IMPACT OF VARIABLE ELECTRICITY PRICES ON HEAT PUMP OPERATED BUILDINGS IN THE AUSTRIAN BUILDING STOCK

Philipp MASCHERBAUER[1], Lukas KRANZL[1], Songmin YU[2]

Introduction

Residential buildings with heat pumps (HP) show promising possibilities for demand-side management (DSM). Further, with the revision of the Renewable Energy Expansion Act [1] and declining prices for photovoltaic (PV) and battery storages, the diffusion of DSM systems may increase in the residential sector in Austria. The cost-optimized operation of such systems can lead to significant cost reduction and at the same time change the electricity consumption of a household. This can especially be the case when a variable price signal is introduced. In this work, we will deal with the following question: How does the volatility of a variable price change the energy consumption of buildings with a smart energy management system (SEMS)? In this context, we also aggregate the findings of individual households to the national level of the Austrian single-family house (SFH) stock.

Method

We developed an hourly optimization model for individual households to address the research question. Based on price, temperature, radiation profiles, and building-specific parameters, the model minimizes the operation costs of the household. The electricity price profile is the driving factor of the minimization problem. By comparing the results from the optimization to a reference scenario, we investigate the impact of the optimization on a single house level. Further, we developed a link between the INVERT/EE-LAB [2] building stock model to get a detailed representation of SFH in Austria. In this way, we can conclude the influence of SEMS on electricity consumption on a national level.

Results

The results show that even with a small variance in the electricity price, SEMS tend to utilize the thermal mass of buildings as storage to decrease their energy costs if no other storage is available. When increasing the price volatility, the electricity consumption of the whole building stock will rise.

In Figure 1 the electricity demand from the grid for buildings in Austria using a HP is visualized as bars. The specific technological configurations are: PV size with 0, 5 or 10 kWp; battery (B) size with 0 or 7 kWh; hot water tank (T) with 0 or 1500 l. The majority of the buildings do not have a PV. Therefore they also represent the largest share of energy demand. The change in electricity demand through SEMS from the grid is depicted for each configuration on the right-hand axis. In general, optimization with a variable price signal results in higher total electricity consumption because of increased storage losses. In this example, households without PV, thermal storage or battery already increase their total consumption due to the utilization of the thermal building mass with a variable price. Further research will show us at what point of price volatility the total amount of used electricity from the grid is not reduced through SEMS for the entire building stock.

[1] Technische Universität Wien, Energy Economics Group, Gusshausstrasse 25-29/370-3, 1040 Wien, Austria, +43 6803104193., mascherbauer@eeg.tuwien.ac.at, kranzl@eeg.tuwien.ac.at
[2] Fraunhofer Institute for Systems and Innovation Research, Breslauer Str. 48, 76139, Karlsruhe, Germany, songmin.yu@isi.fraunhofer.de

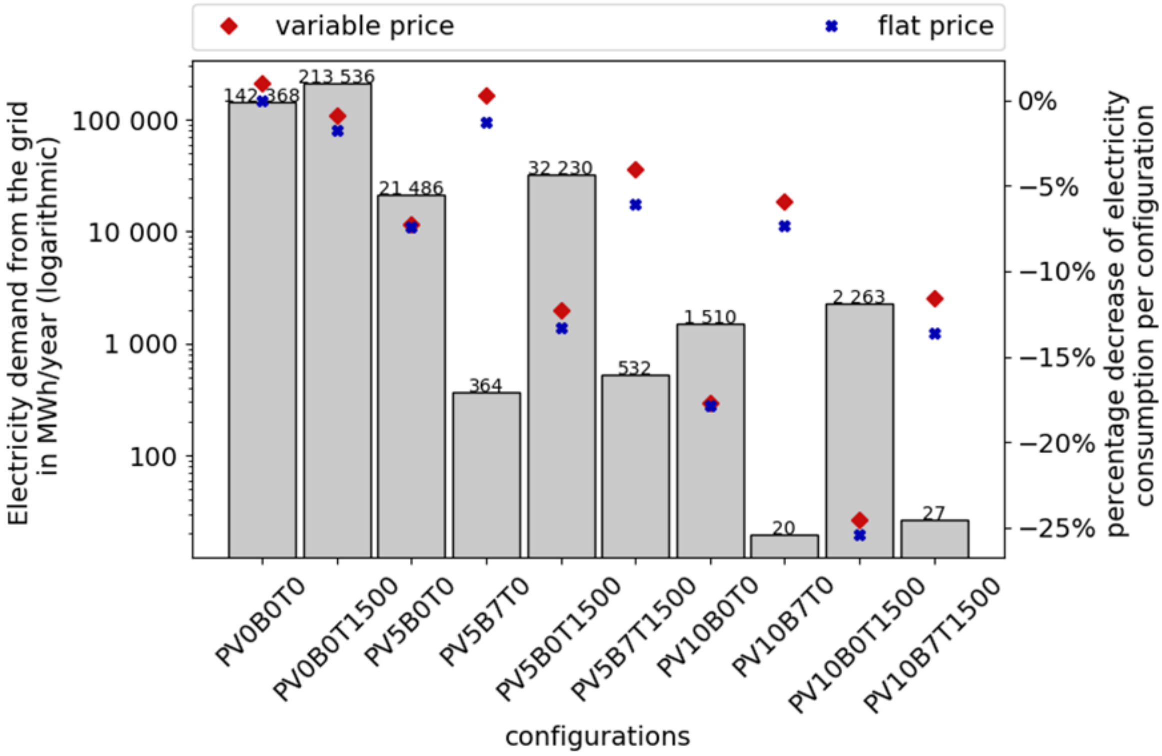

Figure 1: Impact of SEMS on the grid-electricity consumption of the Austria SFH buildings stock with certain configurations.

Literatur

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