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Travel patterns and the potential use of electric cars – Results from a direct survey in six European countries ☆

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ABSTRACT

A significant penetration of electrical drive vehicles (EDVs) in the fleet is possible only if their use is compatible with mobility patterns of individuals. Building on the analysis of car mobility patterns by means of web-based car trips diaries filled in by a sample of individuals in six European countries, this paper provides insights on how EDVs could fit mobility habits. Critical aspects related to driving behaviour, which should be considered to allow the penetration of electric cars in the market, are identified. Among others results, we show that average daily driven distance in 6 countries ranges from an average of 40 km (UK) to an average of 80 km (Poland) and the parking time after the last trip of a day amounts to more than 16 h per day. These findings show that the current drive and parking behaviours are in line with the range limitation of current EDVs and the potential need for a full slow recharge of an average EDV battery. Our results are a starting point for the estimation on energy demand profiles to assess how electrical energy supply can meet demand under the assumptions of a wide market share of EDVs.

1. Introduction

Personal mobility has evolved as a distinctive trait of modernity in Europe. Passenger cars have played a major role in improving the comfort and safety of personal mobility over the last decades. Indeed, the history of easy personal mobility is intrinsically related to the history of mass motorization. Personal mobility and personal cars are deeply embedded in the core of Europe's economy. According to the latest available data, the European automotive sector turnover accounted for 5.3% of the total EU GDP in the year 2009, provided directly 6% of all EU jobs in manufacturing and, indirectly, 5% of total EU employment [1]. The increase in personal mobility through passenger cars brought not only benefits but also related negative externalities such as increases in congestion and greenhouse gas emissions to quote the major ones. Due to this, the mission of transport policy is often interpreted as mitigating negative effects of transport without curbing mobility.

One of the aims of the 2011 European Transport White Paper [2] is to 'grow transport and supporting mobility while reaching the 60% emission reduction target by 2050.' It also includes the objectives of halving the use of 'conventionally fuelled' cars in urban transport by 2030.

1.1. EDV

Electric-drive vehicles (EDVs) are in the forefront of such non-conventional transport technologies. Nevertheless, in some respects, they still lag behind conventional vehicles, namely because of low driving range and refuelling speed, and progress in this area is relatively slow. Thus, in the short and medium terms, the penetration of EDVs in the market would depend on the breakthroughs primarily in battery

☆ The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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technology but also on how they can fit driver needs even though their features are not the same as those of conventional cars. A large share of EDVs in the fleet would result in an increase in daily electricity demand induced by vehicle charging. Other relevant factors determining the energy demand are the charging time and charging patterns of the EDVs as addressed by Pasaoglu et al. [3].

In the absence of a larger scale EDV market share and resulting field data, a detailed description of car usage, driving and parking patterns of current vehicles is a crucial source of information to anticipate the potential impact of EDVs on the energy system and their potential to be adopted in daily life [4,5]. Pasaoglu et al. [3] have done an extensive overview of how the travel information and surveys can be used for this purpose. Our approach is to analyse car drivers' travel data collected in a web-based self-administered travel diary survey as a part of a larger study conducted in six European countries (Germany, Spain, France, Italy, Poland and the United Kingdom) that in 2011 represented a market share of more than 75% of the total new sales of passenger cars in the European Union [6]. A survey based on the current individual driving behaviour (i.e. using conventional cars) could not fully capture all the cultural, social, economic drivers and constraints which would affect the use of electric cars. Nevertheless, in our work an effort was made to have a wide coverage of countries and demographic and social groups (e.g. male and female, young and older, active and non-active). Therefore, we are confident that most of the relevant aspects influencing current and potential driving behaviours are taken into account.

This paper, being part of a larger research project aimed at building a database of load profiles for EDVs, examines some driving habits derived from the survey results which are more significant in relation to the use of electric vehicles. The structure of the paper is the following: Section 2 briefly discusses the survey methodology and its strengths and weaknesses; Section 3 then presents some indicators of the drive and parking patterns and their relevance with the electrical vehicle usage potentials; and, finally, Section 4 presents the conclusions of the study.

2. Methodology

2.1. National survey analysis and survey design

Firstly, we conducted a meta-analysis of available European National Travel Surveys (NTS) to determine their sufficiency for our purposes [3]. It revealed that only the UK NTS was detailed enough to derive data that would be needed for understanding potential future impacts of EDVs.

We proceeded with a direct survey to obtain comparable and detailed data for six countries.

Our direct survey in the form of a web-based questionnaire included four dedicated sections. The introductory section asked demographic information about the interviewees such as age, education level, living area, professional status, etc. The second part of the survey focused on personal mobility with special reference to car usage. This section of the survey also asked questions on the features of the cars driven by the interviewees. The third and core part of the survey was a web-based self-administered travel diary covering a period of 24 h for each of 7 consecutive days. The interviewees were asked to report detailed information for each of their car trips made as the driver over one week. The collected information through the travel diaries were departure time and place, arrival time and place, travel distance, travel purpose, parking place, short intermediate stops (less than 10 min), and usage of motorways. The fourth and final section of the survey was devoted to understanding the level of awareness a person has about electric cars and to estimate their propensity to purchase an electric car in the future.

The questionnaire was administered in the form of Computer Aided Web Interview (CAWI). In comparison to the other alternatives (e.g. telephone interviews, paper diaries) this solution has some advantages; first of all, it is cheaper [7], which allowed us to involve a sample of around 600 individuals in each country. This sample size would have been unaffordable with other techniques. The online questionnaire was accessible to individuals from 4 p.m. to 12 p.m. every day. A reminder was sent daily by e-mail in order to keep the interviewees aware of their task. Interviewees were encouraged to access the online diary and report their travel diary, even if they did not make any car trips in that particular day. If they missed to fill in the questionnaire one day (or if they made more trips after compiling the questionnaire on a given day), they were able to update the diary later. However, interviewees who did not access the diary for three consecutive days were screened out.

Furthermore, a printable form was annexed to the online questionnaire in order to help the interviewees record their travel details correctly. The interviewees were instructed to print the form and keep it in the car to report departure and arrival times, as well as the related trip distance[1] of each journey.

2.2. Representativeness of the sample

In setting the theoretical sample, it was further decided to opt for a non-proportional distribution in relation to the universe, for the demographic variables of gender by age groups, level of education, and occupational status. On the one hand, the reason was to facilitate the interpretation of the data (i.e. by increasing the sample size of strata which otherwise would be very small) and, on the other, it maintained homogeneity between the various countries, enabling them to be compared. In relation to the education and employment statuses, there was another reason for a non-proportional distribution of the sample: i.e. that the proportions of the knowledgeable universe (based on the available official sources) underestimate the share of occupied and educated people because they include underage inhabitants. The size of the strata in the population was estimated based on several sources. As far as possible the same source (namely EUROSTAT) was used across countries for the sake of homogeneity and comparability [8]. However, in many cases, EUROSTAT statistics were not detailed enough for the purposes of our estimations and national sources were used instead [9–13].

[1] They were suggested to report the numbers shown by the odometer.