



Predictors of electric vehicle adoption: An analysis of potential electric vehicle drivers in Austria



Alfons Priessner^{a,*}, Robert Sposato^a, Nina Hampl^{a,b}

^a *Alpen-Adria-Universität Klagenfurt, Department of Operations, Energy, and Environmental Management, Sustainable Energy Management Unit, Universitätsstrasse 65-67, 9020 Klagenfurt am Wörthersee, Austria*

^b *Vienna University of Economics and Business, Institute for Strategic Management, Welthandelsplatz 1, 1020 Vienna, Austria*

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ABSTRACT

Although barriers to the adoption of electric vehicles (EVs), such as purchase price, range limitation, and charging infrastructure are diminishing, sales growth has still fallen short of industry expectations. As industry and governments have an interest in counteracting this negative trend by incentivizing EV purchasing, a better understanding of potential EV adopters and drivers of early adoption becomes paramount for designing effective and efficient incentive schemes. Therefore, drawing on a representative survey of Austrian citizens, this study analyzes early adopters, potential adopters, and non-adopters of EVs. Findings indicate that psychological and, to a lesser extent, socio-demographic factors play a significant role in predicting EV adoption. Non-adopters are more likely to have an individualistic and less egalitarian worldview, and also, compared to early adopters, to fall short in terms of pro-environmental and pro-technological attitude. Further, early adopters are inclined to live in regions with EV policy incentives. Using cluster analysis, this study identifies four groups of potential EV adopters based on their evaluation of EV purchasing and non-purchasing motives. The potential-adopter segments differ considerably in their socio-demographic and psychological characteristics, as well as in their preferences for policy incentives. We discuss implications of our findings for the design of effective policy schemes and marketing measures.

1. Introduction

In December 2015, the Paris Agreement signed by the parties of the United Nations Framework Convention on Climate Change set a clear, but ambitious target to combat climate change by keeping the global average temperature increase below 2 °C above pre-industrial levels (UNFCCC, 2015b). The transportation sector contributes almost a quarter of all global energy-related greenhouse gas (GHG) emissions (IEA, 2016b). One promising pathway to curb emissions from fossil fuels in this sector is to replace conventional internal combustion engines (ICE) with electric ones, coupled with decarbonized energy production (e.g., Bleijenberg and Egenhofer, 2013). Various studies have emphasized the necessity of a major uptake of electric vehicles (EV), i.e., of battery electric vehicles (BEVs) or plug-in hybrid electric vehicles (PHEVs) within the next three decades to meet greenhouse gas reduction targets (IEA, 2016a; IPCC, 2012; UNFCCC, 2015a). Recent advances in technology (e.g., higher battery energy density) have extended the range of available EVs (IEA, 2016a) and, with specific policy support, have lowered vehicle costs in a number of countries

(Sierchula et al., 2014), thereby reducing major consumer barriers. Nevertheless, sales growth has fallen short of industry expectations (IEA, 2016a).

While industry stakeholders and policy makers are looking to accelerate the trend toward investment in EVs, a better understanding of early EV adoption predictors and profiles of potential EV adopters (i.e., people who can imagine to purchase an EV) is needed to create more growth in the market for EVs (Wesche et al., 2016). Larson et al. (2014) ascribe the slow EV rollout mainly to the lacking insight stakeholders have of potential EV customers. Nayum and Klöckner (2014) and Nayum et al. (2016) argue that policy makers should consider (potential) adopters' multifaceted attitudes and psychological characteristics in creating incentives to accelerate EV diffusion more effectively.

Despite this evident need to learn more about (early) adopters and potential EV adopters, to date, only a small body of literature reports on studies of these adopter segments (Axsen et al., 2016; Nayum et al., 2016; Nayum and Klöckner, 2014; Peters and Dütschke, 2014; Plötz et al., 2014). Prior work has shown that certain socio-demographic and psychological differences (Axsen et al., 2016; Nayum et al., 2016;

* Corresponding author.

E-mail address: alfons.priessner@gmail.com (A. Priessner).

Nayum and Klöckner, 2014; Peters and Dütschke, 2014) distinguish between actual EV owners and potential EV adopters currently using ICE vehicles. Our first research objective is to investigate a range of variables as possible predictors of EV adoption, including one particular group of psychological variables, namely cultural worldviews. Existing literature so far has largely neglected the influence of cultural worldviews on the propensity to purchase an EV. Cultural worldviews can be described as “a general perspective from which a person sees and interprets the world” (Cherry et al., 2014: 563), and it is conceptualized as an overarching sense-making system for complex questions (Hedlund-de Witt, 2012). Previous research has shown that cultural worldviews are predictive of people’s acceptance, attitudes, and also behavioral intentions regarding a variety of socially contested issues such as nuclear waste, national security, possession of weapons, public health, climate change (Kahan et al., 2007, 2011, 2012), climate change mitigation policies (Hart and Nisbet, 2011), and clean technologies (Cherry et al., 2014; Sposato and Hampl, 2018). Given such evidence, and in addition to previously studied variables, we introduce this concept here as we expect to find that, depending on their cultural worldviews, respondents will be more or less likely to adopt clean technology vehicles such as EVs. To the best of our knowledge, no study has attempted to analyze the particular relationship between cultural worldviews and EV adoption yet.

Our second research objective is to contribute to the current discussion in literature and among stakeholders on the effectiveness of policy measures in the diffusion of EVs. On the one hand, research argues that policy incentives increase market penetration of EVs (e.g., Langbroek et al., 2016; Mannberg et al., 2014; Sierzchula et al., 2014), and public institutions such as the International Energy Agency (IEA) consistently demand additional policy support to achieve their widespread adoption and deployment (IEA, 2016a). On the other hand, leaders of global automotive companies like Dieter Zetsche, Daimler CEO, argue that financial purchase incentives are the wrong means for grasping customers’ attention and improving their acceptance of EVs (Spiegel, 2017). Recent studies, in fact, support this opinion (e.g., Egbue and Long, 2012; Green et al., 2014). Our study aims to contribute to this ongoing debate by evaluating preferences of different potential-adopter segments regarding a variety of policy measures that have been proposed, as well as implemented. Additionally, the study pays attention to how existing policy measures influence the behavior of EV adopters.

To achieve these objectives, our study examines the joint effect of different socio-demographic characteristics, psychological characteristics, as well as EV policy incentives on the adoption of EVs. Further, we conduct cluster analysis to identify different sub-groups of potential adopters according to distinct socio-demographic and psychological profiles. We use data collected from a sample of 1000 respondents representative of the Austrian population during the final months of 2016. Our findings suggest that psychological factors, in contrast to socio-demographic ones, play a significant role in explaining differences between different adopter segments and are, hence, the better predictors of early EV adoption. Furthermore, we argue that policy incentives reduce the amount of time it takes potential EV adopters to actually purchase an EV, but do not similarly influence ICE fans. In addition, we find four main segments of potential adopters of EVs, distinguished on the basis of significant differences in their attitude towards EV purchasing and non-purchasing motives, as well as their policy incentive preferences.

2. Theory and hypotheses

In the past few years, a growing body of literature has focused on people’s general perception of EVs (Egbue and Long, 2012; Krupa et al., 2014; Peters and Dütschke, 2014; Plötz et al., 2014; Schuitema et al., 2013). More recently, researchers have also begun to analyze the profiles of actual adopters of EVs (Axsen et al., 2016; Hardman et al., 2016;

Tal and Nicolas, 2013) who still represent a very small group (< 0.1%) of the total car owner population globally (IEA, 2016b). Only a few studies have compared early adopters and other potential EV adopter groups to identify differences between the groups, and predictors of early EV adoption. Initial insights suggest that socio-demographic and psychological factors, as well as policy incentives significantly influence EV adoption (Axsen et al., 2016; Nayum et al., 2016; Sierzchula et al., 2014). In his seminal work, Stern (2000) argues that personal characteristics (e.g., socio-demographic characteristics), attitudinal factors (e.g., various psychological factors), habits, and contextual forces (e.g., government-implemented regulations or incentives) induce pro-environmental behavior and eventually facilitate the adoption of high-cost products. Therefore, in the following, we review the relevant literature in more detail and derive hypotheses regarding socio-demographic, psychological, and contextual variables such as EV policy incentives that function as predictors for EV adoption.

2.1. Socio-demographic characteristics

Studies consistently find that early EV adopters have socio-demographic characteristics that clearly distinguish them from potential EV adopters or non-adopters (i.e., from ICE car buyers). At present, the literature suggests that actual or early adopters (depending on the definition) typically (1) are highly educated (Nayum et al., 2016; Plötz et al., 2014; Tal and Nicolas, 2013), (2) have higher incomes (Axsen et al., 2016; Carley et al., 2013; Nayum et al., 2016; Plötz et al., 2014; Tal and Nicolas, 2013), (3) are young to middle aged (Hidrué et al., 2011; Nayum et al., 2016; Plötz et al., 2014) (4) live in multi-car households (Klöckner et al., 2013; Nayum et al., 2016; Peters and Dütschke, 2014; Tal and Nicolas, 2013), (5) live in larger households (Nayum et al., 2016), (6) are predominantly male (Plötz et al., 2014), and (7) live in small- to medium-sized municipalities (Plötz et al., 2014).

However, as predictors of EV purchasing these socio-demographic features need to be interpreted with caution, as contradictory findings exist. For instance, Hidrué et al. (2011) were not able to confirm higher income and multiple car ownership as key characteristics of early EV adopters. Further, including additional variables such as psychological ones, the predictive value of socio-demographic features on consumers’ intention to purchase environmentally friendly cars has been found to be significantly lower (Nayum and Klöckner, 2014). These findings are corroborated by general research in the field of environmental behavior, with several authors finding socio-demographic variables to have minimal explanatory value for most environmental behaviors (Kilbourne and Beckmann, 1998; Leonidou et al., 2010). Even so, in order to develop a comprehensive theoretical model, we also include socio-demographic variables and thus posit the following hypothesis:

Hypothesis 1. *The socio-demographic characteristics (a) gender (being male), (b) education, (c) income, (d) household size, (e) number of cars per household, and (f) dwelling dispersion in the area of residency are positively related, and (g) age is negatively related to the adoption of EVs.*

2.2. Psychological characteristics

As mentioned above, some research has presented evidence pointing to psychological variables (e.g., values, attitudes, norms, etc.) as important determinants of consumers’ uptake of cars with emergent, cleaner technologies (Hefner et al., 2007; Jansson et al., 2011; Kahn, 2007; Lane and Potter, 2007; Ozaki and Sevastyanova, 2011). A recent study by Nayum et al. (2016) tests the relevance of psychological variables as predictors of consumers purchasing more environmentally friendly vehicles such as EVs. In their paper, they build on Klöckner and Blöbaum’s (2010) “comprehensive action determination model,” which incorporates intentional, normative, situational, and habitual influences on environmentally friendly behavior. Overall, they conclude that

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