PROSUMAGER IMPACT ON ELECTRICITY LOAD PROFILES: A MODEL COMPARISON

Philipp Mascherbauer, Technische Universität Wien, Energy Economics Group, Gusshausstrasse 25-29/370-3, 1040, Wien, Austria, +43 6803104193, mascherbauer@eeg.tuwien.ac.at

Yu Songmin, Fraunhofer Institute for Systems and Innovation Research, Breslauer Str. 48, 76139, Karlsruhe, Germany

Lukas Kranzl, Technische Universität Wien, Energy Economics Group, Gusshausstrasse 25-29/370-3, 1040, Wien, Austria

Georgina Asimakopoulou, E3 Modelling, Panormou 70-72, Athens, Greece

Overview

With the increasing uptake of heat pumps (HP) and photovoltaic (PV) within the European building stock, demand side management becomes an increasingly attractive option to balance the volatile share of renewable electricity generation. "Prosumagers," or households that consume, produce, and manage their own electricity, could play a critical role in the energy transition. To increase the knowledge of their impact on the power system, it is essential to model such prosumaging households properly. This paper contributes to this topic by comparing two different modeling approaches for individual prosumaging households with a focus on the following indicators: Load Factor, shifting electricity consumption and PV self-consumption.

Methods

The models, Invert-FLEX and PRIMES-Prosumaging, both focus on prosumagers within the building stock for the years 2020, 2030, and 2050 in a common scenario framework and use an economic optimization approach to minimize homeowners' energy costs. FLEX minimizes operational costs over a single year, building on the long-term development being modeled by the building stock model Invert. On the other hand, PRIMES-Prosumaging minimizes the total costs for individuals over the modeling horizon from 2020 until 2050. Therefore, the PRIMES-Prosumager model is sensitive to the total electricity price as well as hourly changes in price, whereas the FLEX model is solely sensitive to hourly price changes, whereas the sensitivity to absolute electricity price levels comes into play in the underlying Invert model. To reduce computational intensity the PRIMES-Prosumager model uses representative days for each year as compared to the FLEX model, which calculates 8760 hours per year. To be able to compare the models, 4 indicators were chosen: 1) A daily Load Factor, 2) the percentage of shifted electricity, 3) PV self-consumption and 4) the PV production share of the total amount of electricity load. In doing so we focus on all buildings having electrified heating systems within each EU country. Comparing the results on these indicators provides us with insights on the different modeling behaviors.

By comparing these two approaches, this study contributes to a deeper understanding of modeling prosumagers and their interaction with the electricity system as well as the impacts of chosen modeling approaches.

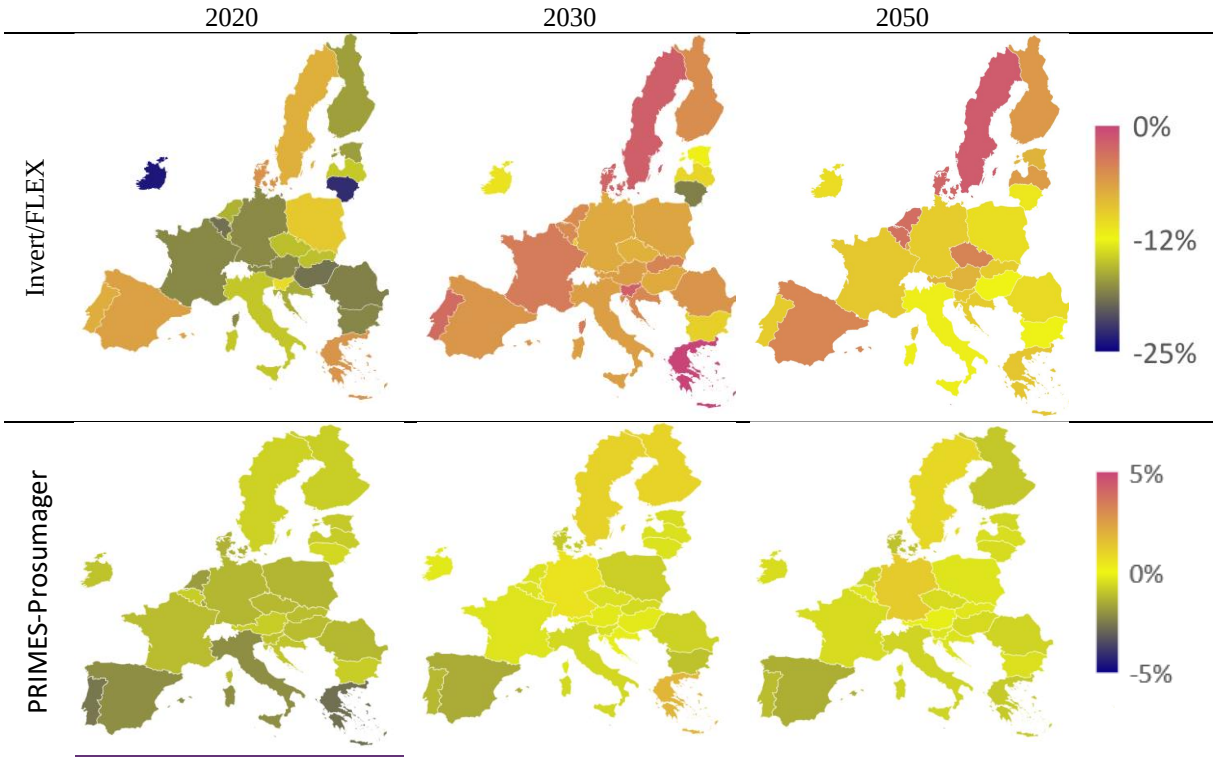
Results

The differences in modeling approaches will explain variations in results between the models. Because of how both models react to prices differently, we see different predicted building stock characteristics for the future. Because of the different approaches to represent the temporal resolution (yearly compared to representative days), the models are expected to show differences in shifted electricity and PV self-consumption as well as in the Load Factor.

Figure 1 shows the change in Load Factor if households with electrified heating were to react to hourly price signals. The Load Factor describes the peakiness of the electricity demand from the grid by households where a high Load Factor means that the grid electricity demand profile is smooth. In the Invert/FLEX model, the Load Factor is reduced through prosumaging; in the PRIMES-Prosumager model, this is not always the case. The Invert/FLEX model has a much higher representation of the behavioral changes due to price changes. In some buildings multiple storages can be combined to bridge longer periods of high prices, at the same time the peaks in low price times are more visible. The Prosumager model is restricted in this respect due to the representation of typical days and hours. For example, storage boundary conditions at the beginning and the end of a typical day might hinder the households from exploiting their full potential to shift load extensively. While the Load Factor is generally higher in northern countries in the Invert/FLEX model, the PRIMES-Prosumager model shows a high Load Factor in countries with high electricity prices. The PRIMES-Prosumager model can include prosumager behavior in its investment decision, leading to much higher PV + storage investments in certain countries than

projected by the Invert/FLEX combination. Both models show that a higher share of PV + storage installations leads to a reduced Load Factor.

Figure 1: Change in Load Factor when prosumagers are reacting to hourly prices for the EU27 for the years 2020, 2030 and 2050 with the Invert/FLEX and the PRIMES-Prosumager model.



Conclusion

Prosumagers will have a large potential to shift electricity demand on a national level in the future. Future research will address how to ensure that a rising share of Prosumagers contributes to grid stability instead of increasing grid stress. In this work, we estimate the impact of Prosumagers on the grid electricity demand through two modeling approaches which are consequently compared to each other. First results show that the Load Factor and the change in Load Factor through prosumaging is differently projected by the two models. Reasons are the different focus of each model. The Invert/FLEX focuses on the behavior of Prosumagers reacting to variable prices. At the same time, the PRIMES-Prosumager model also includes investment decisions focusing on the energy policy framework in which the Prosumager operates.