Transportation Research Part D 52 (2017) 98–111

Contents lists available at ScienceDirect

Transportation Research Part D

journal homepage: www.elsevier.com/locate/trd

Electric vehicle users and their travel patterns in Greater Stockholm

Joram H.M. Langbroek [a,b,*], Joel P. Franklin [a], Yusak O. Susilo [a]

[a] Department of Transport Science, KTH Royal Institute of Technology, Teknikringen 72, 100 44 Stockholm, Sweden
[b] School for Transportation Sciences, Hasselt University, Agoralaan, Diepenbeek, Belgium

ARTICLE INFO

Article history:
Received 1 December 2015
Revised 21 December 2016
Accepted 20 February 2017
Available online 8 March 2017

Keywords:
Electric vehicle
Travel behaviour
Trip production
Mode choice
Rebound effect

ABSTRACT

Electric vehicles (EVs) show promise for improving the environmental sustainability of the transport system since, as opposed to conventional vehicles, they have no tailpipe exhaust gas emissions. The use of EVs can also decrease the amount of greenhouse gas emissions, especially if the electricity has been generated with renewable energy sources. However, the scale of projected benefits can be questioned since the travel patterns of car drivers may not stay the same after changing to EVs, due to various factors such as higher investment costs, lower operation costs and general perceptions associated with electric vehicles. In this study, the travel patterns of both electric vehicle users and conventional vehicle users in Greater Stockholm are compared with regard to the number of trips made and the modal share of the car in the total travel distance. For this purpose, a one-day travel diary carried out in autumn 2014 has been used. The main findings are the following: firstly, the EV is generally perceived by respondents to be more environmentally friendly than public transport modes. Secondly, EV users make significantly more trips than their non-EV using counterparts, according to their one-day travel diaries and controlling for socio-economic and situational variables. Thirdly, EV users choose the car for a significantly larger percentage of their total travel distance than conventional vehicle users. Those observations would suggest a rebound effect, as EVs still consume a considerable amount of energy and contribute to other external effects such as congestion.

© 2017 Elsevier Ltd. All rights reserved.

1. Introduction

The electric vehicle (EV) is widely considered to be a more environmentally friendly alternative to the internal combustion engine vehicle (ICEV), due to the absence of local exhaust gas emissions and a more energy efficient engine (Åhman, 2001). There is, ceteris paribus, less local air pollution in case an EV replaces an ICEV, the effect of which is strongest on roads in high density urban areas with high traffic intensity. Therefore, switching to electric vehicle use might decrease both energy use and environmental and health problems related to personal transport.

However, when making estimates of the environmental impacts of large scale EV adoption, it is often assumed that the travel behaviour of car users remains constant, regardless of whether people use an electric vehicle or a conventional car (e.g. Kim and Rahimi, 2014). This assumption could imply an overestimation or an underestimation of the environmental benefits

* Corresponding author at: Department of Transport Science, KTH Royal Institute of Technology, Teknikringen 72, 100 44 Stockholm, Sweden.
E-mail addresses: joram.langbroek@abe.kth.se, joram.langbroek@uhasselt.be (J.H.M. Langbroek), joel.franklin@abe.kth.se (J.P. Franklin), yusak.susilo@abe.kth.se (Y.O. Susilo).

http://dx.doi.org/10.1016/j.trd.2017.02.015
1361-9209/© 2017 Elsevier Ltd. All rights reserved.

of a transition towards EVs if travel behaviour patterns change after EV adoption. Most of the current travel behaviour research on electric vehicles from a user perspective focuses on whether the current travel patterns of ICEV users are compatible with electric vehicles (De Gennaro et al., 2014; Pearre et al., 2011). Less is known about potential behavioural changes that occur after adopting electric vehicles or behavioural differences between EV users and non-EV users. These differences have an influence on the environmental benefits of a large-scale transition towards EVs. A rebound effect (e.g. Berkhout et al., 2000) would occur if trips currently made by public transport or active travel modes would be replaced by electric vehicle trips or if EV users would make additional car trips, so that car use increases. Part of the "gains" of investing in a transition towards EV use would then be eroded. There are several reasons why increased car use, be it with electric vehicles or otherwise, is undesirable. Electric vehicle use still implies a large use of energy and road space, and it contributes to overall traffic congestion. There also remain local non-exhaust PM emissions, such from brake and tire wear (Van Zeebroeck, 2014).

The main notion in this paper is that the environmental benefits of EVs depend on how these vehicles are going to be used. Future electric vehicle use driving patterns are assumed to be heavily influenced by current car use, but also by the marginal cost of electric vehicle use (the cost per additional EV-kilometre) as well as symbolic attributes such as the perception EVs' environmental profile. The aims of this study are to investigate how people perceive the electric vehicle's environmental friendliness, to explore the travel behaviour of EV users and to investigate whether electric vehicle users have significantly different travel behaviour patterns than non-electric vehicle users, with regard to the number of trips they make, the distance travelled and the performance based modal split of the car. The hypotheses for this paper are the following:

1. Electric vehicles are perceived to be intrinsically environmentally friendly, compared to other modes of transport.
2. Electric vehicle users tend to make more trips in total than conventional vehicle users do.
3. Electric vehicle users tend to use the car for a larger share of their total distance travelled than conventional vehicle users do.

The modal split for car is here defined as the number of kilometres travelled by car divided by the total travel distance travelled on a given day. We use a travel diary of a sample EV users and non-EV users in Stockholm, Sweden. Distinct from its neighbour Norway, Sweden does not have as wide-ranging policy measures that decrease the marginal costs of EV use, such as free parking or congestion charge exemptions. Rather, in Sweden the benefits for EV owners include reductions in the purchase cost and the yearly road tax, as well as a subsidy of up to 4000 euro when purchasing an EV (Swedish Transport Agency, 2015). Electric vehicles are still relatively few in number in Greater Stockholm. In September 2014, approximately 300 Battery Electric Vehicles (BEV) and Plug-in Hybrid Electric Vehicles (PHEV) were privately owned by inhabitants of Greater Stockholm, which implies a penetration rate of less than 0.5% (Swedish Transport Analysis, 2015). When also including company cars and cars owned by public administrations, there were 907 battery electric vehicles (BEVs) and 1850 Plug-in Hybrid Electric Vehicles (PHEVs) registered in Greater Stockholm. Current EV users can be considered as "early adopters" of this new technology.

The remainder of this paper consists of a background section (Section 2), followed by a description of the data collection process in Section 3. The descriptive and inferential analyses are elaborated in Section 4. In Section 5, the results are discussed and directions for further research and policy implications are described. In Section 6, the conclusions are summarised.

2. Background

This section describes theoretical and empirical research relevant to the travel behaviour of EV users. In Section 2.1, the concept of marginal cost of car use is described and how the cost structure of electric vehicle ownership and use deviates from that of conventional vehicle ownership and use. In Section 2.2, empirical findings about electric vehicle use are described. This Section provides the basis for the hypotheses that have been described in Section 1.

2.1. Marginal cost of car use

There are several reasons to suspect that travel behaviour might not stay constant when people change to electric vehicle use. Bamberg et al. (2009) stated that travel behaviour is goal-directed and prone to take positive and negative feedback into consideration. The consecutive choices that people make have an influence on the transport system and the external effects that this transport system causes, which again influence people's travel behaviour. In this paper, the use of electric vehicles is described with this reasoning. When experienced car users adopt electric vehicles, they have certain travel behaviour patterns as a starting point in order to be able to perform activities at different locations. Due to the characteristics of electric vehicles, there is both positive and negative feedback on car use shaping adapted travel behaviour patterns. Finally, these new patterns influence the transport system and its external effects.

Is the electric vehicle a perfect substitute for the conventional vehicle? Due to both range anxiety and real range limitations of EVs (Franke and Krems, 2013a), some EV users may drive shorter distances than they would have been able to drive with ICEVs. Much emphasis has been put on the limitations of electric vehicles that hamper the uptake of these vehicles. On

Download English Version:

https://daneshyari.com/en/article/5119254

Download Persian Version:

https://daneshyari.com/article/5119254

Daneshyari.com