THE ECONOMICS OF SLOW PUBLIC CHARGING FOR ELECTRIC VEHICLES

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Overview

Most public charging stations for electric vehicles (EVs) in the United States consist of slow chargers installed at the premises of pre-existing businesses, such as grocery shops or restaurants. These stations provide a lower-quality service than their fast-charging counterparts, and are in direct competition with home and workplace charging. As a result, one may wonder why so many such charging stations are installed and whether there exist a significant risk of over-investing in slow public charging stations. For example, Rapson and Muehlegger (2021) note: "*there is growing evidence that the majority of day-to-day charging occurs at home, rather than at public charging stations. While this doesn't necessarily speak to the utility of expanding the fast-charging network, it calls into question the public benefit of deploying government resources towards more public level 2 charging stations*."

This paper discusses the economics of slow public charging stations for EVs. We first derive how a social planner or a profit-maximizing charging station owner would be expected to price EV charging sessions. We then confront our normative theory to the price schedules for charging stations actually observed in the United States. We find that our theoretical predictions are in sharp contrast with empirical observations. We further analyse empirically the actual decisions by charging station owners and derive stylized facts suggesting that hosting facilities may be primarily interested in installing charging stations as a way to attract more customers to their core business. We thus construct and solve a model of imperfect competition to study the decision of hosting facilities to install a charging station.

Methods

We use a mix of theoretical models and empirical observations. Theoretical models use standard tools and assumptions from microeconomics and industrial organization to characterize optimal pricing and investment. Original assumptions and modelling techniques are introduced to capture the main fundamental characteristics of EV charging. The empirical analysis primarily relies on a dataset listing charging stations in North America publicly available on the Alternative Fuels Data Center by the U.S. Department of Energy. A first part consist in computing stylized descriptive facts on charging price schedules from the dataset. A second part, currently work-in-progress, will seek to complement this dataset with additional data sources on customer mobility in order to use quasi-experimental methods.

Results

On the theoretical front, we derive a simple model to describe the economics of slow public charging stations. Our model seeks to capture key economic intuitions in a parsimonious way. We show that the price of a charging sessions should in theory include both an energy fee (in $/kWh) to reflect the cost of electricity, and a duration fee (in $/min) to reflect the opportunity cost of parking space. We further note that parking space is generally allocated inefficiently (first-come first-served instead of efficient rationing). When this latter inefficiency can be neglected, the problem of designing and pricing charging stations has a formal analogy with the well-known peak-load pricing problem. Second, we derive a simple model of imperfect competition where hosting facilities may invest in charging stations as a way to poach customers from their competitors. We find that hosting facilities may face a prisoner dilemma game, where the possibility to invest in charging stations increases the intensity of competition, making them worse off in equilibrium. Whether investment incentives are distorted relative to the first-best outcome is however ambiguous, and depends on the nature of competition imperfections.

On the empirical front, we expand the analysis of Arlt and Astier (2020) and provide a comprehensive description of the observed pricing structure for public charging station in the U.S. We find that, in contrast to theoretical predictions, most charging stations bill by either energy or time, but not both. Further empirical work is on-going which uses quasi-experimental methods to estimate causal impacts of charging station installations on customer characteristics and tests whether they are consistent with our modelling assumptions.

Conclusions

This paper confronts normative theoretical models to empirical observations to analyze the rationale behind owners' decisions to install a charging station. We note that (i) observed pricing behavior depart very significantly from the first-best pricing strategy of a social planner or a monopoly ; and (ii) a couple of empirical observations suggest that hosting facilities installing slow public charging stations may be primarily looking for the positive spillovers on their core business. Building on this hypothesis, we explore an imperfect competition model to assess whether such a situation may yield over or under-investment in slow public charging stations relative to the first-best outcome. We find that the resulting level of investment need not be inefficient, at least in a static setting.

We thus get an ambiguous answer to our main question of interest: although hosting facilities seem not to pay too much attention about the economics of EV charging, this observation does not necessarily imply that the currently observed level of investment in slow public charging stations are socially inefficient. Our results however point to the importance of accounting for the heterogeneity of the different segments of the market for EV charging. We indeed find that businesses hosting slow public chargers tend to price EV charging in a somewhat *ad hoc* way, and may have a very limited interest in the EV charging business. In contrast, a number of integrated charging networks are fully dedicated to EV charging. Due to the very distinct nature of the two types of charging stations, using the number of charging stations or plugs to represent the supply side in a model of the EV charging industry may thus prove misleading in some applications.

References

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