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Capturing the usage of the German car fleet for a one year period to evaluate the suitability of battery electric vehicles – a model based approach

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Abstract

The low driving range of battery electric vehicles (BEV) is often considered as relevant reason for the low BEV sales. In order to verify this assumption, the usage of conventional cars in Germany needs to be analyzed. These analyses may help to make more reliable and realistic statements to what extent German cars could be replaced by BEVs without restrictions for their users. Most travel surveys do only consider a single day or a short period of time in the analysis. Longer time periods should be taken into consideration when analyzing the travel data since the daily car usage is not identical every day. Since there are no representative and detailed car usage surveys over longer periods available a hybrid car usage model was developed to close that gap. This model is mainly based on three mobility surveys: the German Mobility Panel (MOP), the car mileage and fuel consumption survey, and the long distance travel survey INVERMO. We show that 13% of the modeled German private car fleet never exceeds 100 km per day during a full year and could be replaced by BEVs without any usage restrictions for their car owners. Another 16% of the modeled private car fleet is driven more than 100 km on 1-4 days during a full year and can be substituted with slight adjustments. These cars are often second cars of a household and used less intensively (6,600 km/year resp. 7600 km/year) than cars not suited for BEV substitution (14,800 km/year). Households that could replace their cars tend to have a lower disposable income. The crux of the matter, however, is that substitution of conventional cars is often not feasible since the mobility budget of BEV suited households tends to be too low or does not make economic sense due to the low annual mileage.

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Keywords: Car usage; daily car mileage; electric mobility; long distance travel; battery electric cars

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1. Introduction

The German Government targets to increase the electric vehicles' share in Germany to 1 million cars in 2020 (BMVBS, 2011). However, the penetration of electric cars is very low at present: in 2012 there were only 4,500 battery electric vehicles (BEV) and 47,600 hybrid vehicles registered in Germany (KBA, 2012). The low driving range, about 100 km under real life usage conditions, and the long recharging processes, which is six to eight hours with normal charging, of BEVs (ADAC, 2013) are considered as mayor reason for the low BEV sales. In order to verify this assumption, the usage of conventional cars in Germany needs to be analyzed. These analyses may help to make more reliable and realistic statements to what extent German cars could be replaced by BEVs without any restrictions for their users. Most travel surveys do only consider a single day or a short period of time, e.g. one week, in the analysis. However, the daily car usage is not identical over a certain period because the car owners use their car for daily routines, e.g. commuting to work as well as for rather seldom events such as holiday trips. Consequently, longer time periods, e.g. for a full year, should be taken into consideration when analyzing the car travel behavior.

2. Research question and literature analysis

In the first place, it is important to analyze how many cars of the German car fleet could be replaced by BEVs according to the cars' daily mileage observed over one year. However, we should also consider which types of cars could be replaced, how they are used over a year and what the owners' socio-demographic background is in order to evaluate the bare number of replaceable cars. Can households owning a replaceable car even afford to buy a BEV? Is it worth to replace a car by a BEV regarding its annual mileage or the owners financial situation? Considering these questions would probably lower the number of replaceable cars.

In order to answer these questions, a high quantity and quality of data is necessary. Several studies in the US (Gonder, et al., 2007; Bernard, 1996) try to estimate the potential of EV's with either National Household Travel Survey (NHTS) data or GPS survey data of one day. Bernard (1996) shows that 91 % of the vehicles that were used in the survey day travelled less than 161 km. These results may suggest the deduction that those cars could be replaced by BEVs. However, Aultman-Hall et al. (2012) notice that the lack of longitudinal data leads to an overestimation of EV's potential.

To our knowledge, only one longitudinal car travel survey is available. These data were conducted by GPS in the Atlanta, Georgia metropolitan area with a sample size of 470 cars that were observed 50 days to 3 years (Pearre, et al., 2011). They found that the share of cars that is not used for LD-travel is rather low: only 9 % of the cars in the sample never exceed 100 miles within a day during one year. This finding is in contrast to the results based on survey data covering only one day. Lin and Greene (2011) show that their results only based on uniform daily vehicle miles travelled differ significant from their results based on varying daily vehicle miles travelled considering the total energy use of PHEV's. Thus, the analyzed surveys must consequently be longitudinally oriented (periods instead of single days). This requirement explicitly excludes data of the usually cross-sectional oriented national travel surveys.

The idea and approach in this paper is to analyze, compile and collate the car uses for a longer period based on existing data of different granularity. We refined and developed the analysis approach of Chlond et al. (2011) further. The methodology allows identifying vehicles with different probabilities and frequencies of car uses for a period of one year. Therefore, we develop a "hybrid" approach which provides detailed estimations on the driving mileage for each day during the period of one year. These model data are used for a disjoint cluster analysis in order to identify cars that could be replaced by BEVs.

3. Data used

We use two mayor surveys which describe the everyday and the long distance mobility for our model: the German Mobility Panel (MOP) and the long distance survey INVERMO.