Generation Z Ready to Embrace the Electric Vehicle Revolution? Predictors of Electric Vehicle Adoption by Youths and Young Adults in Austria

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ABSTRACT

Europe's transport sector is a key contributor to climate change and according to forecasts the emissions of that sector will continue to increase. One possible innovation put forward in recent years to help reduce emissions from this sector are electric vehicles (EVs). Besides technology advancements, consumer acceptance is crucial to ensure a successful transfer to a sustainable transport sector. Particularly interesting are the "consumers of the future". Therefore, drawing on a survey of Austrian citizens (18-70) and building on Value Belief Norm Theory (VBN) as a theoretical foundation, the present study analyses willingness to purchase an EV. The findings of the present study indicate that, in line with previous work, only psychological as opposed to socio-demographic factors yield significant contributions to the models predicting willingness to purchase an EV. We discuss implications of our findings for future marketing and communication efforts with a specific focus on the young generation as future EV adopters.

Keywords: Electric vehicles, generation Z, WTP, potential adopters, social dominance orientation, social norm

Highlights:

- Psychological factors seem to play a significant role in predicting willingness to purchase opposed to socio-demographic factors.
- Positive and negative attitudes regarding technology as well image of EV have a significant impact on potential EV adoption.
- Sceptical beliefs and social norm towards EVs are relevant predictors.
- Social norms with respect to energy use play a significant role in predicting willingness to purchase an EV.
- Energy-saving behaviour is significantly related to an individual's willingness to purchase an EV.

1. INTRODUCTION

With almost a quarter of all global energy-related greenhouse gas (GHG) emissions the transport sector is one of the main contributors to anthropogenic climate change (IEA, 2016a, 2016b; Pachauri & Reisinger, 2007). In Europe road transport is responsible for more than 70% of all GHG emissions in this sector (European Commission, 2019). Several studies indicate that electric vehicles (EVs) may be one of the key levers to meet GHG emission reduction targets in the transport sector (Creutzig, Jochem, Edelenbosch, Mattauch, van Vuuren, McCollum & Minx, 2015; de Haan, Peters & Scholz, 2007; Hickman, Ashiru & Banister, 2010; Lutsey, 2015; Scown, Taptich, Horvath, McKone & Nazaroff, 2013; Turcksin, Mairesse, Macharis & Mierlo, 2013). As the interest in alternative vehicle solutions such as EVs has grown in recent years (IEA, 2016b), EVs have become an important part of the political agenda in Europe. Hence, the partners of the Paris Declaration on Electro-Mobility and Climate Change and Call to Action have committed themselves to a 20% target for all road transport vehicles globally to be electrically driven by 2030 (UNFCCC, 2015). Governments are working on this goal on national levels, too. While Germany, for example, is still in an “early adopter stage” compared to other countries like Norway (Klöckner, Nayum & Mehmetoglu, 2013), its government has decided to support this new technology, aiming to make Germany a market leader in electric mobility by 2020 with at least one million EVs on the road (German Federal Government, 2010; Strogies & Gniffke, 2008). The neighbouring country Austria is equally supportive of this alternative technology. As a result, an increase in the number of EVs is already observable: from 2017 to 2018, for instance, the EV share in new passenger vehicle registrations increased from 2.02% to 2.54% (the EV share of total vehicles registered in Austria was 0.54% by the end of 2018) (BMVIT, 2019).

Apart from overcoming the EVs economic and technological barriers (e.g., high price, low battery capacity, missing infrastructure and long charging time) (Adnan, Nordin, Rahman, Vasant & Noor, 2017; Brownstone, Bunch & Train, 2000; Egbue & Long, 2012; Haddadian, Khodayar & Shahidehpour, 2015; Hidrue, Parsons, Kempton, & Gardner, 2011; Lieven, Muhlmeier, Henkel & Walker, 2011; Neubauer, Brooke & Wood., 2012), issues related to consumer acceptance need to be addressed in order to achieve commercial success. Consumers tend to be resistant to new technology that is considered unfamiliar or unproven (Egbue & Long, 2012). As consumer acceptance plays a crucial role in the continuing transition to a sustainable transport sector (Ozaki & Sevastyanova, 2011), adopters’ multifaceted attitudes and psychological characteristics need to be considered by industry stakeholders and policy makers, e.g., in

the process of creating incentives to accelerate EV diffusion more effectively (Nayum & Klöckner, 2014; Nayum, Klöckner & Mehmetoglu, 2016).

Research so far has studied attitudes related to a variety of aspects of electric cars mainly focusing on environmental (e.g., reduced CO2 emissions) and technological (e.g., driving range) aspects (Graham-Rowe et al., 2012; Hjorthol, 2013; Nayum & Klöckner, 2014; Schuitema, Anable, Skippon & Kinnear, 2013; Skippon & Garwood, 2011; Thiel, Alemanno, Scarcella, Zubaryeva & Pasaoglu, 2012). For instance, scholars have shown that certain socio-demographic (e.g., age, gender, income, education) (Axsen, Goldberg & Bailey, 2016; Hidrue et al., 2011; Nayum et al., 2016; Plötz, Schneider, Globisch & Dütschke, 2014; Tal & Nicolas, 2013) and psychological (e.g., attitudes, habits) (e.g., Priessner, Sposato & Hampl, 2018) factors distinguish between actual EV owners, potential EV adopters and non-adopters. While these studies offer a good overview with regards to an adult population, younger generations have been notoriously understudied. Considering that they represent future customers of EVs and will thus play a major role in the transformation of the transport sector this represents a major shortcoming of existing literature, which this paper aims to address.

Thus, research presented here will place a major focus on investigating socio-demographic and psychological predictors of willingness to purchase an EV by Austria citizens (1250 respondents aged 18-70 years; oversampling of younger adults). Building on Stern (2000) this paper investigates a range of variables which have been found to predict willingness to purchase an EV among adults. Continuing work by Priessner et al. (2018) we also introduce social dominance orientation (SDO) (Pratto, Sidanius, Stallworth & Malle, 1994; Sidanius & Pratto, 2001) as an ideological variable that is assumed to further aid with prediction of EV purchase intention.

In line with previous research socio-demographic variables (e.g., age, gender, education, etc.) has made not significant contribution to willingness to purchase an EV. The included psychological variables by contrast are found to be significant predictors of willingness to adopt an EV.

2. THEORY AND HYPOTHESES

Despite the fact that technology behind EVs exists for more than a century now (Høyer, 2008), research on electric vehicles and even more so predictors of willingness to purchase an EV in particular has a quite short history. Nowadays, there are over 3 million electric cars worldwide on the roads (IEA, 2018) but in relative terms actual EV adopters still represent a very small group (< 0.1%) of the total car

owner population globally (IEA, 2016b). In spite of this, or better, because of these relatively low figures, consumer acceptance is of increasing relevance (Ozaki & Sevastyanova, 2011) and for a couple of years now public perceptions of and uptake of EVs has attracted more and more scholarly attention. In a literature review Rezvani, Jansson and Bodin (2015) point out that consumer EV adoption has mainly been studied by focusing on adoption intention in contrast to actual adoption, which is not overly surprising as current market shares of EVs, as explicated above, are still extremely low. The number of studies on public perceptions of EVs and profiles of actual adopters of EVs, however, is constantly increasing (Axsen et al., 2016; Hardman, Chandan, Tal & Turrentine, 2016; Peters & Dütschke, 2014; Plötz et al., 2014). More recent research has looked at different adopter subgroups in more details by differentiating between early adopters, potential adopters and non-adopters (Priessner et al., 2018). This study suggests that psychological factors, rather than socio-demographic, play a significant role in explaining differences between segments of potential adopters and non-adopters. Other studies have shown the effect of both psychological and socio-demographic factors on EV adoption (Axsen et al., 2016; Nayum et al., 2016; Sierzchula, Bakker, Maat & Van Wee, 2014).

Partly because this literature is of rather recent origin and the fact that theoretical models specific to EV adoption are thus not well established yet, much of the existing findings are to a large extent not based on existing theory and explorative in nature. We aim to base our research on an established theoretical model which we deem applicable to EV adoption. Value Belief Norm (VBN) theory (Stern, 2000) is considered as one of the most central conceptual frameworks explaining environmentally significant behaviour building on central theories of values and norm activation. The basic premise of VBN theory is a causal chain of five variables: values, beliefs, awareness of consequences, ascription of responsibility and pro-environmental personal norm. It is important to note however, that VBN serves much more as a conceptual framework here, than an exhaustive list of influential factors to determine pro-environmental behaviour. Not least because Stern and colleagues (1999) themselves discuss a variety of other potential variables and concepts to influence environmentally relevant behaviour stating that “a dialogue among such models is needed to move the field toward synthesis.” (Stern, 2000, p. 418). Introducing another conceptual perspective (ABC theory) they classify potential factors to influence environmentally relevant behaviour into four categories: attitudinal factors, contextual factors, personal capabilities and habits. This is why even though we explicitly build on VBN theory we are considerate of other factors that might influence EV-purchase intention and include those both in our theoretical discussion but also our empirical analysis. With its origin in literature on pro-environmental behaviour Stern’s (2000) VBN theory appears highly

applicable to EV adoption it distinguishes between four major classes of causal variables, notably: *attitudinal factors*, *personal capabilities, contextual forces* and lastly *habit or routine* (Stern, 2000). Our research aims to investigate each class of variables, given the relatively small number of actual users, with a distinct set of variables. Building on Stern's VBN framework the following paragraphs thus review relevant literature with respect to attitudinal, personal and contextual predictors of EV adoption in an effort to define hypotheses which are then tested through multiple regression analysis.

2.1. Attitudes

This research will examine attitudes at various levels of abstraction looking at attitudes specific to EVs, specific to renewable energy technologies in general, as well as an ideological component, theorized here to be linked directly to the issues at hand. Attitudes can be defined as ''a psychological tendency that is expressed by evaluating a particular entity [or attitude object] with some degree of favour or disfavour'' (Eagly & Chaiken, 1993, p.1). Their measurement has been applied in preference studies to provide insights with respect to the importance of EV attributes (Cocron et al., 2011). In research on EV attitudes both positive and negative attitudes towards EVs differ by experience, knowledge and the everyday context (Roche, Mourato, Fischedick, Pietzner & Viebahn, 2010). In this context a growing body of literature has in fact investigated EV attitudes (Egbue & Long, 2012; Glerum, Stankovikj, Thémans & Bierlaire, 2013; Junquera, Moreno & Álvarez, 2016; Larson, Viáfara, Parsons, & Elias ,2014; Li, Long, Chen & Geng, 2017) to show that attitudes, in contrast to demographic and situational factors, are the most dominant predictors of a consumer's will to buy an EV. In this line of research studies have demonstrated that weaker evaluations of the disadvantages of EVs and positive attitudes towards EVs (e.g., EVs are emission-free and protect the environment), in contrast to negative attitudes, encourage individuals' adoption intentions (Bockarjova & Steg, 2014). It is thus not surprising that they are described as key psychological factors influencing the willingness to purchase an EV (Jensen, Cherchi & de Dios Ortúzar, 2014; Li et al., 2017; Plötz et al., 2014). Building on the above-cited work we therefore hypothesize:

H1: *Positive and negative attitudes towards EVs are significantly associated with the willingness to purchase an EV.*

While attitudes related to EVs yield a strong effect on willingness to purchase EVs, given their specific nature, it is not overly surprising and also of limited value to identify these associations in isolation.

It is for this that we propose to investigate attitudes on more abstracted levels too. Extrapolating from attitudes specific to EVs we argue that EVs are integrated into the wider Renewable Energy Technology (RET) discourse and that EV adoption should therefore be related to attitudes to RET in general. We build on work by Sposato and Hampl (2018) who have previously investigated attitudes to renewable energy technologies, showing that they are significantly associated with local acceptance of wind and photovoltaic power plants. In the same vein we hypothesize that:

H2: *Attitudes to renewable energy technologies are significantly associated with the willingness to purchase an EV.*

As suggested by the name *Value* Belief Norm Theory, Stern (2000) introduces values as a specific set of attitudinal variables. While attitudes are by definition specific to a particular entity, values instead operate at a rather abstract level. A similar construct in various social sciences are worldviews or ideologies applied, for example, in cultural cognition research (Kahan, Slovic, Braman, Gastil & Cohen, 2011). Priessner et al. (2018) applied the construct of cultural worldviews to EV adoption and found that, despite being far removed from the actual issue at hand – that is EV adoption – the more individualistic participants reported to be, the less likely they were to show an intention to buy an EV. With the exception of Priessner et al. (2018) ideological components such as cultural worldviews have not been investigated, despite a wealth of findings that have demonstrated their importance in predicting individual differences regarding a host of issues from environmental and climate change related issues and behaviour intentions to risk perceptions and technology acceptance (cf. Kahan, 2007). However, the short cultural-cognition scales, in a European context, have not performed well in terms of reliability and intended factor structure (Capstick & Pidgeon, 2014; Priessner et al., 2018) and so for this study the applicability of the related construct of social dominance orientation is explored.

Milfont et al. (2013) theorize how current environmental problems can be based in beliefs of human dominance over nature, which they conceptually link to social dominance theory (SDT). SDT attempts to combine social psychological theories of intergroup relations and social process of ideology and the legitimization of social inequalities (Pratto, Sidanius, Stallworth & Malle, 1994; Sidanius & Pratto, 2001). The core of this theory is the individual-level variable of social dominance orientation (SDO). It is characterized as “a generalized orientation towards and desire for unequal and dominant/subordinate relations among salient social groups, regardless of whether this implies ingroup domination or

subordination" (Pratto, Sidanius & Levin, 2006, p. 282) comparable to a hierarchist-individualist orientation in cultural cognition theory.

An increasing number of studies has investigated this construct with respect to environmental issues showing that SDO is significantly associated with a lack of concern for the natural environment, endorsing a polluting industry, climate change denial (Häkkinen & Akrami, 2014; Hoffarth & Hodson, 2016; Jackson, Bitacola, Janes & Esses 2013; Jylhä & Akrami, 2015; Kashima, Paladino & Margetts, 2014; Milfont & Duckitt, 2010; Milfont & Sibley, 2016; Milfont, Milojev, Greaves & Sibley 2015; Pratto, Sidanius & Levin, 2006). Building on this research and the tentative results from Priessner et al. (2018) we thus hypothesize:

H3: Social dominance orientation (SDO) and climate change concerns are significantly and negatively associated with willingness to purchase an EV.

2.2. Personal capabilities

With respect to the class of personal capabilities a large part of the suggested variables in this range is commonly referred to as socio-demographic variables. Existing literature shows that potential EV adopters and non-adopters can be distinguished from early adopters according to specific socio-demographic characteristics. In this line of research actual or early adopters of EVs have been described as mostly male, young to middle-aged (30-50 years), married or in a relation, better educated and wealthier (Axsen et al., 2016; Hidrue et al., 2011; Hjorthol, 2013; Nayum et al., 2016; Plötz et al., 2014; Tal & Nicolas, 2013). In addition, related research has demonstrated, that people living in a household that is large with more children, a higher household income, more driving license holders and a greater number of cars are more likely to choose fuel-efficient cars (e.g., Hjorthol, 2013; Nayum et al., 2016). Contrasting these results, studies have also reported weak effects of socio-demographic characteristics as predictors of EV adoption (Hidrue et al., 2011; Priessner et al., 2018). This seems to be particularly true for studies that include psychological variables, which apparently weakens the effect of socio-demographic variables (Nayum & Klöckner, 2014). These results are in line with other studies equally finding that socio-demographic variables have relatively low explanatory value for most environmental behaviours (e.g., Diamantopoulos, Schlegelmilch, Sinkovics & Bohlen, 2003; Leonidou, Leonidou & Kvasova, 2010). With regards to socio-demographic variables we thus do not expect to find any significant relationship with EV

adoption and therefore specify no hypothesis. Socio-demographic variables however are still included in the analysis as controls.

2.3. Contextual factors

In terms of contextual factors this study will investigate the effect of social norms and experience with EVs. Individuals do not only define themselves in isolation, but also as a member of groups and communities, which influences the way they think and make decisions (Cialdini & Trost, 1998). Three major types of norms can be distinguished: descriptive, injunctive and subjective. Descriptive norm refers to what group members commonly do (e.g., “Austrian do not drive EVs”; Cialdinig & Trost, 1998). Injunctive norm refers to what is commonly approved/disproved within the group (e.g., Cialdini & Trost, 1998; Smith & Louis, 2009). Subjective norm then describes what individuals expect of significant others to expect from them e.g., the opinion of family members and friends that influence individual´s behaviour (Ajzen, 1991). In the context of EV adoption, the influence of norm has not received much attention by researchers (Klöckner, 2014). Some work has highlighted social norms as a relevant factor influencing EV adoption and it has been shown that they influence intentions in the pre-decisional stage (Klöckner, 2014; Axsen & Kurani, 2011; Axsen et al., 2013; Graham-Rowe et al., 2012; Noppers, Keizer, Bolderdijk & Steg, 2014). According to Smith, Louis, Terry, Greenaway, Clarke and Cheng (2012) the perception of only a few people using EVs is negatively associated with EV adoption. In line with this assumption another study finds that subjective and personal norms are positively related to the intention to use alternative fuel vehicles (Petschnig, Heidenreich & Spieth, 2014). Furthermore, Jansson, Marell and Nordlund (2011) show that adopters and non-adopters of EVs differ in terms of personal and social norms. Barth, Jugert and Fritsche (2015) analysed the influence of social norms on prediction of EV showing that norms alongside collective efficacy have an equal or even stronger effect on acceptance than cost-related factors. In this paper we investigate both descriptive and injunctive norms for renewable energy technology and energy use. Based on the findings reported above we hypothesize:

H4: Social norms with respect to renewable energy technology and energy use are positively associated with the willingness to purchase an EV.

As the second contextual variable the present paper will look at EV experience. Various papers have suggested that preferences and attitudes might change with the experience individuals get from using

or consuming a certain product (e.g., Thøgersen & Møller 2008). This is even more likely to occur when the product is new, since significant misconceptions are more likely to exist about the impact that new product characteristics have on the individual's life (for example the lower driving range of EVs compared to that of conventional cars). In existing literature on EV adoption some studies have underlined the importance of experience as a significant predictor (Axen et al., 2012; Burgess, King, Harris & Lewis, 2013; Egbue & Long, 2012; Jensen, Cherchi & Mabit, 2013; Peters & Dütschke, 2014). Jensen et al. (2013), show that preferences and attitudes are affected by real-life experience as respondents also develop a more positive view of the driving performance of EVs. In a study in Denmark, Jensen, Cherchi and Mabit (2013) showed that hands-on experience with EVs can alter consumer preferences and attitudes to favour EVs. Skippon and Garwood (2011) further showed participants attributed clearly positive symbolic meanings such as high agreeableness and conscientiousness onto a brief experience with EVs. In a study by Graham-Rowe et al. (2012) household participants reported feeling good and less guilty about driving an EV because of the environmental benefits associated with it. Besides this, the adoption of an EV became more likely, disadvantages were evaluated as less negative and subjective ability to drive an EV increased (Bockarjova & Steg, 2014). Following these findings, we expect to find a positive effect of experience and thus define the following hypothesis:

H5: Experience with EVs is positively associated with the willingness to purchase an EV.

2.4 Habit/routines

This category represents another determinant in the ABC framework mentioned above. Habits/routines can be defined as automatic performance of behaviour patterns, which are triggered by context cues (Triandis, 1979). It has been shown that when behaviour is preformed often (on daily/weekly base) then past behaviour has a stronger influence on future behaviour than the actual intention (Quellette & Wood, 1998). With respect to the novelty EV-adoption and the rarely frequent behaviour of buying a vehicle altogether there is very little reason to believe that a habit or routine has developed. We do however believe that other environmentally-relevant behaviour can be understood as somewhat of a proxy for a habit component, as the purchase of an EV could be conceived as a one-off action in a greater stream of habitual pro-environmental action. It is for this reason that formulate the following hypothesis.

H6: Energy-saving behaviour is positively associated with the willingness to purchase an EV.

3. METHODOLOGY AND DATA

3.1. Sample

For the present study sample (N = 1250; oversampling of younger adults) was collected in course of an online survey conducted in October 2017 in Austria divided in: (1) generation Z (n = 288, 18-24 years), (2) generation Y (n = 350, 25-39 years), (3) generation X (n = 357, 40-54 years) and (4) generation baby boomer (n = 255, 55-70 years). The data was collected by an external market research company (*meinungsraum.at*). The respondents were compensated for their participation in the survey.

3.2. Questionnaire and measures

The survey contained a variety of different questions related to EVs but also to renewable energy technologies in general, policy measures etc. In this study, however, we only considered the questions and scales relevant to our context of EV adoption (for overview see Table 1). The scales used in this paper were developed according previous studies on pro-environmental behaviour and EV adoption (Fielding et al., 2008; Hunecke et al., 2007; Jansson, Marell, & Nordlund, 2009, 2010; Klöckner & Blöbaum, 2010; Klöckner & Matthies, 2004; Priessner et al., 2018; Thøgersen, 2006).

To generate our *dependent variable*, we assigned the respondents to five different groups of potential adopters according to their willingness to purchase an EV (1 (*very low willingness to purchase an EV*) to 5 (*very high willingness to purchase an EV*)). The survey participants were asked to indicate their general preference with respect to the vehicle type in a scenario related to a potential future car purchase (e.g., diesel, gasoline, hybrid, electric, etc.). If “electric” was selected participants were scored as 5 (*very high willingness to purchase an EV*). All other respondents were asked in a follow up question whether they would also consider purchasing an EV on a 4-point Likert-type scale ranging from 1 (*not likely at all*) to 4 (*very likely*). The respondents that indicated 1 (*not likely at all*) in this second question were assigned a 1 (*very low willingness to purchase an EV*) on the scale of our dependent variable and the remaining respondents equally were assigned to the interim scale values 2-4 of our dependent according to their interest in purchasing an EV.

Additionally, a range of items and measures, both well-established measures and newly formulated items, were included in the analysis as possible predictors of potential EV adoption (social dominance orientation, positive and negative attitudes towards EVs, beliefs towards renewable energy technologies,

social norm with respect to energy use, energy-saving behaviour, and experience with EVs) (for more detail see Table 3).

Social dominance orientation (SDO) is a scale assessing preference for inequality among social groups (Pratto et al., 1994). The scale applied here consisted of 8 items based on a short version by Ho et al. (2015) and was translated into German by relying on previous translations of SDO scales by Cohrs et al. (2005) and Six et al. (2001,). A 4-point Likert-type scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*) was provided for the responses. Reliability of this scale was α = .77. In this scale items as following were used: e.g., 'No one group should dominate in society.' or 'Groups at the bottom are just as deserving as groups at the top.'[1].

The two scales *positive* and *negative attitudes towards EVs* were based on a range of different items included in the survey (positive attitudes scale: 10 items; negative attitudes scale: 14 items). A 4-point Likert-type scale (1 (*not important at all*) to 4 (*extremely important*) was used. The positive attitudes scale was further divided into two sub-scales as suggested by exploratory factor analysis: positive attitudes technology related (e.g., emission-free, protection of the environment and the climate; α = *.74*) and positive attitudes image related (e.g., charm of modern technologies, status symbol; α ,= *.70)*. Analogously the negative attitudes scale was split into a technology related (e.g., range of the electric cars too low, batteries are rather short-lived; α = *.79*) and image related subscale (e.g., a petrol or diesel vehicle is clean enough, electric cars are only a transition technology; α = *.79)*.

For a scale measuring attitudes and *Beliefs towards renewable energy technologies (RET)* exploratory factor analysis yielded three sub-scales: optimism (α = *.81*), scepticism (α = *.55*) and social norm (α = *.81*). All items were measured on a 4-point Likert-type scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*). The optimism scale consists of six items such as 'Renewable energy technologies enable future economic growth without an increase of climate-damaging CO2 emissions.' and 'I would endorse the siting of a photovoltaic power plant in my community.'. The scepticism scale includes three items e.g., 'Renewable energy technologies are a luxury and not everyone can afford it.' and 'Austria will never get along without fossil fuels (gas, oil, coal).' Last but not least, the social norm scale consists of four items such as for example 'Many of my neighbours use renewable energy technologies.' and 'Many of my friends and relatives use renewable energy technologies.'.

[1] Since the items used all included statements favouring an egalitarian social orientation it is important to point out that the signs for correlation are in fact opposite to what one would expect for SDO. We did however choose not to rename the scale in an effort to adhere to the commonly used wording of SDO.

Furthermore, four items were included in the survey to measure respondents' *social norm with respect to energy use.* Examples for items are: 'I often talk to my friends about energy because this is an important topic to me.' and 'Most of the people in my personal environment get active to save energy.'. Once again, a 4-point Likert-type scale was used (1 (*strongly disagree*) to 4 (*strongly agree*)). Reliability of this scale was α = .72.

In addition, a scale measuring energy-saving behaviour (α = *.67*) consisted of 8 items such as: 'Turn off lights, the computer and other electronic devices when they are not needed.' and 'Walk short distances or use the bike.'. Likewise, the scale before, 4-point Likert-type scale was used (1 (*strongly disagree*) to 4 (*strongly agree*)).

EV experience was measured using a single item asking respondents: 'Have you had any experience with electric vehicles?' with answer options ranging from 1 (*No experience with an EV*) to 4 (I own/owned an EV.).

Additionally, at the end of the questionnaire respondents were asked about several *socio-demographic* characteristics (gender, age and education level).

3.3. Data analysis

For the aim of this study we used multiple linear regression analysis (MLR), which examines the linear relationship between a dependent variable Y (in our case EV purchase intention) and two or more predictive or independent variables X (in our case age, gender, social dominance orientation, positive and negative attitudes towards EVs, etc.) (Backhaus et al., 2016). MLR has been widely used in the research field of EV adoption (Hardman et al., 2017; Helveston et al., 2015; Mersky et al., 2016; Sierzchula et al., 2014; Schuitema et al., 2013; Zhang et al., 2014).

4. RESULTS

In the first step of data analysis we checked the correlation matrix of all variables included in the MLR models (see Appendix, Table 2). In contrast to socio-demographic variables, psychological variables show significant correlations with the dependent variable EV purchase intention. Overall, the model explains 27% of the variance (R^2 = .27, F 15, 1094) = 27.844, p < .000). According to the results there is no evidence that gender (ß = .03, p = .32), *educational level* ((ß = -.02, p = .48) or *age* (ß = .04, p = .16) have a significant effect on EV purchase intention. Psychological variables seem to be better predictors of

respondents' willingness to purchase an EV in the future. Confirming hypothesis H1 we find that, technology- and image-related *positive attitudes towards EVs* (H1) are significantly and positively linked to EV purchase intention (ß = -.25, p < .000; ß = -.12, p = .001). In the same vein *technology- and image-related negative attitudes towards EVs* (H1) are, as expected, negative and significant predictors of willingness to purchase an EV (ß = .08, p = .023; ß = .19, p < .000). Furthermore, the results show that *scepticism* (ß = .14, p < .000) towards renewable energy technologies significantly decreases the willingness to purchase an EV. Besides this, *social norm* (H2) (ß = -.09, p = .008) *towards renewable energy technologies as well related to energy use (*ß = .10, p = .003) are significant predictors of EV purchase intention of Austrian adults. Two further scales, *EV experience* (H4) (ß = .05, p = .047) and *energy-saving behaviour* (H6) (ß = -.09, p = .003), have positive influence on willingness to purchase an EV, whereas *optimism* (H2) (ß =-.03, p = .28) (H2) does not play a significant role in predicting willingness to purchase an EV. Further scales included in this model were not significant predictors of willingness to purchase an EV (*social dominance orientation* (H3) (ß = .03, p = .26) and *climate change concerns* (H3) (ß = .05, p = .09)).

To summarize, the results show, that there is a wide range of relevant factors predicting WTP an EV. These factors are: *positive and negative technology and image related attitudes towards EVs*, as well general *scepticism towards renewable energy technologies* are significant predictors of the willingness to purchase an EV. Additionally, we find *social norm regarding the use of renewable energy technologies and with respect to energy use*, in general, *EV experience and energy-saving behaviour* to be significant predictors of EV purchase intention of Austrian resident.

5. DISCUSSION & CONCLUSIONS

Our current private car-based transport system is inefficient and unsustainable (Strömberg et al., 2016) and its role as a main contributor of energy-related greenhouse gas emissions causing global warming (e.g., IPCC, 2014) warrant efforts geared at finding new solutions for how we travel (El Zarwi, Vij & Walker, 2017). Various studies highlight EVs as eco-innovations with the potential to trigger a substantial emission reduction in the transportation sector (e.g., Egbue & Long, 2012; Lane & Potter, 2007; Schuitema, Anable, Skippon & Kinnear, 2013). In order to do so the identification and characterization of potential adopters is key to successfully promote EV adoption in the individual transportation sector. Our study

contributes to this research area by investigating willingness to purchase EV with a particular focus on young adults – as future users of existing and upcoming low-carbon technologies.

Building on VBN theory (Stern, 2000) we measured a series of psychological constructs and applied multiple linear regression analysis to predict willingness to purchase.

Our study results indicate that the intention to purchase an EV is most strongly influences by psychological variables as opposed to socio-demographic characteristics, such as age or gender. The multiple regression analysis yields positive and negative attitudes towards EVs as strongest predictors of willingness to purchase an EV. As an exploratory factor analysis indicated separate image- and technology related categories for both types of EV-attitudes (positive and negative) a separate investigation of these suggested that in term of positive attitudes it was technology related attitudes that had a greater impact in the regression model (ß =-.25, $p < .000$ vs. ß =-.12, $p = .001$), as opposed to image-related attitudes for negative EV-attitudes (ß = .08, $p = .023$ vs. ß = .19, $p < .000$)). This paints a picture of EV-support based on central aspects and advantages of the technology, and EV-rejection focusing on peripheral non-technology related factors. To our best knowledge this is the first study to offer such a nuanced look at attitudes and their predictive value and future studies will have to investigate whether the here proposed distinction of technology and image related attitudinal aspects is of value to further illuminate EV-adopter profiles. For a future investigation of EV-attitudes it should further be interesting to determine the temporal stability and equally their independence from other variables such as actual experiences with EVs. Ideally an experimental and/or longitudinal study design would be very much suited to allow for this type of insight.

Our two measures of social norm provided a significant contribution to the model suggesting that the behaviour of significant others and their expectations are decisive parameters with respect to the preferences of the present sample. Scepticism with respect to renewable energy technologies (RET) also significantly predicted willingness to purchase an EV. This is not overly surprising but it interesting to find that the contrary optimist stance towards RET is not associated with the dependent variable. Investigating the simple correlations both constructs are significantly associated with willingness to purchase an EV but it is only scepticism that prevails in the regression model. It is plausible that a positive general belief towards renewable energy technologies is mediated by a positive evaluation of the technology as well image related qualities of an EV, as the correlation for these two variables does in fact represent one of the strongest correlation overall. More in depth analysis of potential mediation effects would certainly help here to paint a clearer picture.

With respect to social dominance orientation we did not find a significant effect in the model as hypothesized. The results contrast some of the previous results (e.g. Kahan, 2007; Priessner et al., 2018). Apparently, cultural worldviews opposed to SDO are less applicable in the context of EV adoption.

With respect to EV-experience the current analysis was able to map a marginal effect on willingness to purchase an EV. It is important to note however that we encountered substantial restrictions in measuring this variable, with a relatively high number of “don’t know” answers and thus, missing values and an equally problematic skewness in terms of levels of experience. Future examinations of this effect of experience will thus have to take care to investigate a more evenly balanced sample in terms of experience, potentially even looking at an experimental setting.

As the above paragraph has begun to address and despite carefully designing the survey which generated the data analysed here, the present study comes with certain limitations. Most notably the analysis presented here relied on willingness to purchase as a dependent variable, rather than actual purchase decisions, a design aspect that comes with certain limitations (cf., Carrington, Neville & Whitwell, 2010). Since EV penetration is still relatively low (with about approx. 1,5% of the newly registered cars being EVs (Statistik Austria, 2018)) however, an analysis of actual EV buyers using the sampling technique applied here is practically, even more so when oversampling younger adults. It is in fact common practice to study acceptance of new products on the market by using purchase intention or preferences in place of actual purchase decisions (Plötz et al., 2014; Priessner et al., 2018; Schmalfuß, Mühl & Krems, 2017; Schuitema et al., 2013). Nevertheless, it would be highly commendable, if future research efforts were able to collect a large enough sample, to investigate profiles of actual EV-buyers to further expand on the findings presented here.

Another limitation of the study equally concerns the dependent variable. While the assumption that the definite choice of an electric vehicle in a hypothetical purchase scenario weighs more heavily than the general willingness to purchase an EV the collapse of the two purchase related variables might have an introduced a certain amount of error into the model, rooted in the two distinct measurements. It would be preferable for future studies in this domain to rely on one continuous measure to eliminate this potential source of error. One further restriction concerns the sample which was not representative of the Austrian population and so results must be interpreted bearing in mind the particular characteristics of the sample collected. This obviously does not only concern generalizability to an Austrian population but even more so the potential to transfer results to other national contexts.

Despite these critical aspects we strongly believe that our study offers an important contribution to the extant literature by providing a focused investigation of predictors of willingness to purchase. Further, the present research investigated a wide array of variables at various levels, thus offering a comprehensive look at potential predictors of willingness to purchase an EV. Using these results as a base for further in-depth analysis of potential mediation effects could prove highly insightful.

This study, to our best knowledge is the first to offer a more in-depth look at predictors in a younger adults sample. Following Himmel et al. (2014) it is integral to include the future user into the early development process in order to successfully increase the acceptance of EVs. Results however do not show a significant effect of age as well as other socio-demographic factors on willingness to purchase an EV. This seems to contrasts the idea of a unique typology of young mobility users. According to Williams et al. (2010) the generation Y responds well to “green” living and energy-efficient features, which comes as no surprise, seeing that young people are more environmentally aware than previous generations (Department for Environment Food and Rural Affairs, 2002) and that is this increased environmental awareness that actually discourages young adults from driving cars (Forward et al., 2010; KRC Research, 2010). However, this in turn might also explain findings in recent studies showing that young people are being less likely to get a car license at all and to generally drive less (Kuhnimhof, Buehler & Dargay 2011; Raimond & Milthorpe, 2010; Sivak & Schoettle, 2011, 2012). This could then be an indication on why EV adoption did not differ between older and younger respondents.

Combining this insight with the fact that the average car is parked 92 percent of the time so that their capacity is not nearly optimally used (MacArthur et al., 2015) it further becomes evident that new business models are in demand. Authors have suggested that seamless and reliable mobility without owning a car will represent the fundament of new mobility services (Ambrosino, Nelson, Boero & Pettinelli, 2016). Future research must therefore widen its scope to include alternative mobility concepts while still including EVs. This shift in focus will be of vital importance to future studies in this domain. A continued look at individual car ownership will otherwise run the risk of producing research on future mobility that is based on outdated preferences. With the present study we firmly believe that the findings presented here can serve as a starting point for future research efforts on mobility users of tomorrow discourse.

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APPENDIX

Table 1 *Description of variables (in means or percentages)*

Variables	Variable code	Descriptive statistics
No. of respondents		1267
Willingness-to-purchase	1 = very low 5 = very high	3.16
Socio-demographic variables		
Gender	1 = male	45.5%
	2 = female	54.5%
Age	Years	2.46
Education	1 = compulsory school	11.1%
	2 = vocational training	51.1%
	3 = high school	23.5%
	4 = university	14.3%
Psychological variables		
Positive attitudes towards EVs[1]		
Technology-related	e.g., “Protection of the environment and the climate.”	3.99
Image-related	e.g., “Charm of modern technologies.”	3.12
Negative attitudes towards EVs[1]		
Technology-related	e.g., “Low availability of charging stations (in Austria and abroad).”	4.11
Image-related	e.g., “Electric cars are only a transition technology.”	3.27
RET Beliefs[2]		
RET optimism	e.g., “It is our responsibility to use renewable energy technologies as this is the only way to prevent long-term harm to the environment.”	3.10
RET scepticism	e.g., ”Austria will never get along without fossil fuels (gas, oil, coal).”	2.58
RET social norm	e.g., “I have the feeling, that my family and friends expect from me that I use renewable energy technologies where ever possible.”	2.19
Energy use social norm [2]	e.g., “I often talk to my friends about energy because this is an important topic to me.”	2.54
Social dominance orientation (SDO)[2]	e.g., “No one group should dominate in society.“	2.08
Energy-saving behaviour	e.g. “Turn off lights, the computer and other electronic devices when they are not needed.”	2.78

EV Experience	1 = I own/owned an EV.	0.07%
	2 = I already drove an EV or someone drove me with an EV.	16.3%
	3 = I have informed myself about EVs.	28.6%
	4 = I have no experience with EVs.	47.0%

Note: RET = renewable energy technologies; EV = electric vehicle.
[1] 1 = not important at all; 5 = very important.
[2] 1 = disagree; 4 = agree.

Table 2: Multiple linear regression output

Dependent variable = Willingness-to-purchase	*b*	SE B	ß	p
Constant	3.38	.44		.000
Gender (male)	.07	.07	.03	.32
Age	.05	.03	.04	.16
Education	-.03	.04	-.02	.49
Pos. attitudes EVs (technology-related)	-.44	.64	-.25	.000
Pos. attitudes EVs (image-related)	-.19	.06	-.12	.001
Neg. attitudes EVs (technology-related)	.14	.06	.08	.02
Neg. attitudes EVs (image-related)	.03	.06	.19	.000
RET optimism	-.08	.07	-.03	.28
RET scepticism	.29	.06	.14	.000
RET social norm	-.14	.05	-.09	.008
Energy use social norm	.20	.07	.10	.003
Energy-saving behaviour	-.21	.07	-.09	.003
Climate change concerns	-.07	.04	-.05	.09
Social dominance orientation	.08	.07	.03	.26
EV experience	.09	.04	.05	.05

Note: R^2 =.27
Note: N = 1110 (140 observations were excluded from analysis due to missing values)

Table 3: Psychological measurement scales used in survey

Scale/dimension	Items	Source(s)
Positive attitudes towards EVs		
Technology-related	Free of emissions	
	Protection of the environment and the climate	
	Low operating costs	
	Ideal for short journeys and city traffic	
	High efficiency of the electric motor	
	More independence from energy suppliers	
Image-related	Status symbol	
	Charm of modern technologies	
	Good experience made by friends/relatives	
	Lower driving noise at low speed	
Negative attitudes towards EVs		
Technology-related	Range of the electric cars too low	
	Low availability of charging stations (in Austria and abroad)	
	No charging possible near the apartment/house	
	Too expensive	
	Long charging duration	
	Batteries are rather short-lived	
	Technology is still not fully developed	

Image-related	A petrol or diesel vehicle is clean enough Electric cars are not safe enough High complexity Electric cars are only a transition technology Electric cars are rather small and therefore, e.g., not suitable for a family car Limited selection	
RET Beliefs		
RET optimism	Renewable energy technologies enable future economic growth without an increase of climate-damaging CO2 emissions. It is our responsibility to use renewable energy technologies as this is the only way to prevent long-term harm to the environment. Efforts to support the development of renewable energy technologies is more important than efforts to increase the use of fossil energy sources. I would endorse the siting of a photovoltaic power plant in my community. I would endorse the siting of an ecological small hydro power plan in my community. I would endorse the siting of a wind turbine slightly outside of my community.	
RET scepticism	Renewable energy technologies are a luxury and not everyone can afford it. Austria will never get along without fossil fuels (gas, oil, coal). I believe that solar cells use more energy during their manufacturing than they later produce.	
RET social norm	Many of my neighbors use renewable energy technologies. Many of my friends and relatives use renewable energy technologies. I have the feeling, that my family and friends expect from me that I use renewable energy technologies where ever possible.	
Energy use social norm	I often talk to my friends about energy because this is an important topic to me. I often talk to my family about saving energy at home and beyond. Most of the people in my personal environment get active to save energy. Most of the people in my community care about saving energy.	
Social dominance orientation (SDO)	No one group should dominate in society. Groups at the bottom are just as deserving as groups at the top. We should do what we can to equalize conditions for different groups. We should work to give all groups an equal chance to succeed.	Ho et al. (2015) Cohrs et al. (2005) Six et al. (2001)
Energy-saving behaviour	Turn off lights, the computer and other electronic devices when they are not needed. Using warmer clothes at home instead of heating more. Disconnect the phone and other devices to be charged as soon as they are fully charged. Walk short distances or use the bike. Choose holiday destinations that do not require a flight. Consume seasonal, local and organic foods. If possible, avoid the consumption of meat products. Engage for energy saving measures writing letters politicians and/or the employer, as well as similar actions.	