Electric vehicle users and travel patterns in Greater Stockholm

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Introduction

The electric vehicle (EV) is considered to be a more environmentally friendly alternative for the conventional car using fossil fuels because of the absence of local emissions and a more energy efficient engine. When making emission estimates, it is generally assumed that the travel behaviour of car users stays stable regardless of whether people use an electric vehicle or a conventional vehicle (e.g. Kim and Rahimi, 2013). However, because of the higher investment cost of electric vehicles and the assumed lower operation cost, people may be tempted to change their behaviour, which could partially offset the beneficial effect of the EV. On the other hand, because of range anxiety and real range limitations, there may be a group of EV users who will drive shorter distances.

Background

An early study about stated behavioural adaptations as a result of electric vehicle use concluded that many household are quite flexible in changing their travel patterns when facing a situation with an electric vehicle with a limited range (Kurani et al., 1994). Klöckner et al. (2013) investigated the effect of electric vehicle use on distance travelled in Norway and found that the stated total mileage of electric vehicle users is larger than in households without electric vehicles. Furthermore, they also found that the share of the car in the total number of trips is higher than in case of households without electric vehicles. However, it was not known whether the respondents travelled further and whether they replaced slower modes trips by car trips after switching to an EV, which would imply a rebound effect as described in Berkhout et al. (2000).

Aim

The aim of this study is to explore whether electric vehicle users have different travel behaviour patterns than non-electric vehicle users, with regard to the number of trips they make, the distance travelled and their mode choice. A shift towards more sustainable modes is propagated in the framework of Sustainable Urban Mobility Plans (European Commission, 2013). Modal split is defined as the number of kilometres travelled by a certain travel mode divided by the total travel distance travelled on the given day.

Methodology

For this study, a survey with a one-day travel diary has been conducted among a group of active drivers in Greater Stockholm who were driving at least once a week. The group consists of EV users (N=121) and non-EV users (N=173). For each trip, the respondent indicated the travel mode he/she had used for all stages, the address of the origin and destination, the time he/she travelled, trip purpose and in case of multimodal trips the location of all interchanges. Based on the reported addresses, the distances between the origins and destinations have been estimated. The travel diary has been complemented with questions about general travel behaviour and attitudes towards the environmental impact of personal transport as well as towards the electric vehicle.

For preliminary comparisons of scale variables, independent t-tests are used. For comparisons of the modal split, non-parametric tests (Kruskal-Wallis test, Mann-Whitney-U test and Wilcoxon Signed Rank Test) are used because the dependent variable modal split is the ratio of two normally distributed variables and cannot be assumed to be normally distributed (Kronmal, 1992). For categorical analysis, the Chi-Square test is used.

Results

Out of 121 electric vehicle users, only seven respondents report to have a battery electric vehicle as their only vehicle and are therefore bound to the range limitations this vehicle implies. Most EV users have either a plug in hybrid vehicle (PHEV) or they have more than one car in their household. Based on preliminary indicators, that in the final analysis will be controlled for socio-economic characteristics, EV users seem to make more trips than conventional car users (independent t-test, p=0,055*) Moreover, regular electric vehicle users use the car for a larger part of their total distance travelled (Mann Whitney-U, p=0,005***, with distance constraint 0 km< total distance < 250 km).

Among all respondents, the perceived negative environmental impacts (in general, per km) of the electric vehicle are significantly lower than the perceived environmental impact of the train, (Wilcoxon, p=0,011**), the metro (Wilcoxon, p=0,024**) and the bus (Wilcoxon, p=0,000***). The stated use of public transport is significantly lower among electric vehicle users than among non-electric vehicle users (Mann-Whitney-U, p=0,000***). The same is found for the use of the bicycle (Mann-Whitney-U, p=0,032**). A possible reason for this is the perception that the electric vehicle has less environmental impact than the public transport modes. Type of housing has a significant correlation with the modal split (Kruskal-Wallis, p=0,003***), where single-family home owners seem to drive more. Single-family home owners also seem to be more likely to use EVs (Chi-Square, p=0,000***). No significant correlation between modal split and income (Kruskal-Wallis, p=0,249) or education (Kruskal-Wallis, p=0,282) has been found.

After having found significant behavioural differences between EV users and non-EV users, regression models were estimated in order to control for socio-economic and situational variables. Both for the number of trips made (Poisson-regression), and for the modal share of the car (Tobit-regression), a statistically significant correlation between EV-use and travel behaviour was found. The EV users have made significantly more trips and they have used the car for a significantly higher percentage of their total distance travelled.

Discussion and future research

The preliminary results suggest that electric vehicle use might stimulate car use rather than the use of more sustainable travel modes such as public transport and bike. As car use still implies a large use of energy and space and contributes to traffic congestion, this is an undesirable side effect of the introduction of the electric car. Policy measures should not only focus on the purchase of an electric car but also on the use of it, so that a more sustainable mix of the electric car, public transport, bike and trips by foot can be obtained. However, since this is a cross-sectional study, there are limitations. A longer period, within-person, approach can shed more light on behavioural changes as a result of the use of electric vehicles. The next step of the analysis will be looking at the results of a stated adaptation study which is based upon the current travel diary study. People can indicate their behavioural adaptations as a result of switching their vehicle to an electric vehicle with a certain range and battery level. Here, also different trip purposes will be taken into account.

References

Berkhout, P. H. G., Muskens, J. C., & W. Velthuijsen, J. (2000). Defining the rebound effect. *Energy Policy*, *28*(6–7), 425–432.

European Commission. (2013). A concept for Sustainable Urban Mobility Plans. European Commission.

Kim, J. D., & Rahimi, M. (2014). Future energy loads for a large-scale adoption of electric vehicles in the city of Los Angeles: Impacts on greenhouse gas (GHG) emissions. *Energy Policy*, *73*, 620–630.

Klöckner, C. A., Nayum, A., & Mehmetoglu, M. (2013). Positive and negative spillover effects from electric car purchase to car use. *Transportation Research Part D: Transport and Environment*, *21*, 32–38.

Kronmal, R. A. (1993). Spurious Correlation and the Fallacy of the Ratio Standard Revisited. *Journal of the Royal Statistical Society. Series A (Statistics in Society)*, *156*(3), 379–392.

Kurani, K. S., Turrentine, T., & Sperling, D. (1994). Demand for electric vehicles in hybrid households: an exploratory analysis. *Transport Policy*, *1*(4), 244–256.

* significant at a 90% confidence level

** significant at a 95% confidence level

*** significant at a 99% confidence level