CAN THE INSTALLATION OF PHOTOVOLTAICS MOTIVATE HOUSEHOLDS TO ADOPT BATTERY ELECTRIC CARS?"

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Overview

The increasing threat to human health and well-being caused by climate change and air pollution demands fossil fuel use reduction measures worldwide (IPCC, 2023). As part of the European Green Deal, the European Union's (EU) Fit for 55 policy package includes measures such as expanding emissions trading, increasing renewable energy, promoting clean transport, and enhancing energy efficiency (EC, 2023). Despite the EU's and its state members' ambitious efforts, the low adoption rates of energy-efficient technologies, particularly electric vehicles (EVs), highlight the need to understand consumer preferences and barriers better. Bundling EVs with complementary technologies, such as solar photovoltaic (PV) systems, can accelerate their adoption and contribute to the EU's goals (Hesselink & Chappin, 2019). However, the potential of the joint adoption of EVs and solar PVs has not been adequately investigated. This study aims to fill the gap in the literature regarding Greek consumer preferences for passenger EV technologies and to investigate how the installation of residential solar PVs can increase the demand for battery electric vehicles (BEVs) by enabling households to charge their vehicles with self-generated solar power while promoting affordable and just carbon transition.

In this study, we use discrete choice experiments (DCE) to elicit Greek consumers' preferences and estimate their willingness to pay (WTP) for four different passenger vehicle technologies, including BEVs, when this technology is offered alone or as a bundle with solar PVs. The data are econometrically analysed, estimating mixed logit models. The findings show consumers' strong preference for bundling BEVs and PVs, with a notable shift in their choices towards this alternative and a higher WTP compared to a BEV alone. The purchase price, operating costs, wallbox subsidy, and charging time are the key factors affecting the choices of potential car buyers in Greece. Finally, the results reveal unobserved and observed preference heterogeneity, highlighting the importance of tailored policies and measures for the promotion of electromobility.

Methods

An original survey, which included two DCEs, was carried out. The two DCEs were almost identical, varying only in one key component. First DCE included only passenger vehicles, a conventional car which use an internal combustion engine (ICE), a hybrid electric car (HV), a plug-in hybrid car (PHEV), and a BEV, while a subsidised residential solar PV system enriched the choice set task in the second DCE. Monetary, technical, and policy characteristics described the vehicles and the PV system. Specifically, the vehicles were described by purchase price increased by malus (ICE, HV, PHEV) or decreased by bonus (PHEV, BEV), fuel operating costs, driving range, normal and fast-mode charging time, wallbox subsidy, and free parking policy. A PV system was described by installed capacity, purchase price, and investment subsidy. We incorporated several features in the study design to avoid several sources of the hypothetical bias. First, the purchase price and fuel operating costs were respondent-specific, considering the expected price and size of a vehicle they intend to buy. Information about the annual fuel costs also implicitly included mileage, as expected by the respondent. Second, driving range and recharging time were tailored to vehicle size. Third, we used the unforced choice design (including the opt-out) to avoid hypothetical bias. Last, only people who intended to buy a passenger vehicle in the next three years were interviewed. D-efficient design was prepared using the NGENE software for both DCEs.

Respondents were asked to examine and compare the available alternatives in several hypothetical scenarios and choose their preferred alternative, considering their income and capabilities. The respondents who had already installed a PV with sufficient capacity to charge a BEV were asked to reply only to the first DCE, while all others were engaged in both DCEs. This strategy allows us to analyse differences in consumer preferences with and without

a PV system included in the choice task (between-experiment comparison) or between people with and without a large-scale PV system installed (between-segment comparison). A representative sample of more than 1000 potential car buyers residing in Greece were interviewed using a professional survey company located in Athens, Greece. Following the random utility theory (McFadden, 1974), we estimate mixed logit models. We focus on the preferences of a sample of 891 respondents who do not already own a large PV system in order to examine the impact the addition of a combination of a BEV and a PV system installation has on consumers' decisions.

Results

We find a positive attitude of consumers towards BEVs and PHEVs. Including a subsidised installation of PVs is instrumental in exploiting the full benefits of BEVs. Offering the bundle of BEV and PVs in the choice task, we observe a notable shift in preferences, with 16% of respondents opting for this alternative, demonstrating the potential of combining renewable energy generation with electromobility. Although ICE vehicles are, as expected, the most often chosen alternative, when the bundle product is added, the share of those who choose a BEV in total is getting higher. In addition, a significant share of respondents shift their choices from buying a BEV alone. The implicit marginal WTP for the BEV-PV bundle (€59,203) significantly exceeds the WTP for BEVs alone (€50,951), highlighting the added value consumers place on this integrated solution. Finally, the analysis confirms previous studies, revealing a positive association between the current ownership of PV systems and the higher preference for EV technologies.

Results from mixed logit models show that a lower price, lower normal charging time, getting a subsidy for installing a wallbox, and lower operating costs enhance the adoption of low-emission car technologies. However, there is a high unobserved preference heterogeneity for all the studied technologies' attributes, revealing the need for further understanding of the individual and unique tastes, needs, and capabilities. Exploring observed heterogeneity, education, income, region, household size and dwelling ownership shape consumers' decisions. Finally, we highlight the importance of an in-depth exploration of individual beliefs and motivations, including knowledge about the available incentives for the promotion of EVs and PVs, which may impact consumers' preferences for them.

Conclusions

The findings of this study attempt to understand consumers' preferences for low-emission passenger vehicles in Greece, with a special focus on the impact of offering a BEV jointly with a PV system on consumers' choices. A bundle of subsidised green technologies, such as BEV and PVs in our case, which both receive a subsidy, can enhance the attractiveness of adopting one of these green technologies. The monetary attributes, such as purchase price and operating costs, are of primary importance when potential car buyers make their purchase decisions. Therefore, reducing the wedge between the purchase prices and operating costs of ICE vehicles and EVs may contribute to the faster and broader diffusion of low-emission cars. In addition, lowering normal charging time and providing a subsidy for the wallbox installation at home can significantly increase the adoption of plug-in electric vehicles (BEV, PHEV). Moreover, a higher electric driving range, lower fast charging time, and the ability to enjoy public parking for free can motivate at least some consumers to adopt plug-in electric car technologies (BEV, PHEV). Understanding the role of individual characteristics and preferences, mobility patterns and lifestyle, and one's access to charging infrastructure is crucial for efficient policymaking.

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