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Dynamic Electric Vehicle Charging Tariffs: A Preference Analysis of German Consumers

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To meet the climate targets outlined in the Paris Climate Agreement, the participating nations have committed to reducing their CO2 emissions. While the share of renewable energy sources in electricity generation has increased dramatically over the last decade (International Energy Agency), the CO2 emissions from the road transport sector in the European Union (EU) have risen by approximately 21% since 1990 (Eurostat, 2024). To counteract this trend, comprehensive electrification of passenger car transport based on renewable energies is necessary. Currently, electric vehicles (EV) account for only 1.2% of the European car fleet (EEA, 2023). An enormous increase is needed here, which, on the other hand, also means a significant increase in electricity demand, and thus the amount of electricity that needs to be generated from renewable energies. An increased supply of electricity from renewable energy sources poses significant challenges for the electricity sector. The irregularity of electricity generation from renewable energy sources can lead to grid congestion and thus to grid instabilities. The growing adoption of EVs exacerbates this problem because simultaneous, unmanaged charging increases electricity consumption and puts additional pressure on the grid (Huang et al., 2021). One possible solution to this problem are smart charging concepts. We analyze the preferences of consumers regarding dynamic tariffs when charging electric vehicles are examined in a large-scale discrete choice experiment with a high level of individualization in a representative sample of households in Germany. Specifically, this paper addresses a type of dynamic tariff which is situated between time-of-use tariffing and real-time tariffing, meaning that it is potentially flexible to a degree which is exceeding what is found in practice, while still being less flexible than complete real-time tariffing. With a representative sample of 7,150 participants, the findings will offer information about how consumers judge various attributes of dynamic tariffs of electric vehicles. Our main findings reveal that customers, on average, display a preference for dynamic EV tariffs over a static fixed-price tariff. This result contradicts some of the existing findings
that potential increasing costs and an active user role during charging lead to low acceptance of dynamic electricity tariffs. We find that our respondents show stronger preferences against additional costs, which indicates that customers are rather risk-averse. These two emphases
imply that customers are driven by risk-aversion when choosing among dynamic tariffs for EV charging. In addition to risk considerations, it was observed that the respondents also demonstrate preferences related to other attributes of dynamic tariffs. Notably, respondents show preferences for tariffs with fewer zones of low/high prices within a day. This reflects that complexity plays an important role in tariffs. Preferences related to the timing of low- and high-price zones suggests that the respondents have no clear preferences for when prices are high, but show clear preferences for low prices during midday. This result suggests
that the advanced communication of prices plays a central role in consumer acceptance of dynamic EV charging tariffs. The heterogeneity analysis also shows that there is a large degree of variation in preferences among different respondent characteristics. Of particular note is the fact that non-adopters or future adopters of EVs have a strong preference for dynamic tariffs in comparison to adopters of EVs. This is an important implication regarding the potential for dynamic tariffs to influence expectations and behavior related to charging in the still early stages
of EV diffusion. A further implication is that respondents with high annual mileage show strong preferences against the risk of additional costs, which may reflect a higher probability of exposure to charging costs and a greater demand for cost predictability. There are also a number of socio-demographic and attitudinal factors that play a significant part in preference heterogeneity, including age, gender, patience, institutional trust,

and political beliefs. A number of implications arise from these findings. Firstly, the existence of strong preferences against possible additional costs indicates that the adoption of dynamic tariffs by consumers in relation to charging their electric vehicles will be significantly dependent on managing risks. Regulators could propose strategies involving the promotion of tariffs with inherent risks managed through maximum possible price caps, or ceiling rates for possible additional costs. Second, the general preferences against a higher number of daily price changes suggests that tariff complexity needs to be handled cautiously. This is because, although lower pricing complexity could enhance efficiency at an organizational level, it might have a negative effect on consumer acceptance. Third, the observation that both non-EV owners and prospective EV buyers display a strong attitude towards dynamic tariffs implies that the availability of dynamic tariffs and the communication of their benefits and risks might be a future driver for EV adoption. Fourth, the presence of heterogeneity in preferences means that differentiated policies to promote the adoption of dynamic EV charging tariffs might be needed. High-mileage car users may have a higher willingness to pay when given additional support options that could shield them from peak periods with higher prices, for example by periodically opting out of very high prices. In more general terms, tailored communication strategies should be employed to reflect heterogeneity with respect to risk concern.
In conclusion, our the results of our study indicate that dynamic EV charging tariffs have the potential to be widely adopted by consumers, given that the potential risks are minimized and clearly communicated.

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