



Article

Characterisation of Norwegian Battery Electric Vehicle Owners by Level of Adoption

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Abstract: In this paper we investigate differences between groups of Norwegian electric vehicle owners, sorted by their adoption level. The grouping is based on adoption theory and the share of battery electric vehicles in new car sales numbers. We investigate Norwegian adopters' preferences, values, and motivations for choosing a battery electric vehicle. The main data source is a yearly survey between 2015 and 2020 amongst Norwegian electric vehicle drivers. The motivation of the study is to reveal different choices by the adopter groups, contributing to policy recommendations and incentives for other countries. However, the Norwegian case might be a special one, having economic advantages which many other countries do not have access to. We assess the validity of the results and policy recommendations by analysing the results of a survey amongst the Nordic countries on investment choices concerning battery electric vehicles.

Keywords: policy; market development; user behaviour



Citation: Bjørge, N.M.; Hjelkrem, O.A.; Babri, S. Characterisation of Norwegian Battery Electric Vehicle Owners by Level of Adoption. *World Electr. Veh. J.* **2022**, *13*, 150. <https://doi.org/10.3390/wevj13080150>

Academic Editor: Joeri Van Mierlo

Received: 13 July 2022

Accepted: 5 August 2022

Published: 9 August 2022

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1. Introduction

As a response to local pollution and aims to reduce greenhouse gas emissions in the atmosphere, many countries have applied extensive measures in different sectors. Targeting the transport sector, Norway has focused on electromobility and has introduced and upheld beneficial local and national policies, making it convenient and affordable to own electric vehicles [1]. This accelerated the sales and the adoption of battery electric vehicles (BEVs), as data on new vehicle registrations in 2022 (year to date) show that 83.7% of new registrations are BEVs [2].

Multiple incentives were introduced in Norway throughout different periods of the adoption phases. The added value taxes have traditionally been high, and already in 1991, the BEV users were exempted from this tax. The exemption led to considerable price reduction and accelerated the import of BEVs onto the Norwegian market [1]. In the late 1990s, exemption from toll road fees were introduced, and after a test period of free parking, this was fully established in 1998 [1]. These measures contributed to expanding the share of BEVs onto the Norwegian market, starting the diffusion of the early market phase. In this phase, the innovation process also took place in Norway. Even though international car producers dominated the market in the long run, the technology development was important for policy incentives. The exemption from VAT and BEV access to the bus lanes were pointed out to be of the most important incentives provided in the early market phase. Numbers from the former Norwegian EV-producer, Th!nk, shows that the demand for BEVs increased considerably after the adoption of these policies [1]. In 2009, the bus lane access became a permanent incentive, and all BEVs could also use ferry connections without cost [3].

Two key documents were launched in 2012: “The Climate Message” and “The Climate settlement” [4]. The documents pointed out clear goals for the transport sector and put a maximum limit of greenhouse gas emission for new cars in 2020. The limit should

not exceed an average of 85 g of CO₂ per km. “The Climate Message” also emphasised several measures to make the Norwegian car park more climate friendly, such as utilising low emission technology for taxis, facilitating the use of electric vehicles and establishing new electrification infrastructure. These measures contributed to the spread of BEVs in other sectors as well, enforcing the spread of technology onto freight operators and other transporters.

The measures above have contributed to decreasing the barriers to purchase BEVs and have been important for the increasing adoption in Norway. A report from 2020 suggests that BEV owners have become more similar to internal combustion engine vehicle (ICEV) owners. They have also become richer, emphasising economic incentives when purchasing a BEV. Moreover, there are specific trends to own a BEV as a second car [5]. Gradually, the state authorities have reversed many of these exemptions; ferry fees and toll road tickets were reintroduced in 2018, and the bus lane access became more restricted. It is therefore likely that there are some differences between people who purchased BEVs in the early market phase, compared to those purchasing it after the incentives became more prominent, and later removed. Identifying and discussing these differences is the main aim of this paper.

Previous Literature on BEV Adoption

The diffusion phase of BEVs in Norway started already in the 1970s, and the period from 1990 to 2009 is the “technology niche creation phase” characterised by an almost non-existent market. As stated above, several policies were implemented during this period with the main intent to nurture the BEV industry and to create a market [6]. The BEV users in Norway have since evolved from a typical innovator and early adopter group in 2014–2015 to an early majority in 2018. During this evolution, the BEV users have become more akin to ICEV users [5].

Several factors seem to affect people to adopt BEVs, and multiple studies have been done on Norwegian adopters due to the high uptake of BEVs in Norway compared to other countries. A study on local electromobility policies in Oslo and Bergen found that the policies contributed to an increase in the relative advantage of BEVs and therefore spiked the sales of BEVs in these cities [7]; in particular, policies that expanded the charging infrastructure and gave access to bus lanes for BEVs. A study from 2016 [8] reports that in small communities such as Norway, pricing incentives are the most efficient measure for encouraging people to adopt BEVs. This result was confirmed in another study [3], which highlights the exemption of both purchase tax and VAT as the most important incentive for BEV adoption in Norway. The people responding to reduced BEV costs are often highly educated, with lower income, and living in the third largest city of Norway, Trondheim [3]. Users that are concerned with incentives being removed are often over-emphasising the importance of the incentives itself [3].

Multiple studies on electromobility in other countries than Norway also investigate criteria for users to adopt BEVs. A study from 2017 [9] identified barriers for adopting BEVs in China through surveys. Experienced drivers emphasised battery and purchase cost as an important barrier for adopting BEVs. An increase in the amount of public charging infrastructure, installing new charging infrastructure as well as purchase subsidies were also measures emphasised in the literature. The cost considerations being the most powerful incentive in China was confirmed in another study in 2019 [10]. Also in China, it was found that only 33.6% of the respondents not owning a car were interested in purchasing BEV [9]. Of the respondents already owning a vehicle, 46.8% were interested in purchasing a BEV as a second family car. The Chinese BEV population has now developed to an early majority. However, by comparing China and the early adopter staged South Korea, [11] investigated motives behind BEV purchases in the two countries. The environmental concern was higher in China than in South Korea, where the economical motives were the most important for buying a BEV [11]. The Chinese early majority also had a stronger level of symbolic perception towards their vehicle and were sensitive to the fact that driving a BEV would

contribute to an image of being environmentally conscious and responsible. However, the Chinese respondents were less satisfied in general, and emphasized lack of charging points and too high purchasing price. The Korean BEV users were more satisfied, mainly due to the large cost exemptions.

A comparison between Chinese and US BEV users from 2015 [12] focused on the difference in willingness to pay, and found that users from the US were willing to pay higher prices for BEVs than Chinese users. The study also suggests that the Chinese respondents are more receptive to BEVs than American respondents regardless of the subsidies. This is due to key distinctions of the Chinese market, which is not prominent in the US. About 2/3 of the Chinese adopters are first time car buyers who typically have less experience with both gasoline and plug-in vehicle technology [12].

Several studies have looked into specific traits of BEV users and what they emphasise as motivating factors for adopting BEVs. A Norwegian study [5] state that most people owning BEVs are characterised by high income and adds that very few have a minority background. Their study also confirms that BEV owners usually live in large cities and suburbs. Households owning one BEV are often families consisting of couples with kids or households consisting of singles [5]. In this group, the age span between 25 to 44 years is dominating. Couples, with or without kids, are found to be most frequent in the group owning two BEVs [5]. A qualitative study [13] investigated BEV users through in-depth interviews and found that the BEV users were a heterogenous group, which for either economical or practical purposes, adopted a BEV. They also emphasised to be environmentally friendly expressing pride of their vehicle. In a German study [14], the early adopters of BEVs in Germany were found to be middle-aged men living in suburbs and rural areas. Another study of Danish and Swedish BEV users found that males with high levels of income and education were predominant [15]. For regions without strong policies for BEV uptake, it was found that BEV users were characterised by high income, high technological competence, home ownership and green political preferences [16]. Regarding changes in attitudes over time as BEVs become more widespread in a market, it was found in [10] that people with more experience with BEVs were also more willing to adopt them. The more people who are in favour of BEV technology and aware of environmental issues, the more others are willing to adopt them [17].

Several studies have used theoretical frameworks to classify groups of BEV adopters. In [18], two distinct groups of early adopters are identified, which are high-end and low-end adopters, with differences in opinions, preferences, and sociodemographic properties. As high-end adopters had a more positive view on future BEV ownership, it was suggested that policies should target low-end BEVs. A study of EV adopters in China showed that a specific type of adopter, lead users, are important for successful adoption of BEVs due to their expertise and experience [19].

It is apparent from the presented literature that there are differences between BEV adopters, but the studies are almost exclusively focusing on early adopters. Hence, there is a gap in the literature on the classification of BEV adopters beyond the early adopter stage. The main aim of this paper will be to contribute to this field by characterising how Norwegian BEV users have developed from the early marked phase until today, and which incentives they emphasise in different adoption phases.

It is important to investigate Norwegian BEV adopter groups to gain more insight on adopter choices. This knowledge may contribute to recommend policies and incentives for other countries. In this study we address this issue by investigating how BEV users have changed from 2015 to 2020, depending on how long they have owned a BEV. Based on previous literature, it is reasonable to assume that there will be distinct differences between a user adopting a BEV in 2015, versus a user adopting it in 2020. We therefore aim to investigate these research questions:

Which incentives were emphasized by first movers and early adopters when purchasing BEVs in Norway?

How can the adoption experiences from Norway be used in policy making for further BEV acceleration in other European countries?

First, we investigate data from a yearly survey amongst Norwegian BEV users between 2015 and 2020 to see what influenced different stages of first movers, early adopters and early majority when adopting BEVs. The second part is to investigate numbers from European countries (EU + EFTA + UK + Turkey), to see what stage each country is in, depending on the theory.

2. Theory of Diffusion of Innovation

The increase in market share for BEVs in the Norwegian market, demands for an investigation of different type of user groups. In [20], Roger's theory of diffusion of innovation is presented. The theory is based on different characteristics related to groups that adopt new innovations at different times, which are presented in short in this chapter.

The very first segment of the population to adopt are innovative in nature and are referred to as first movers. They are characterised as a deviation from the social system, having high technological competence. The first movers might be closely related to the innovation process, and a prerequisite to be a first mover is control over substantial financial resources and the means by which to cope with non-profitable investments. The innovator also plays a crucial role in the diffusion process. An early adopter is someone that starts using the innovation earlier than the rest of the participants in the social system. Rogers describe an early adopter as an opinion leader that is quite respected by his or her peers. This person often ends up as a role model to whom later adopters turn for advice. Further on, Rogers describes early adopters as more educated, having higher social status and are in general more wealthy than later adopters. They are well integrated into the social system, trust science and cope well with risk taking.

In the social system among the first movers and the early adopters, the early majority, late majority, and the laggards also exist. The early majority are the most numerous groups of adopters and deliberate for a while before deciding on adopting a new technology. They are the last group to adopt before the other half of the social system. The late majority adopts a technology later than the rest and are in general sceptic towards new innovations. The laggards are the last adopters and have their point of reference in the past. Comparing socioeconomic characteristics between early adopters and late adopters, Roger points to a small difference in age. Early adopters have higher years of formal education and are more eager to change, coping well with risks and uncertainties.

The stages of diffusion of innovation are shown in Figure 1, which groups the population according to percentages of the population that sequentially adopt an innovation. The first 2.5% of the population that adopts an innovation are known as first movers. The second group are the early adopters and consist of the next 13.5% of adopters in the population. The segment of the population which is within the adoption interval of 16% to 50% are regarded as early majority. The late majority are in the range of 50% to 84%, while the last 16% that adopts an innovation are called laggards. In our study we limit the social system to new vehicle buyers and define the stages of adoption in line with the percentage of BEVs sold per year compared to total new vehicle sales.

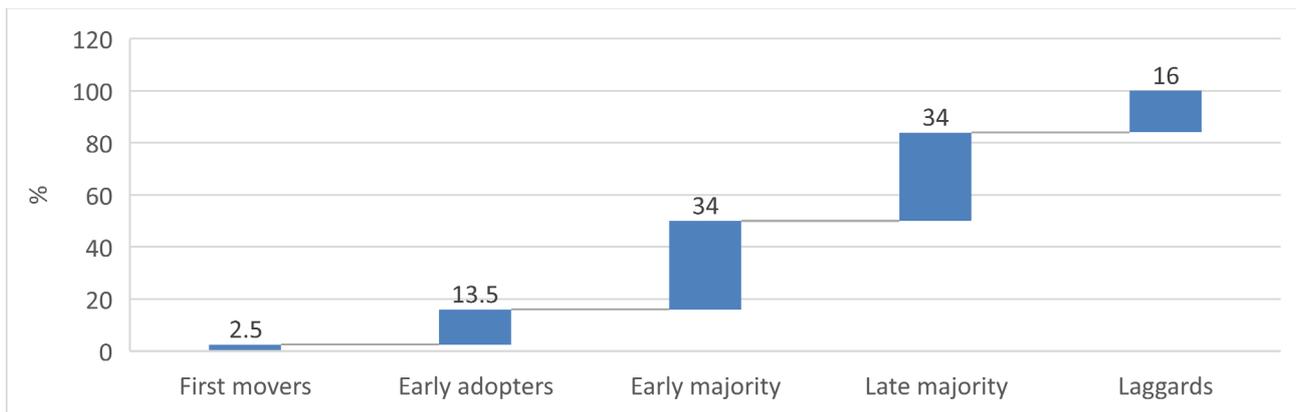


Figure 1. The sequence of adopter stages from Roger’s “Diffusion of Innovation” [20], and the size of each group in terms of percentage of the population.

3. Data and Methods

The main data source in this study is a survey conducted by the Norwegian EV association between 2015 and 2020. This is a yearly survey amongst members of the EV association, and the number of respondents is in the order of 10,000 each year. Most of the questions are repeated each year.

The reasons for choosing data between 2015 and 2020 are based on our theory, “Diffusion of innovation” and numbers on new BEV registration obtained from European Alternative Fuel Associations (EAFO) [2]. The numbers from Norway from the year 2011 to 2020 are shown in Table 1.

Table 1. New registrations of passenger BEVs in Norway. Source: [2].

First Movers			Early Adopters			Early Majority			Late Majority
2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.5%	3.1%	5.8%	12.6%	17.1%	15.7%	20.8%	31.2%	42.3%	54.3%

According to our application of Roger’s classification theory, the Norwegian new registrations of BEVs already went into the phase of early adopters in 2012. The early majority stage was reached in 2015, and the late majority stage in 2020.

With data from 2015, it will be possible to extract data from respondents who obtained a BEV four years earlier, i.e., in 2011. This gives us important insight into first mover reasons for obtaining a BEV. Applying data from 2015 and investigating respondents that obtained BEV two or more years prior, we will see the important factors for BEV adoption in the early adopter stage. By applying data from 2020 and investigating people that obtained a BEV two or more years earlier, we will gain insights into early majority reasons for adopting BEV.

We chose newly registered passenger cars because we know that these are cars that most likely are in everyday use. If we chose to investigate the total amount of BEVs in the car park, it might be large parts of a country’s total car park that are old vehicles being used less frequently.

The surveys have been distributed mostly through the BEV associations channels, and it is therefore reason to believe that the results will be generalisable to the populations of BEV users.

In addition to the Norwegian survey described above, the Nordic EV barometer is conducted yearly. This is a narrow survey focusing only on the next car purchase of the respondent. A representative sample of the populations in Denmark, Finland, Iceland, Norway and Sweden are interviewed through a web-based questionnaire.

The method applied in this paper includes a descriptive analysis of the data from the survey conducted by the Norwegian EV Association, with the theory of diffusion of

innovation as a framework for classification of BEV users. This is further discussed in a European setting using new car registration data from EAFO and the Nordic EV barometer to discuss the main barriers for higher EV adoption on a European level.

4. Results

In this chapter, we present differences between the defined adoption groups, with results from both the Norwegian and Nordic survey. Some of the demographic differences between the groups are shown in Figure 2. Here, we see that the first movers are mainly men, older, have higher education levels, and are more often in smaller households compared to the early adopters and early majority. The share of females increases further as the adoption groups evolve. The education level decreases throughout the adoption groups. Usually, first movers are in households of 1–2 and 3–4 people.

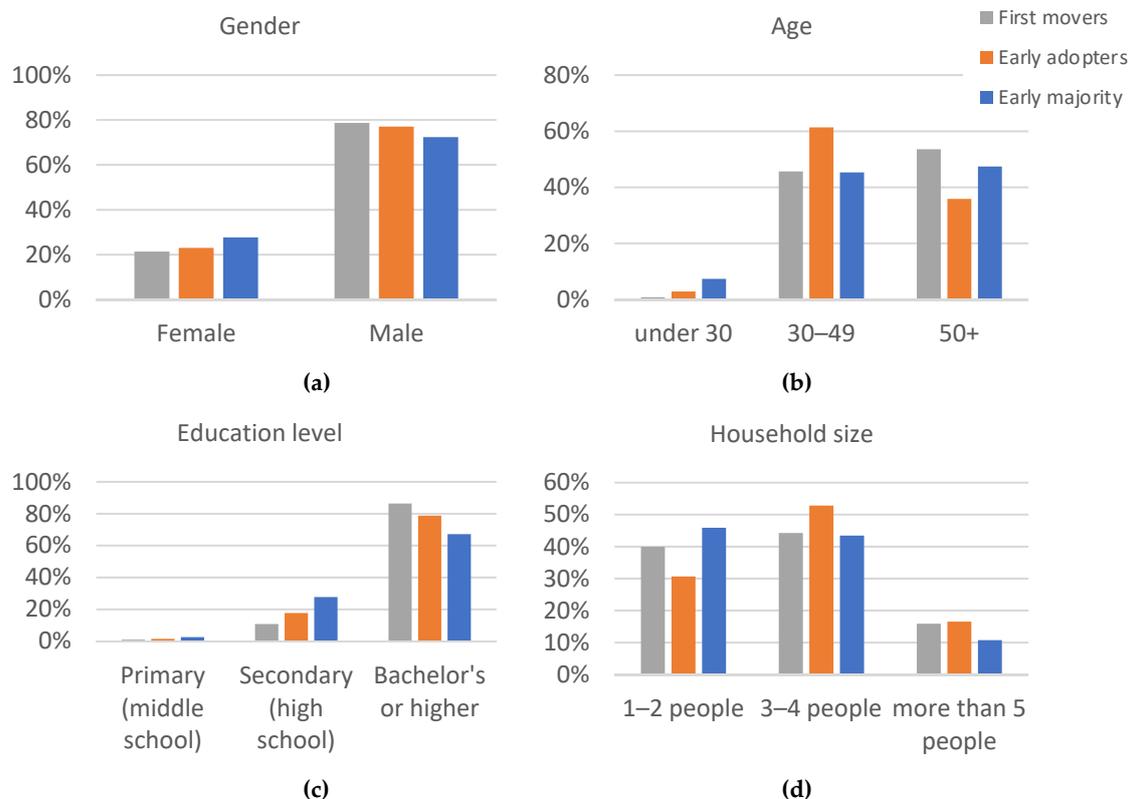


Figure 2. The distribution of sociographic differences across the three adopter groups in percent: First movers (grey), Early adopters (orange), Early majority (blue). (a): Gender distribution. (b): Age distribution. (c): Education distribution. (d): Household size distribution.

In Figure 3, results about vehicle choice, travel mode choice and purchase inspiration are presented. Regarding car purchasing choice, this question is also asked in the Nordic EV barometer. However, the latter is sampled in a representative part of the population, while the sample in Figure 3a are members of the EV association. We see that the limited sample—theoretically representing adopters up to and including the early majority—states that only 2–4% would have bought a petrol or gasoline car. In the Nordic survey, the equivalent numbers are 26% (Norway), 34% (Sweden), 30% (Denmark), 45% (Finland) and 39% (Iceland).

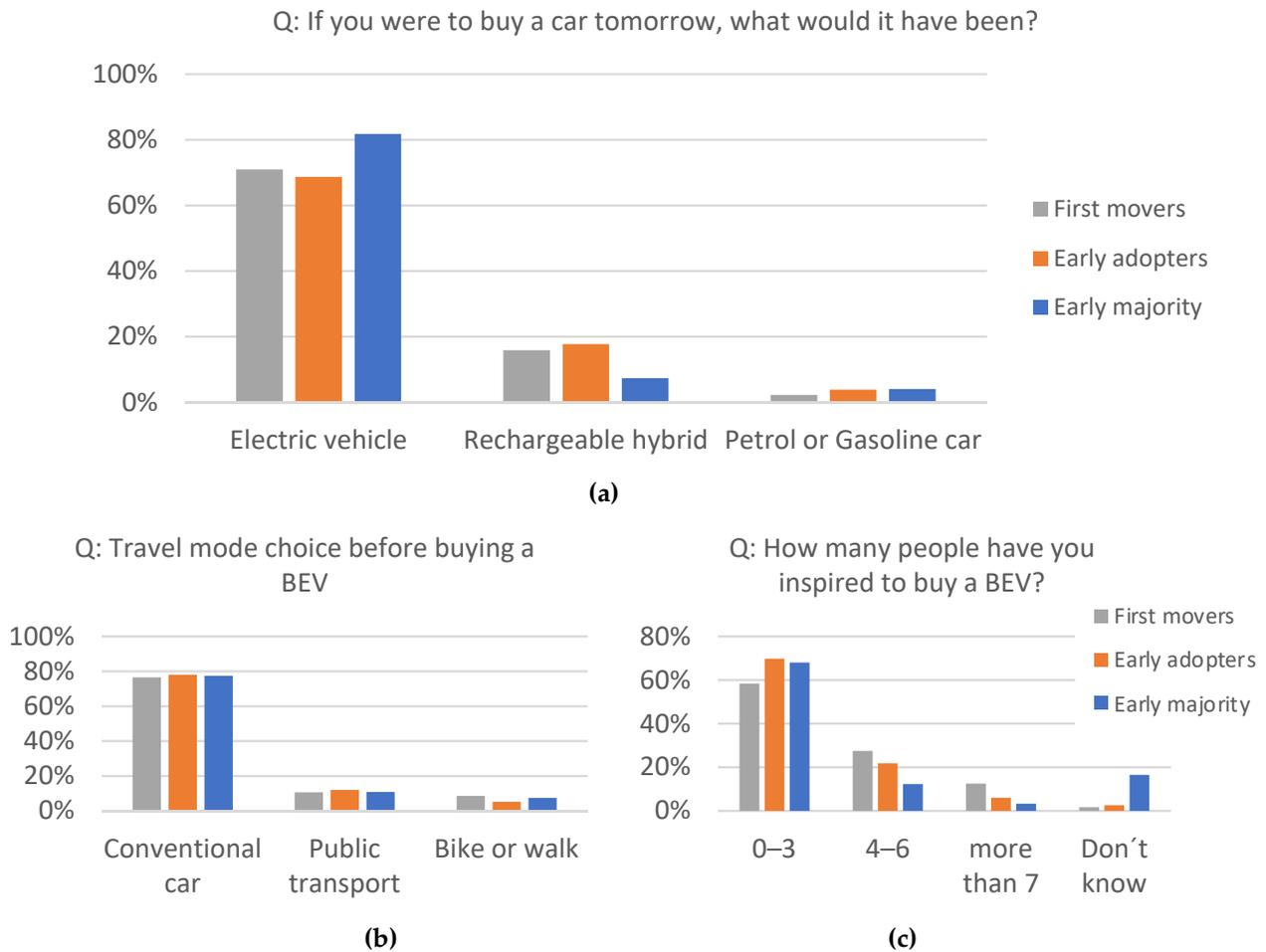


Figure 3. The share of responses for the three adopter groups regarding questions about their future choice of vehicle (a), previous travel mode (b) and the amount of people they have inspired to buy a BEV (c).

In Figure 3b, the main travel mode choice before buying a BEV is investigated. The results indicate that early adopters had a slightly higher preference for cars than other modes compared to the first movers and early majority. Regarding inspiring other people to buy a BEV, Figure 3b shows that the first movers and early majority state to a higher degree than the early majority that they have been influential in other people’s choices.

When looking at the drivers for buying a BEV, as shown in Figure 4, we see that the first movers emphasized climate friendliness, while the early majority emphasized low operating costs. Regarding the most important information source used before buying a BEV, the first movers found information about BEVs in media before purchasing. However, the early majority got information to a higher degree from friends, family and from web pages.

As shown in Table 2, each adopter group consists of responses sampled over several years. To see if there is a change over time, a specific response for one of the adopter groups is investigated. In Figure 5, the differences in opinions by early adopters between 2015 and 2017 regarding drivers for buying a BEV are presented. Regarding lower operating costs, the opinions are the same for each year. For the other responses, the change between years is within a difference of two percentage points, in contrast to the maximum difference between adopter groups to the same responses of five percentage points.

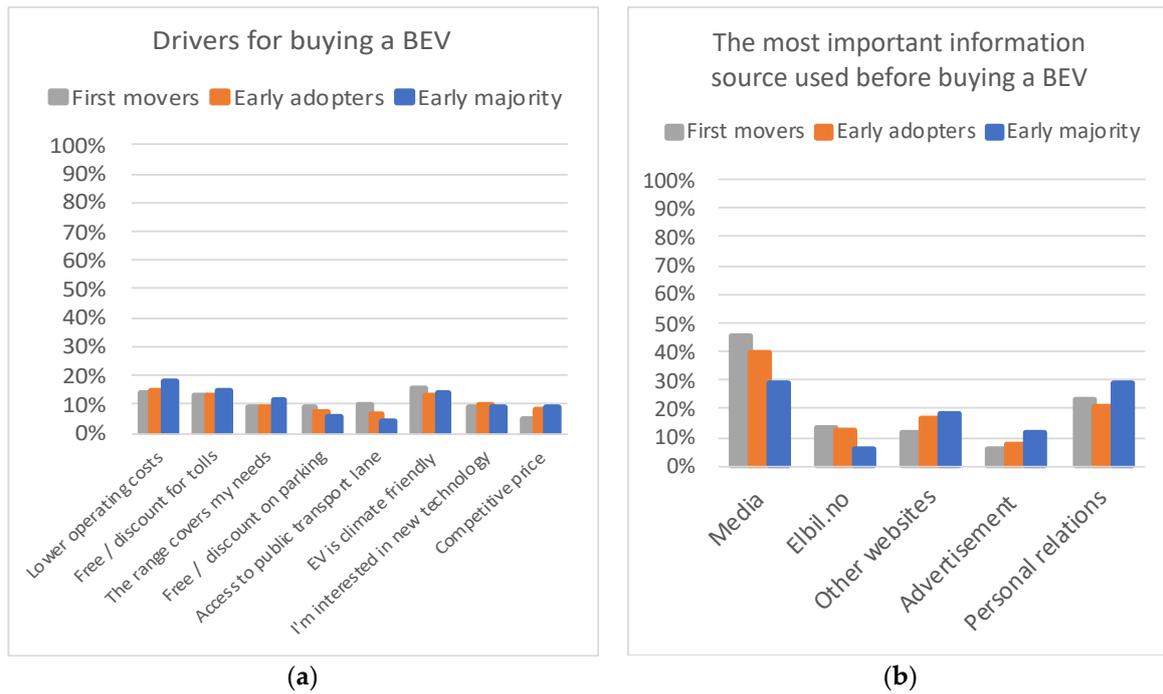


Figure 4. The share of responses for the three adopter groups regarding drivers for buying a BEV (a) and important information source when buying a BEV (b). Elbil.no is the website of the Norwegian EV association.

Table 2. The classification of adopters in the surveys and number of respondents per year.

Group	Definition of Each Group from the Dataset	No. of Observations
Early majority	Dataset 2020: Those who has owned BEV for 1–4 years.	6784
	Dataset 2019: Those who has owned BEV for 0–4 year	7997
	Dataset 2018: Those who has owned BEV for 0–3 year	6766
	Dataset 2017: Those who has owned BEV for 0–2 year	7183
Early adopters	Dataset 2018: Those who has owned BEV for 4–5 years	718
	Dataset 2017: Those who has owned BEV for 3–5 years	1547
	Dataset 2016: Those who has owned BEV for 2–4 years	914
	Dataset 2015: Those who has owned BEV for 1–3 years	3107
First movers	Dataset 2016: Those who has owned BEV for more than 5 years	139
	Dataset 2015: Those who has owned BEV for more than 4 years	423

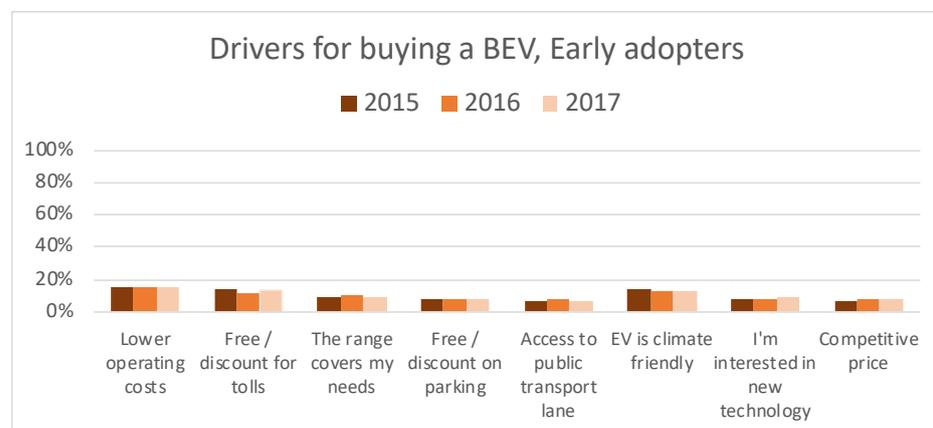


Figure 5. The share of responses between 2015 and 2017 regarding drivers for buying a BEV by early adopters.

align completely with this. Instead, the early adopters have a higher number of people between 30 and 49 years old than the rest of the adopter groups. Our results point to the education level among people adopting technology in the early stages being higher than later adopters. This aligns with the theory stating that early adopters are more likely to have higher education than late adopters. First movers are also specified as highly technologically competent, which also might be related to the amount of higher educated respondents in this group.

There are several reasons for purchasing a BEV, and the driver for purchasing varies between each adopter group. In our results, the first movers emphasise on being climate friendly, the access to public transport, and environmental discount on parking in public parking lanes. Overall, the first movers are emphasising on economic incentives to a smaller degree than the early adopters and early majority. The theory establishes that first movers often are in a robust financial situation since they are investing in a technology very early in the innovation process. Because of this, the first movers do not seem to emphasise on economic incentives as much as the later adopter groups. This is visible in our results and might imply a smaller emphasis on economic incentives for this group, since they are relatively affluent.

The first movers emphasise on being climate friendly more than the later adopters when purchasing a BEV. The diffusion of innovation theory points to first movers emphasising on knowledge and science to a high degree, therefore acquiring much knowledge before choosing to invest. This might be seen in relation to their BEV adoption and their concern regarding climate change and environmental research.

The theory points to early adopters as opinion leaders, which implies their being used as reference points for providing information for later adopters. In our results, the first movers and the early adopters get most of their information from the media, while the early majority favours consulting other people that own a BEV, such as family or friends.

5.2. Transferability to European Countries

Our results show differences in how incentives are emphasized by adopter groups. In this section, we will attempt to draw some main learning points from our adopter study with transferability to other countries in Europe in mind.

Electric mobility is relatively new for large parts of Eastern and Southern Europe regarding the small share of BEVs in new car sales. According to the implementation of adoption theory presented in this paper, these markets are in the first mover phase. To accelerate and make it a desired means of transport, the evidence from our result might give important insights for policy makers in the respective countries. As per our results, it was not necessarily a case of economic incentives that drove the adoption for the first movers, since they already hold substantial amounts of money. This group seemed more driven by exclusive accesses and being recognised as environmentally friendly when choosing a BEV. Therefore, exclusive access to, for example, bus lanes or restricted parking areas might apply to the first mover group in Eastern and Southern Europe. This group also emphasises the environmental aspects of BEV technology. The first movers tend to rely on science and knowledge in their decision. The authorities in the respective countries can, based on this, run information campaigns with information about BEV and their impact on emission reduction and other environmental benefits.

For the countries in the early adopter phase, which is mostly North Western Europe, another set of incentives could be more efficient. We see that price reductions are more efficient for this group. However, it is worth mentioning that Norway is in a special position regarding both general wealth and taxes on fossil fuel cars, which is not necessarily transferable to other countries. Therefore, any incentive which increases the economic benefit of car ownership in favour of BEVs should be prioritised.

These kinds of incentives should also be continued when entering the early majority phase to continue the adoption and accelerating the BEV share. In this stage, purchasing price and operating costs are even more emphasised than by first movers and early adopters,

suggesting a higher priority should be given to economic incentives compared to other facilitatory incentives.

6. Conclusions

This study has related the theory of diffusion of innovation on BEV users to classify them in different stages of adoption based on the percentage of new cars sold being BEVs. By applying this classification on respondents in surveys conducted by the Norwegian EV association, we investigated differences between adopter groups to see if the characteristics of each group coincide with adoption theory. The majority of the results, and especially gender distribution, educational level, environmental opinions and influencing power, are as expected with regards to adoption theory.

With the Norwegian BEV users already being in the late majority phase, large parts of Europe are still in the first mover and early adopter stage. While the first movers are driven by, e.g., environmental reasons, it seems to be necessary with economic incentives to accelerate the transition to other adoption stages to increase the BEV share in general.

Author Contributions: Conceptualization, N.M.B. and O.A.H.; methodology, N.M.B., O.A.H. and S.B.; formal analysis, N.M.B. and S.B.; investigation, N.M.B. and S.B.; data curation, S.B.; writing—original draft preparation, N.M.B., O.A.H. and S.B.; writing—review and editing, N.M.B., O.A.H. and S.B.; supervision, O.A.H.; project administration, O.A.H.; funding acquisition, O.A.H. All authors have read and agreed to the published version of the manuscript.

Funding: This research was supported by the project “Grid and Charging Infrastructure of the Future” (FuChar). The FuChar project is funded by the Research Council of Norway and industry partners under the ENERGIX programme, with project number 295133/E20.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data from the survey “Elbilisten” is not publicly available and was made available for this study by the Norwegian EV Association. Data from the Nordic EV barometer is available at <https://www.nordicenergy.org/project/nordic-ev-barometer-2021/> (accessed on 6 July 2022).

Conflicts of Interest: The authors declare no conflict of interest.

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