stage (Kubli et al. 2018; Mengelkamp et al. 2018). Previous studies in the area of flexible energy supply and demand by private households have rather focused on participation in regional or local electricity markets, i.e., trading or consuming locally produced electricity (Mengelkamp et al. 2018; Mengelkamp et al. 2019). Kubli et al. (2018), for example, has examined flexibility co-generation in more detail, but only as part of an electricity contract. So far, it is rather unknown to what extent and under which conditions private households are willing to opt for a flexibility contract that explicitly includes the provision of demand-side flexibility services.

Our paper contributes to filling this research gap. Based on a subsample of 541 households from a large-scale online survey in Germany, we investigate households' preferences for integrating their heat pump into RFMs and for remotely controlling their heat pump for grid balancing purposes. Looking at the residential heating sector is also of particular interest in this context, as an increasing electrification of the sector can significantly contribute to the decarbonization of the economy, while at the same time offering high potential for demand-side flexibility.

Methods

To determine the acceptance of demand-side flexibility provision in the residential heating sector, a subsample from a large-scale online survey of customers of a regional grid operator in Germany is used. The study was carried out between January and May 2020 and included a stated-choice experiment on the hypothetical choice of flexibility contracts. Choice experiments are frequently used to investigate energy behavior and useful to identify preferences for and willingness to accept new products or services and for which real data is not available (Buryk et al. 2015).

In our choice experiment, respondents were asked six times in a row to freely choose either one of three hypothetical flexibility contract options or to choose nothing (“no-choice option”). The flexibility contract options were characterised by different contract modalities, namely the (1) monthly compensation for the willingness to provide flexibility, (2) guaranteed minimum room temperature in case of a shutdown, (3) number of flexibility calls per month, (4) information on flexibility calls, and (5) additional options to prevent flexibility calls. Before starting the first choice task, respondents received a detailed description of the choice context and contract modalities. In addition, respondents were divided into three groups, with one group serving as a control group and the other two groups receiving additional information about climate and grid benefits of demand-side flexibility. In this way, we aim to investigate whether additional information can increase the acceptance of demand-side flexibility services.

The collected choice data is analyzed in two ways. On the one hand, we rely on maximum likelihood simulation and use flexible mixed logit models to estimate preferences for and willingness to accept the different contract modalities considered. Furthermore, we analyse the general willingness to opt for flexibility contracts and treatment effects using probit regressions.

Results

Analysing the general willingness to provide demand-side flexibility, i.e. to opt for a flexibility contract, our results indicate a higher potential for demand-side flexibility compared to previous studies. In 55% of all choices, respondents choose one of the three flexibility contracts, which is quite high considering the poor familiarity with such services. Moreover, providing additional information about climate and grid benefits associated with demand-side flexibility even increases acceptance, i.e., the share of flexibility contract choices increases.

If a flexibility contract is chosen, our results so far show that the discomfort associated with demand-side flexibility, i.e. the decrease in room temperature, plays a major role in respondents choices. The lower the guaranteed minimum room temperature in case of a shutdown, the less likely respondents are to provide demand-side flexibility. This result is also in line with findings from previous studies (Kubli et al. 2018; Balint and Kazmi 2019). In addition, however, service attributes like information on flexibility calls and additional options to opt-out from flexibility calls are also highly valued by respondents. Therefore, offering such kinds of services potentially increase the uptake of demand-side flexibility services. However, estimating willingness to pay for the different contract modalities shows that respondents demand very high compensation for their demand-side flexibility, suggesting that future adoption of flexibility contracts may be somewhat limited if compensation is too low.

Conclusions

The transformation of the energy system, with proceeding electrification of heat generation and transport as well as increasing, volatile generation from renewables, poses rising challenges for the electricity grids today and in the future. In this context, our study investigates the extent to which private households would be willing to make their electricity demand more flexible and adapt it to the electricity supply in order to stabilize the grid. Our results so far indicate a quite promising potential of demand-side flexibility. However, it must be noted that any loss of comfort, such as a reduction in room temperature, must be compensated at a high level. On the other hand, our results also show that the acceptance and adoption of demand-side flexibility can be increased by providing additional services to consumers and also by communicating information regarding climate and grid benefits.

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