ANALYSING DIFFERENCES IN HOUSEHOLD'S RENEWABLE TECHNOLOGY PROFILES: A COMPARISON OF SOCIO-PSYCHOLOGICAL CHARACTERISTICS

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Overview

Globally, the residential sector currently accounts for more than 22% of total final energy consumption, according to the data from the IEA (2022). It is therefore essential to accelerate the energy transition through a substantial expansion of renewable energy sources and electrification of heating and transport. In this context, electrifying the heating and transport sectors with renewable electricity has become one of the major decarbonization strategies in Germany (Rinaldi et al. 2021). Thus, in the residential sector, the coupling of photovoltaic systems (PV) with heat pumps (HPs) and battery electric vehicles (BEVs) plays an important role. These strategies will lead to a stronger interaction between traditionally decoupled sectors, which may additionally be supported by storage systems.
Especially in Germany, a significant increase of small-scale PV systems with integrated battery storage as well as an increase in BEVs and HPs could be observed in the last few years (bwp 2022; Figgener et al. 2021; Perau et al. 2021). These parallel developments on the generation and demand side have a large synergy potential, as the actual decarbonization impact of BEVs and HPs is highly dependent on the power source and, thus, PV expansion and storage capacity. To support these synergies between technologies as well as sectors, it is important to understand consumer choices related to different sector coupling technologies to better understand the mutual interactions between them.
In this study, we model different technology profiles in German households based on a representative survey. Next to establishing the distinct profiles, we examine their relationship with a diverse set of potential predictors including sociodemographic characteristics, characteristics of the household's building, as well as individual motivations and beliefs.

Methods

In order to analyze different predictors of a household's renewable technology profile, we conducted an online survey among a representative sample of the German population in terms of age, gender, income, and household size between August and September 2022 (N = 809). The first section of the survey examined the socioeconomic and housing characteristics of the respondents. The second section included individual values as well as beliefs and norms related to renewable energy based on the value-belief-norm theory (Stern 2000).
In a first step, latent class analysis (LCA) with maximum likelihood estimation was used to determine subclasses of households based on the household's building, its renovation status, and the use of photovoltaics, a battery storage system, a heat pump, and an electric vehicle. Subsequent analyses using multinomial logistic regression analysis assessed the associations between household subclasses and potential predictors, including socio-demographics, values, beliefs, and norms.

Results

Models between one and eleven clusters were estimated by a latent class cluster analysis approach. Considering model fit indices (AIC, BIC, and Log-likelihood), model fit based on the AIC improved gradually for up to four clusters, and worsened for models with five clusters and more. The best model fit according to the BIC was with a 2-cluster model, slightly decreasing with additional clusters added. In accordance with Nylund et al. (2007) and Weller et al. (2020), who point out that statistical criteria should always be evaluated in conjunction with theoretical reasonability when deciding on the number of clusters in LCA, we decided to proceed with the 4-cluster model in favor of a better interpretability. We named the clusters for illustrative purposes as 'non-adopters of renewable energy technologies' (class 1: 84.5% of respondents) 'PV, battery, and heat pump owners' (class 2: 3.2%), 'heat-pumps owners without battery storage systems' (class 3: 7.2%), and 'one- and two-family homes with PV" (class 4: 5.1%). However, there was overlap between clusters.
With regard to the predictors of household technology profiles, compared with non-adopters, participants with building ownership are more likely to be in any other cluster. Also, participants that live in newer buildings and those with stronger egoistic values seem to be more likely in class 2, whereas participants that prioritize the prevention of pollution and conserving natural resources seem to be less likely in class 2. Comparing non-users to

residents of one- and two-family homes with PV, participants who live in a larger city are less likely to belong to the latter.

Conclusions

The latent class approach demonstrated variability in technology synergies across groups of households with different technology profiles. The results further showed that specific individual values and certain socio-demographic characteristics can predict a household's technology profile.

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