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On the preferences for electric vehicle energy tariffs with direct load control in Germany

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In order to meet the climate goals of the Paris Climate Agreement, participating nations are committed to finding measures to reduce CO2 emissions in their country. Over the last decade, the share of renewable energy sources (RES) in the electricity generation has increased (IEA, International Energy Agency, 2021), but the amount of CO2 emitted by the road transport sector in the EU has also increased by about 21% from 1990 to today. In the EU, the total amount of emitted CO2 is about 740 million tons in 2022 (Eurostat, 2024). The electrification of the transport sector is a measure to reduce overall emissions, but leads to an increase in overall electricity demand. Despite strong growth in electric vehicle (EV) adoption in the EU in recent years, EVs account for only 1.2% of the Euroean car fleet and further growth is needed to meet the EU's goal of climate neutrality by 2050 (EEA, 2023; European Commission, 2024). Increased supply from renewable energy sources poses several challenges to the power sector, such as increased intermittency, which stresses the distribution grid and increases risk of grid congestion. The growing adoption of electric vehicles (EVs) exacerbates this problem, as simultaneous and unmanaged charging means significantly higher power consumption and additional stress on the distribution grid (Huang et al., 2021). This study aimed to explore preferences for electric vehicle (EV) energy tariffs with direct load control. We conducted a stated choice experiment of a representative sample of the German population (n=2,771) in which participants were offered different electric vehicle charging tariffs, all of which included the option for a third party (the grid operator) to intervene in the charging process of EVs. Both the choice scenario and the attribute levels were individualized based on the annual mileage and vehicle classification of respondents.

We elicit the preferences of car owners and participants who plan to purchase a car in the future for electric vehicle energy tariffs in Germany. The discrete choice experiment contains six choice sets for each participant. At the beginning of the choice experiment, all participants receive detailed and identical information about the hypothetical choice situation, with individualized information based on previous responses in the questionnaire. In the experiment, respondents are asked to choose between several hypothetical options for electric vehicle energy tariffs. Most of the attribute levels shown in the stated choice experiment were individualized based on previous responses in the questionnaire. We specifically asked for the annual mileage in the household and for the corresponding vehicle classification. Based on this information we calculated the current monthly charging duration per respondent. The attribute levels of the additional monthly charging duration and monthly remuneration were also individualized based on this information. The key dependent variable is the dummy variable "choice", which takes the value 1 if a respondent chooses a particular smart charging tariff in a choice situation and the value 0 otherwise. Our analysis of the discrete choice experiment relies on a mixed logit model, as it does not require the independence of irrelevant alternatives assumption (IIA) and it ensures efficient estimates even if respondents make sequential choices (Lancsar et al., 2017; Revelt andTrain, 1998).

First, the statistically significant positive estimated coefficient of the opt-out variable suggests that, on average, respondents have a general preference for choosing the opt-out or a "standard" charging tariff without any intervention or remuneration. Regarding the attributes of the charging tariffs with direct load control, we find that respondents prefer higher remuneration. Regarding the preferences for more additional charging hours due to the longer charging process, we find that respondents have preferences for fewer additional hours. On average, respondents are willing to give up €0.15 of monthly remuneration to reduce the additional monthly charging duration by 1 additional hour. However, this effect is only statistically significant at a 10% significance level. This result is somewhat surprising, given the fairly unanimous evidence from previous

literature that people typically prefer fewer additional hours of charging time. The same is true for the maximum number of intervention days per month, where we also find a negative preference for a higher number of days, but only at a 10 % significance level. Here we find that, on average, respondents are willing to give up €0.30 of monthly remuneration for one less monthly intervention. Regarding the number of opt-outs available, Model 1 suggests a clear positive preference for more opt-outs, with an average willingness to accept of €1.38 for one additional opt-out. Regarding information provision, we find that respondents have a general preference for any of the given information provision options compared to receiving no information at all. Daily information about possible upcoming interventions appears to be the most preferred, with respondents willing to forgo €14.05 of monthly remuneration to receive it. For weekly information, respondents indicate that they are willing to give up €11.99 of their monthly remuneration. Finally, respondents show a fairly strong preference for hourly information, with an average willingness to accept of €8.34.

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