Global Environmental Change 52 (2018) 86–100

Contents lists available at ScienceDirect

Global Environmental Change

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

The demographics of decarbonizing transport: The influence of gender, education, occupation, age, and household size on electric mobility preferences in the Nordic region

Benjamin K. Sovacool[a,b,*], Johannes Kester[b], Lance Noel[b], Gerardo Zarazua de Rubens[b]

[a] Science Policy Research Unit (SPRU), School of Business, Management, and Economics, University of Sussex, United Kingdom
[b] Center for Energy Technologies, Department of Business Development and Technology, Aarhus University, Denmark

ARTICLE INFO

Keywords:
Sustainability transitions
Low-carbon transport
Electric vehicle adoption
Vehicle-to-grid
Electric mobility

ABSTRACT

Many researchers, policymakers and other stakeholders have explored and supported efforts to transition towards more sustainable forms of low-carbon mobility. Often, discussion will flow from a narrow view of consumer perceptions surrounding passenger vehicles—presuming that users act in rationalist, instrumental, and predictable patterns. In this paper, we hold that a better understanding of the social and demographic perceptions of electric vehicles (compared to other forms of mobility, including conventional cars) is needed. We provide a comparative and mixed methods assessment of the demographics of electric mobility and stated preferences for electric vehicles, drawing primarily on a survey distributed to more than 5000 respondents across Denmark, Finland, Iceland, Norway and Sweden. We examine how gender influences preferences; how experience in the form of education and occupation shape preferences; and how aging and household size impact preferences. In doing so we hope to reveal the more complex social dynamics behind how potential adopters consider and calculate various aspects of conventional mobility, electric mobility, and vehicle-to-grid (V2G) systems. In particular, our results suggest that predominantly men, those with higher levels of education in full time employment, especially with occupations in civil society or academia, and below middle age (30–45), are the most likely to buy them. However, our analysis also reveals other market segments where electric vehicles may take root, e.g. among higher income females and retirees/pensioners. Moreover, few respondents were orientated towards V2G, independent of their demographic attributes. Our empirical results can inform ongoing discussions about energy and transport policy, the drivers of environmental change, and deliberations over sustainability transitions.

1. Introduction

The continuing diffusion of privately owned, gasoline-powered vehicles used primarily by single occupants is a major source of several pressing social problems inclusive of deteriorating air quality, aggravated climate change, congestion, and negative alterations to urban form and function. Many policymakers and other stakeholders have explored and supported efforts to transition towards more sustainable forms of mobility, such as more efficient vehicles, vehicles powered by low-carbon fuels, and improved transit and urban density. To date, however, few of these efforts have substantially improved the sustainability of global transportation systems.

Often, academic and policy discussions of mobility or low-carbon transitions have shortcomings. Firstly, they advance a narrow view of consumer perceptions surrounding passenger vehicles—as if the only meaning behind conventional use concerns its basic functions (e.g. a means to get somewhere) and the private financial costs involved in doing so (Chen and Kockelman, 2016). From this limited viewpoint, an alternative mobility paradigm needs only to replicate these functions in a way that is either similar or better than the status quo in order to be successful; other alternatives are marginalized if not entirely obscured (Bergman et al., 2017). Secondly, most techno-economic assessments of innovation or decarbonization have a limited representation of the actors involved (mostly firms and consumers interacting via markets, which are shaped by exogenous policymakers) and overly simplistic models of their decision-making (rational, optimizing) (Stern et al., 2016). Likewise, academic accounts of transitions within the field of automobility studies largely focus on “manufacturers and regulators, strategies and policies” but neglect “consideration of consumers, early adopters, and related ideas” (Wells and Nieuwenhuis, 2012). Thirdly,

* Corresponding author at: Science Policy Research Unit (SPRU), University of Sussex, Jubilee Building, Room 367, Falmer, East Sussex, BN1 9SL, United Kingdom.
E-mail address: B.Sovacool@sussex.ac.uk (B.K. Sovacool).

https://doi.org/10.1016/j.gloenvcha.2018.06.008
Received 10 January 2018; Received in revised form 1 June 2018; Accepted 19 June 2018

many popular conceptual frameworks, such as Rogers "Diffusion of Innovations" approach, represent transitions as tame processes with smooth diffusion curves (Geels, 2014), when in reality they are more abrupt, discontinuous, and unpredictable (Geels et al., 2018). Fourthly, the policy mechanisms literature tends to be gender or demographic neutral (presuming that a single mechanism such as a carbon tax will work across all markets or market segments) and that incentives can be reduced to mere financial numbers (such as $2500 or $20,000 per vehicle) (Hardman et al., 2017). Similarly, some literature argues that diffusion patterns for EVs are politically determined by electric vehicle or transport policy at singular national, state or city levels (Stokes et al., 2018; Heidrich et al., 2017).

In this paper, we argue that such dominant perspectives are ill equipped to deal with the required "revolution" needed to transition to electric mobility. Instead, we hold that any rapid and comprehensive transition to electric mobility will require a combination of technological, regulatory, institutional, economic, cultural and behavioral changes that together transform the sociotechnical systems that provide energy or mobility services (Geels et al., 2017). A central part of this process is better understanding the social perceptions of electric vehicles (compared to other forms of mobility, including conventional cars). This is especially the case given that full battery electric vehicles (EVs) represent not only a consumer choice problem about what car to purchase, but a behavioral adjustment problem given functional characteristics such as limited range and availability of charging. Bockarjova and Steg make the analogy that EV adoption is therefore more similar to health-related challenges such as quitting tobacco smoking or promoting exercise, which require older behavioral patterns to be "broken" and new behaviors "established" (Bockarjova and Steg, 2014). In this process, Bergantino and Catalano (2016: 342) write that "age, gender, working condition and the number of young children have proved to be significant explanatory factors of respondents' psychological profiles."

But how? In this paper, we provide a comparative and quantitative assessment of the demographics of electric mobility and its influence on stated interest in electric vehicles, including the potential for such vehicles to be configured with vehicle-to-grid capabilities (V2G) where they can store energy and offer services to the grid (Sovacool et al., 2017). Based primarily on a survey distributed to more than 5000 respondents across five countries, and supplemented with a comprehensive literature review and bivariate statistical analysis, we examine how perceptions and attitudes towards electric vehicles and V2G differ by gender, education, occupation, age, and household size. In doing so we hope to reveal the more complex social dynamics behind how potential adopters in Denmark, Finland, Iceland, Norway, and Sweden say they consider and calculate various aspects of mobility. We also seek to inform ongoing discussions about energy and transport policy, the drivers of environmental change, and deliberations over sustainability transitions.

While we did not use our data to invent a particular theory or model, in line with other empirical studies (Marquart-Pyatt et al., 2014; Unsworth and Fielding, 2014; Knox-Hayes et al., 2013), our findings can be used to validate existing approaches or generate new ones. We would also underscore the novelty of our approach in terms of emphasizing V2G (extremely rare in the literature), including a comparatively larger sample size (enhancing the validity of our findings), analyzing a sample that included hundreds of actual EV owners and adopters (also a rarity), and looking at a nexus of demographic attributes (gender, education, employment, occupation, age, and household size) rather than only one or few. Ultimately, our research can be framed more as confirmatory (testing and validating earlier hypotheses in the literature) than exploratory (generating entirely new hypotheses) (Sovacool et al., 2018).

Lending support to our approach, Arranz (2017) conducted a meta-analysis of 44 sociotechnical transitions across electricity, heat, and transport. Although she did not study demographics directly, she noted that "societal factors" such as lifestyle or ideals played a significant role in many of the transport transitions analyzed. Perceptions of pollution, notions of hygiene, attitudes towards inconvenience, and changes in tastes all affected preferences for safety or lifestyle, or buttressed beliefs about progress, quality, or national prestige. She posited that results from previous transport transitions in particular suggest that social aspects become "very important" once a sector is more open to competition, arguably the case concerning electric mobility in the Nordic region. As such, we maintain that better comprehending the demographics of electric mobility becomes paramount to better analyzing the social elements of both historical transition processes as well as future transition pathways.

2. Research methods and limitations

To collect data on the demographics of electric mobility, our primary method was a structured questionnaire (an online survey) consisting of three parts with 44 total questions (including a choice experiment, which we do not report here). The first part asked about the vehicle background and the existing mobility patterns of respondents, namely how often they drive or use other forms of transport, how far, how much they are willing to pay for a new car, etc. The second part asked respondents what they valued most (or least) when they considered future purchases and forms of mobility, such as acceleration, size, safety, etc. as well as some questions specifically about electric vehicles (such as charging availability, range, battery life, and so on), asking them to rate these features according to a five point Likert (1932) type scale ranging from very unimportant to very important. The final part of the survey asked respondents for basic demographic information such as age, gender, education, and occupation as well as more sensitive questions about income, political affiliation, and environmental values (among others). A complete copy of the survey is offered in the Supplementary Online Material (SOM).

Distribution of the survey was online and anonymous, with a research design intended to minimize dishonesty and promote candor. For instance, psychological studies of survey design have found that the more impersonal the conditions, the more honest people will be. For eliciting truthful answers, internet surveys are better than phone surveys, which are better than in-person surveys, as "people will admit more if they are alone than if others are in the room with them" (Stephens-Davidowitz, 2017: 2). Our survey was completed by a mix of 4322 random respondents (facilitated through a survey hosting firm) and 745 non-random respondents (facilitated through an online version where the authors invited the public to participate) shown in Table 1. This puts the total respondent number at 5,067, and this already excludes surveys that were incomplete (although we allowed for people to skip questions) or obviously answered falsely.

Admittedly, our research design has a number of limitations. First, we ended up combining the sample of randomized respondents with a purposeful sample to increase response rates from Iceland and in particular to include more adopters or previous owners of electric vehicles. Both of these are hard to reach groups that were underrepresented in the randomized sample. Indeed, in their review of the literature, Rezvani et al. (2015: 130) caution that a flaw many survey articles have

Table 1
Summary of survey distribution.

Country	Respondents (random)	Respondents (non-random)	Total
Denmark	953	185	1138
Finland	962	143	1105
Iceland	496	214	710
Norway	959	103	1062
Sweden	952	100	1052
Total	4322	745	5067