



Charge up then charge out? Drivers' perceptions and experiences of electric vehicles in the UK



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ABSTRACT

The UK government has made substantial investments in electric transport as a potential means of reducing CO₂ emissions (DoECC, 2012). This paper investigates responses to recharging plug-in battery electric vehicles from the perspective of electric vehicle (EV) drivers. Drivers in the UK Ultra Low Carbon Vehicle trial ($n = 135$, 29% female, $M = 47$ years) completed questionnaires and were interviewed to assess their attitudes and experiences before they obtained their EV and after driving the EV for 3 months. The results demonstrated that drivers were positive about recharging – preferring it to ‘refuelling’ – and they became more relaxed over time about the frequency of recharging. Drivers managed without using a public charging infrastructure although such an infrastructure may be desirable to promote EV use. Finally, there was an interesting difference in drivers’ awareness of the environmental impact of driving and recharging an EV before and after the trial in relation to CO₂ emissions and the energy cycle. The results are discussed in relation to the implications for developing the future EV market.

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1. Introduction

Plug-in battery-electric vehicles (PBEVs) are those that have an all-electric drivetrain and are powered from a battery that is recharged from an external electricity supply. A PBEV (hereby abbreviated to EV) charged with grid electricity produces 100 g CO₂/km (Anable et al., 2006) compared to 138 g CO₂/km for an average new car in the UK in 2011 (Society of Motor Manufacturers and Traders, 2012). EVs thus have the potential to reduce the UK’s dependency on oil and decarbonise road transport, which accounts for approximately one quarter of UK CO₂ emissions (Department of Energy and Climate Change, 2013). In the UK, public awareness of EVs is on the increase owing to government policies supporting EV commercialisation and increasing media attention. Public perceptions of EVs have recently been described as being at a ‘tipping’ point, with many people holding *Ambivalent* stereotypes of EVs as opposed to negative stereotypes (Burgess et al., 2013). We therefore require a practical assessment of the extent to which EVs can fulfil daily travel needs and become an integral part of daily mobility if they are to become stereotyped positively and enter the mainstream vehicle market.

The key differences between EVs and conventional vehicles powered by an Internal Combustion Engine (ICE) are how energy is stored on board and the behaviours required to transmit power to the vehicle. EVs are powered by electrical energy, which is stored in bulky batteries (usually Lithium-Ion) whereas a vehicle with an ICE is powered by liquid fuel, which is stored in a relatively compact fuel tank. Powering an ICE requires the driver to visit a petrol station for a few minutes whereas EVs are powered by ‘plugging-in’ to an external mains electricity supply. Recharging an EV typically takes longer than refuelling an ICE, thus it is envisaged that it will usually be recharged overnight at home, with the cost of energy being

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paid for through the domestic electricity supply. EVs offer significantly cheaper running costs, costing around £2 to £3 to charge for a typical range of 100 miles compared to £12 to £18 for an equivalent petrol or diesel car to drive 100 miles (Energy Saving Trust, 2013). Recharging an EV thus requires drivers to learn new behaviours and establish new routines relating to how, when, where, and for how long to connect their vehicle to an electricity supply for recharging.

With these differences in mind, this report examines EV drivers' expectations and actual behavioural responses to powering an EV, as well as their attitudes towards EVs as contributing to reducing the UK's CO₂ emissions. Although issues involving recharging EVs are interlinked with vehicle range (because range is affected by the duration and frequency of recharging opportunities), range has been addressed elsewhere (e.g., Franke and Krems, 2013a; Franke et al., 2012; Pearre et al., 2011) and will not form part of this paper.

Currently the general public have a limited understanding of EVs as well as misconceptions about their perceived inadequacies (Lane, 2011). Unsurprisingly, previous research examining attitudes towards EVs amongst potential buyers has found little enthusiasm for paying more for a car that appears to be less convenient than a conventional vehicle (Chéron and Zins, 1997). In a recent survey study by Krause et al. (2013) 2302 urban resident drivers from the US were questioned about their knowledge of EVs. The results revealed a high number of misconceptions over purchase price, driving range, operating costs and recharging time. For example, 70% of drivers underestimated the extent of fuel savings (see also Carley et al., 2013; Dagsvike et al., 2002). Similarly, in a survey of 500 UK consumers, over 70% reported that they would worry that they would run out of charge quickly, that recharging the car would be inconvenient and that they might not be able to travel as far as they needed (Smart, 2010). Similar attitudes have been found in other countries including Sweden (Gärling, 2001) and Belgium (Lebeau et al., 2013) with negative perceptions revolving around recharging time, the financial cost of electricity, and driving range.

In contrast, EV drivers have emphasised advantages of powering an EV over refuelling conventional vehicles. In a trial conducted by Graham-Rowe et al. (2012) 40 participants ($M = 41.5$ years) living in the South of England, UK, were interviewed after they had driven an EV for 1 week. Drivers reported that the charging process was straightforward and convenient, but one of the most valuable attributes was the ability to recharge the vehicle at home: "You can actually plug it into your own mains... whenever it suits you" (p. 146). Although this trial was only 1 week long, the findings are supported by a much larger 6 month field trial of 80 MINI E drivers in Berlin (Franke and Krems, 2013b). In that trial, 71% of drivers preferred recharging (at home or at a public charging site) compared to refuelling at a gas station, and 87% agreed that charging was easy although some (57%) found the charging cable cumbersome.

EV drivers have also reported that they enjoy substantial savings on the cost of powering their EV compared to an ICE (Graham-Rowe et al., 2012; Kurani et al., 2008). Most drivers have not, however, performed any specific financial calculations to support their belief that their vehicles actually saved them money on fuel – rather it seems that the *idea* of saving money was important (Kurani et al., 2008; Turrentine and Kurani, 2007).

Despite these positive aspects, some drivers experienced difficulty with lengthy charge times. In the Graham-Rowe et al. (2012) trial some drivers had a negative perception of the time it took to charge the EV compared to the 5 min it takes to refuel a conventional vehicle: "while the car's plugged in, it's marooned, it's in an undriveable state" (p. 146). Participants viewed this time waiting for the car to charge as 'dead time', compromising freedom of movement and flexibility to 'take-off'. In another trial by Gärling (2001), 32 Renault Clio drivers living in a metropolitan area in Sweden were given (free of charge) an electric Renault Clio to drive for 3 weeks. At the end of the trial drivers noted that 50% of their trips could not be completed due to limited range coupled with lengthy charging times. However, this study can be criticised on the basis that drivers may have viewed the vehicles as a 'free gift' and thus not invested the effort required to adapt to driving the EV.

Another potential barrier to EV use concerns the perceived availability of publicly accessible charging points. In the Smart survey (2010), 60% of potential consumers stated that they would only consider buying an EV if the public charging infrastructure (PCI) was improved and 87% agreed that local councils should invest more in the infrastructure. Among drivers who have actually taken part in an EV trial, opinions about the need for a PCI are mixed. In the Graham-Rowe et al. (2012) trial, drivers were anxious about access to recharging points: "[there are] tens of thousands of garages in the country, there's millions of 13 amp sockets, but they're not accessible to you" (p. 146). Similarly, drivers in the US MINI E trials were initially worried about the lack of infrastructure but after 3 months experience realised that these concerns were unwarranted (Turrentine et al., 2011; Vilimek et al., 2012). In the 6 month MINI E trial in Belgium (Franke and Krems, 2013b) 83.7% of charging events took place at home and only 4.8% took place at a public charging station: given that participants drove on average 37 km in the EV per day, this also suggests that the drivers could manage without an extensive PCI. However, when drivers in the Kurani et al. (2008) study of 23 EV owners from the USA experienced difficulties with the lack of public charging points, they received negative reactions from people such as hotel clerks or parking attendants when asking permission to plug-in (see also Caparello et al., 2013). Given that the availability of home charging is such a valued attribute among EV drivers it is unclear whether publically accessible charging points are only necessary from a psychological perspective among potential EV owners (Carroll, 2010; Turrentine et al., 2011).

Previous research has also examined the extent to which consumers believe that EVs can make an important contribution to reducing CO₂ emissions. Only one third of potential consumers in the Smart (2010) study believed that driving an EV can have a positive impact on the environment, which is lower than their belief in other environmentally friendly behaviours such as recycling. In studies of EV drivers, Kurani et al. (2008) found that the desire to use energy generated from renewable sources was strong and some PHEV owners were uncomfortable with using power from coal-generated electricity. In the Graham-Rowe et al. (2012) trial, EV drivers in the UK were similarly uncomfortable about the green credentials of EVs

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