The drivers behind Electric Vehicle adoption

A quantitative study of EV owners in Norway

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Abstract

BACKGROUND: The electric vehicle is an environmental innovation that is perceived by many governments and organizations as a valuable zero-emission replacement of traditional fuel cars. The adoption of electric vehicles differs across countries. Norway is the only country where EV adoption rate is outstanding and therefore many scholars try to explain the reasons for such a successful result. However, most of them focus on national and regional level thus leaving the individuals as an important unit of analysis.

OBJECTIVE: The adoption rate in many countries is very low compared to Norway. Scholars point several factors that influence the EV adoption rate and explain the differences among the countries. However, none of them examined individuals' attitude to these aspects. People differ when it comes to their characteristics and values. It is therefore my goal to determine quantitatively what can explain the reasons for buying an electric vehicle by individuals.

METHOD: The study uses a cross-sectional analysis of secondary data about EV owners in Norway. In the analysis, the independent variables describing the characteristics of individuals are regressed on five dependent variables that represent the main reasons for EV adoption determined by theories. In addition to independent variables, several control variables describing the characteristics of EV owners are used in the analysis.

RESULTS: It was found that early adopters put more importance on environmental friendliness of EV when making a purchase decision. However, they do not care about relative advantage of EV. Individuals with higher income put less importance on incentives and eco-friendliness of EV when adopting an EV. Environmentalists are interested in eco-friendliness of EV and their degree of interest in new technologies when buying an EV. Opinion leaders are less interested in eco-friendliness of EV than its popularity and their degree of interest in new technologies. Those who can take advantage of incentives are less interested in eco-friendliness of EV, its popularity and their degree of interest in new technologies when adopting an EV. They are interested in relative advantage of EV when making a purchase decision.

CONCLUSION: Environmental friendliness of electric cars is a very important factor when deciding to adopt it, especially for earlier adopters. Also, it was found that relative advantage of electric cars is closely related to incentives and therefore incentives must be kept in order to sustain the diffusion process. Also it was found that incentives do not necessarily have to be a wrong decision, since they do not affect the structure of diffusion process to a large degree.

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1 Introduction

One of the reasons for CO2 emission increase is the transport sector, which in 2009 was responsible for 25% of CO2 emission in European Union (Kihm & Trommer, 2014). This situation clearly indicates that increasing number of vehicles on the roads and in the cities causes considerable damage to the environment. Since the problem of CO2 increase in the atmosphere is well known both in scientific world and public debate, governments and international institutions are forced to take an action towards combating climate change. In its White Paper, the European Union decided to fight against CO2 emission coming from transport sector and set a goal of reducing transport emissions to 20% below 2008 level by 2030 (Kihm & Trommer, 2014). Besides encouraging people to choose public transport rather than car in everyday trips, policy makers are also interested in promoting development of carbon-free technologies for transportation (Catenacci et al., 2013) such as zero emission electric vehicles (EV). One of the examples of this initiative is a decision of several countries to increase the number of electric vehicles on their roads. For instance, German government announced in 2009 that their goal is to have at least 1 million EVs on the road by 2020 (Kihm & Trommer, 2014). Other countries such as US, Austria, Norway, and UK are also interested in increasing the number of electric cars in their markets. However, the adoption of EVs is constrained by several factors that inhibit seamless diffusion of this technology. As electro-powered transportation technology is not a new topic, electric cars as a competitor to ICE are still in their infancy. The traditional car technology is well developed and it is not surprising that EVs might have problems competing with fuel-powered cars, taking into account many drawbacks electric cars bring to the user. The limited range, high price, uncertainty around charging possibilities and lack of second-hand market – they all contribute to lowering the relative advantage, compared to ICE cars. Aasnes et al. (2015) point out that while EVs offer benefits to society, the aforementioned restrictions have not been accepted by consumers in different parts of the world, which led to very low sales volume. Facing this problem, several countries have introduced a set of incentives which aimed to help diffuse EVs more rapidly in the market. However, despite these initiatives, most countries are still far behind 3% in EV market penetration. Norway was the only country that reached a significant increase in EV market share up to 14% in 2014 (Figenbaum et al., 2014). Figenbaum et al. (2015b) claim that this uptake is the effect of the broad range of incentives offered to the public. However, many other countries have also introduced incentives in order to speed up the EV diffusion process.

Nevertheless, they were not able to reach a significant market share. This difference between Norway and other countries raises the questions of other reasons than incentives that might explain such a successful adoption rate.

1.1 Rationale for choosing this topic

Many scholars have already tried to examine the reasons for such a successful adoption of EV's in Norway. There are also studies that try to explore the EV landscape in other countries. However, most scholar focus on national or regional level, thus leaving the individual level of analysis. None of the scholars, to my knowledge, tried to find what can explain the reasons for EV adoption as seen by individuals who adopted the innovation. It would be interesting to examine the underlying drivers for EV adoption by people who usually have different characteristics and values. Understanding the diversity of the adopters and values they express in the context of EVs would give an invaluable knowledge for policy makers, companies and marketing agencies trying to increase the sales of electric cars, which still struggle to take off in most countries. Furthermore, by analyzing the existing research about EV adoption and adding the individual perspective we might receive a true picture of the diffusion process and why people want to participate in it. It is therefore my motivation to find new patterns in the EV purchase decision process. I believe that there might be many underlying factors influencing the decision to adopt or not. It would be interesting to see how people value different aspects of electric cars and how their traits affect their perception of this innovation. Furthermore, scholars sometimes differ and do not agree on certain aspects. For instance, many scholars evaluating the EV market in Norway argue about the usefulness of incentives. Holtsmark et al. (2014) state that EV incentives are ineffective, detrimental to the society and should be stopped immediately. Figenbaum et al. (2015b) however, conclude that Norwegian EV incentives do work as intended. By testing individuals' attitude towards the most important aspects when adopting an EV, these conflicting statements might be quickly accepted or abandoned.

1.2 Objectives and research question

The research question under investigation is the following:

What can explain the reasons for buying an EV by individuals?

The research question will be answered in two parts. First, the current theoretical perspective will be evaluated. The existing scholars will help find certain patterns that might explain the adoption rate of EVs. The reasons derived from the theory will be used as dependent variables in examining the attitude of EV owners towards these aspects. I believe that testing the individuals' attitude towards the reasons purported by scholars will give more interesting insights.

1.3 Outline of the thesis

The paper begins with explaining the situation of electric vehicle markets in the world, with special attention to Norway. It then continues with literature review, which focuses on Rogers' diffusion of innovations theory and reviews the existing research on adoption of EVs.

In the next section, the methods used in the analysis are explained, together with description of sample, dependent, independent and control variables. It also includes the explanation of data analysis process.

In the results and discussion section, the findings are presented and they are put into perspective of theories used in the literature review. The main implications are further discussed, followed by limitations.

In the last section, the main findings and conclusions are presented, together with recommendations. The section is closed with some notes about further research options.

2 The EV landscape in the world

The increase of CO2 in the atmosphere and problems related to this change have forced many governments and international organizations to take an action towards reducing, or at least sustaining the same level of emission to protect the environment. One of the areas that is partly responsible for increasing CO2 level in many countries is transportation sector. In European Union, the transport sector is responsible for around 24% of total EU emissions of greenhouse gas (European Commission, 2016). Similarly, in U.S. the transportation sector accounts for 25% of total greenhouse gas emissions (United States Environmental Protection Agency, 2016). These numbers clearly indicate that there is a room for improvements, especially in the context of passenger cars which are most commonly used transportation means. For example, in European Union, the number of cars registered was almost 500 per 1000 inhabitants in 2014 (European Automobile Manufacturers Association, 2016). Therefore, not surprisingly, governments try to focus on reducing the CO2 emissions by controlling the road transport and its impact on environment. Apart from several limitations and strict requirements when it comes to production of cars and fees levied on owners of cars that pollute the atmosphere (negative incentives, as defined by Rogers (2003)), there is also a focus on promoting a relatively new and emerging industry – electric vehicles (positive incentives). These cars are 100% green alternative for traditional ICE (internal combustion engine) vehicles and they do not produce any greenhouse gases when used. Furthermore, they use electricity as a source of power, which means that potential user is not dependent on fluctuating fuel prices and in countries, where electricity is cheap and green, the use of EV might be less costly than using traditional gasoline/diesel car. The increasing awareness of climate change might be also a strong driver for EV introduction, because people have higher expectations towards the quality of air and they require that their places of living are free from pollutants. Therefore the EV topic is present in agendas of many governments and organizations that try to increase the use of EVs among citizens. However, despite the various incentives introduced by several countries, the EV adoption still struggles to take off. In 2014, only four countries had a sales market share greater than 1% - USA and Sweden with both about 2%, the Netherlands with about 4% and Norway with outstanding result of 14% (van Sloten, 2015)(Figenbaum et al., 2014). All the remaining countries were not able to reach 1%. Figure 1 presents market shares of 14 countries with highest EV adoption. As shown in the chart, the difference between adoption rates is significant and most countries still have

problems diffusing the EV technology to the satisfactory level. For the sake of clarity, only all-electric cars (BEV) are taken into consideration in this work. The situation of PHEVs (plug-in hybrid electric vehicle) is not analysed.

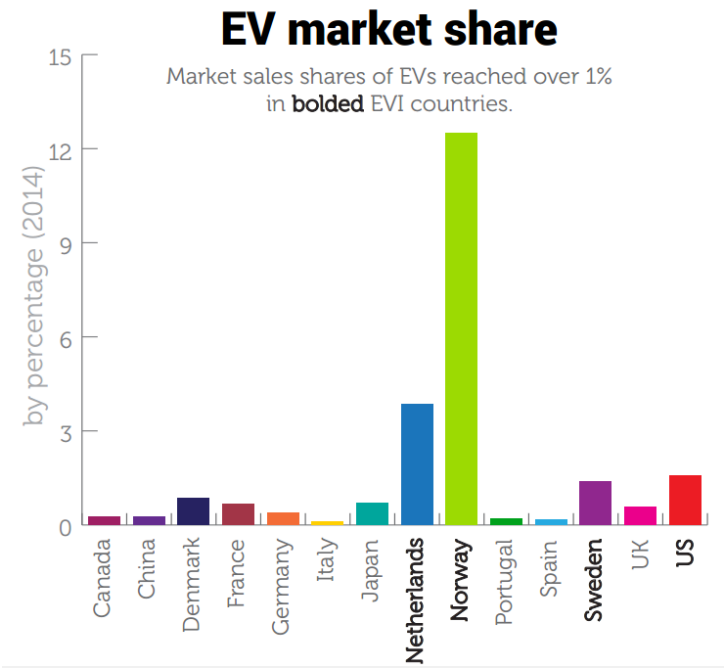

Figure 1. EV sales market share in chosen countries in 2014 (International Energy Agency, 2016)

The reason for this situation might lie in the fact that electric cars impose certain limitations compared to traditional diesel/gasoline cars. Range anxiety (the fear of being stranded due to a limited range of the battery) is one of the main barriers for EV adoption (Figenbaum et al., 2015b). Carley et al. (2013) also point out limited driving range, together with high purchase price and relatively longer charging time compared to refuelling of ICE car as three major disadvantages for potential customers. Other barriers include scarce and fragmented charging infrastructure, lack of standards and regulations and scepticism of consumers towards this new emerging technology (Steinhilber et al., 2013). Figenbaum et al. (2015a) also underlines the fact that EV second-hand value is difficult to measure, since this market is still underdeveloped and there is no information about the life expectancy of batteries used in EVs. In their study of electric vehicle adoption in 30 countries, Sierzchula et al. (2014) point out financial incentives, the number of charging stations and the presence of local EV manufacturer as the most important factors influencing the EV adoption rates. This confirms that apart from EV technology itself, a potential customer might need additional support such as infrastructure and lowering the costs and uncertainty of EV use. Therefore incentives and regulations might play an important role in diffusion of EV technology. Many countries have

already developed a package of policies/incentives which aim to boost the adoption rate of the innovation. However, the effect of incentives is usually moderate in most countries. This might be explained by the difference in spending on favourable policies between countries. Figure 2 presents the amount of government spending on incentives compared to their corresponding market shares. When studying the chart, one can easily notice that EV adoption is not necessarily correlated with spending on incentives. Most European countries failed to significantly increase the EV adoption rate, despite heavy investments in this sector. Norway, again, is the only country where the result is opposite. The relation between EV spending and market share is outstanding, compared to other countries.

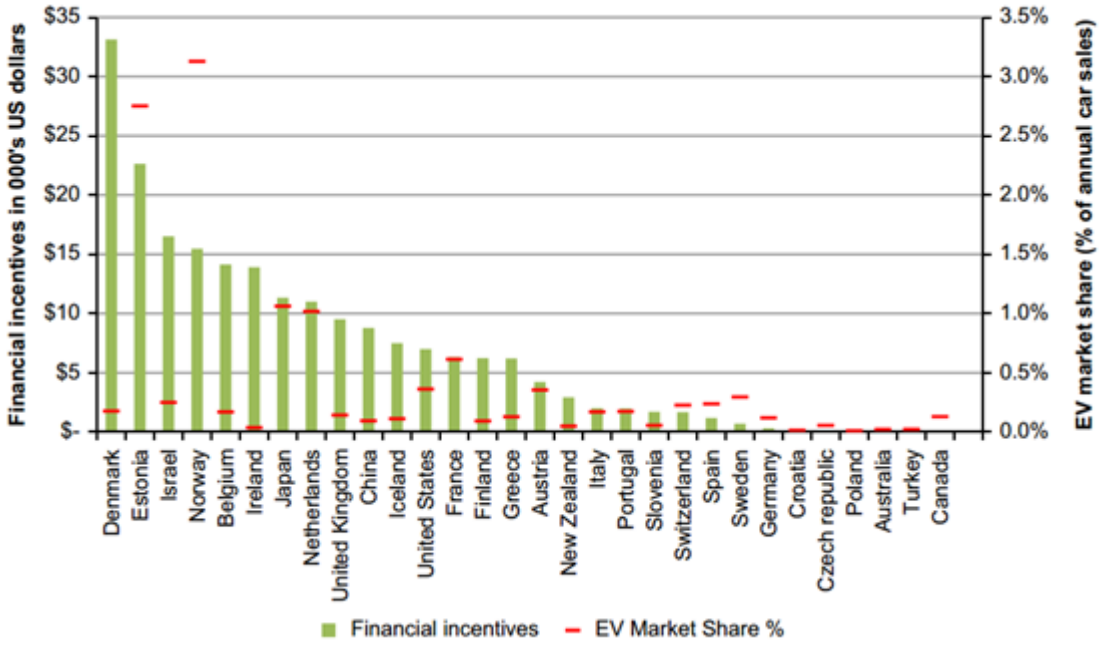

Figure 2. Financial incentives by country and corresponding EV market share for 2012 (Sierzchula et al., 2014)

There is also a difference in the types of incentives introduced, which might also affect the adoption rate. Countries provide different packages of incentives which aim to solve different problems. Figure 3 presents an overview of incentives package in different countries in 2013.

Country	EV market share 2013	Purchase grant/ subsidy	Registration tax exemption	Annual tax rebate/ exemption	Free street parking	Free toll roads	Bus lane access	VAT exemption	Other incentives
Norway	6,10		x	x	x	x	x	x	
Netherlands	5,55		x	x	(x)				
Iceland	0,94				x			x	
France	0,83	x							x
Estonia	0,73		x						x
Sweden	0,71	x	x	x					x
Switzerland	0,44		x	x					
Denmark	0,29		x		(x)				
Austria	0,26		x	x					
Germany	0,23			x					
Portugal	0,21	x	x	x					
Spain	0,18	x							
Belgium	0,17		x	(x)					x
Finland	0,17		x						
United Kingdom	0,17	x				London CC			
Italy	0,11			x					
Ireland	0,08	x							

Figure 3. Financial incentives by country and corresponding EV market share for 2012 (Figenbaum et al., 2015b)

In summary, one can easily notice that there might be multiple reasons why EV adoption took off in some countries, while it still struggles to reach a desired level elsewhere. In the next two sections the EV landscape of four countries with market share above 1% in 2014 (United States, Netherlands and Sweden and Norway) will be analysed. Since other countries did not manage to reach 1% market share, they are not taken into consideration.

2.1.1 The EV landscape in United States, Netherlands and Sweden

As Figure 1 shows, Norway, United States, the Netherlands and Sweden are the only countries that managed to reach over 1% of EV market share. Norway reached an outstanding share of 14% in 2014 (Figenbaum et al., 2014), therefore there is another section devoted solely to the EV landscape of this country. The current section provides an overview of incentives that are currently in place in Netherlands, United States and Sweden, together with EV market share in each country.

The Netherlands

In 2014, the EV market share in Netherlands reached around 4% (International Energy Agency, 2016), which is the second largest number after Norway. The policies that aim to increase to EV market share include:

- Exemption from BPM (motor vehicle purchase tax)
- Exemption from MRB (motor vehicle road-use tax)
- Exemption from vehicle circulation tax

- 4 percent company-car addition to taxable income for people leasing BEVs
- €3,000 subsidy on the purchase of all-electric taxis or delivery vans
- 5,421 public charging stations available in 2014

Local incentives in Rotterdam:

- Free parking for EV drivers in the city centre
- Subsidies of up to €1,450 towards installing home EV chargers that use 'green' electricity
- Potential EV buyers get €2,500 for scrapping old polluting ICE vehicles

Source: (Netherlands Enterprise Agency, 2016), (Harryson et al., 2015)

United States

The EV market share in United States reached around 2% in 2014 (International Energy Agency, 2016). The incentive package includes:

- $2.4 billion subsidy in the form of federal grants to support the development of next-generation electric vehicles and batteries
- Tax credit of $2,500 to $7,500, depending on the size of the battery in the car
- Discounts on Insurance (5% or more, depending on insurance company)
- Some states offer EV buyers and businesses a credit for the purchase and costs of charging equipment
- Various state incentives

Source: (Usa Today, 2016), (PluginCars, 2016).

Sweden

The EV market share in Sweden reached around 2% in 2014. The current incentives aimed at speeding up the diffusion process include:

- Exemption from yearly circulation tax for five years
- Rebate for "super green cars"

From 2012 to 2014, the government provided SEK 40,000 to the buyers of vehicles classified as 'super green car'. However, this rebate was not reserved for EVs, but was applicable to any type of car with CO2 emissions below 50 g/km. The subsidy was not fully financed in 2015 resulting in payments being delayed until 2016.

- Discount on company car tax for employees (the maximum reduction permitted is SEK 16,000 per year)

Source: Harryson et al. (2015).

2.1.2 The EV landscape in Norway

In 2014, the EV share in Norway accounted for 14% of total passenger car market (TØI, 2014). This result was not repeated by any other country and it is doubtful that this will happen in the near future. Figenbaum et al. (2014) claim that this uptake is the effect of the widest array of incentives, compared to other countries. Norway currently offers three types of incentives: fiscal, direct subsidies and other incentives giving relative advantages Figenbaum et al. (2015a). Figure 3 shows the EV incentives which are currently in place.

Incentive	Type
VAT exemption buying	Reduce purchase price
Exemption from registration tax	Reduce purchase price
Access to bus lanes	Reduce time cost, make EVs more practical to use
Free parking	Reduce usage cost (and time cost)
Free toll-roads	Reduce usage cost
Reduced rates on ferries	Reduce usage cost
Reduced annual vehicle license fee	Reduce ownership cost
Reduced company car tax	Reduce ownership cost
Financial support for charging stations	Accessible charging, reducing range anxiety
Financial support for fast charge stations	Accessible charging and reduced user costs
Reserved EL number plates	Make it easy to control the eligibility of incentives, and make EVs visible

Figure 4. EV incentives in Norway and their purpose (Figenbaum et al., 2014)

As it can be seen, the purpose of each incentive is different, but they all contribute to the same goal – reducing the uncertainty and increasing relative advantage of EV for potential

consumers. However, the broad range of incentives also entails certain costs. Figenbaum et al. (2014) underline the significant economic burden these incentives cause on the budget. Therefore, the Norwegian government decided to stop the most expensive one – tax benefit – by the end of 2017 or when the overall registration of EVs reaches 50 000, whichever comes first (Aasnes et al., 2015). Since the EV registration has already exceeded 50 000, it can be expected that tax incentives will be withdrawn in 2017. Nevertheless, the full bundle of incentives is still available and EV owners can benefit from it.

Electric vehicle development

The history of EV in Norway began in 1970s. Figenbaum et al. (2015a) divided the EV development into five phases: (1) Concept development, (2) Testing, (3) Early market, (4) Market introduction and (5) Market expansion.

In the concept development phase (1970-1990) several private Norwegian companies developed prototypes of electric vehicles. They received financial support from Research Council of Norway which saw opportunity in this new sector (Figenbaum et al., 2015a).

The testing phase (1990-1999) was the period when EVs were tested by the public. The first EVs were released commercially – PIVCO and Think, and the first users were companies and organizations. The desire to create a Norwegian EV production was justified by environmental benefits electric cars would give to the society. The first attempts were made to decrease the barriers of EV adoption, which resulted in establishing the Norwegian EV Association (NEVA) and first incentives such as exemption from the registration tax, toll road charges and the annual vehicle license fee. Subsequently, further incentives were introduced – free public parking and reduction on benefit tax on company cars (Figenbaum et al., 2015a).

An early market phase (1999-2009) is a period when the small EV industry began to emerge. One of the examples is Ford Motor Company who bought Think Nordic AS and launched production of Think City in Norway. In the meantime the new incentives were introduced – the exemption from VAT (25% in Norway) and test of bus lane access in Oslo region (this became permanent in 2005). The minibuses who enjoyed free access to bus lane, lost this advantage in 2009 in favour of electric vehicles. In 2009 the reduced rates on coastal ferries were added as they are perceived as coastal toll roads. However, the development of EV technology was not free from restrictions and this resulted in slow market response. Ford decided to pull out Think and only few EV models were available for customers. Kewet also

had to reshape their strategy and adapt their electric car as 4-wheel motorcycle. All in all, in spite of obstacles which are inevitable in the new emerging industry, Norway was the only country that managed to keep up the EV activity through 2009 when no other countries were active (Figenbaum et al., 2015a).

The market introduction phase (2009-2012) was the period when larger car companies such as Mitsubishi, Peugeot, Citroen and Nissan came into play and launched their new electric car models. This resulted in broader range of options available for potential customers and rapidly falling prices as a result of competition between brands. The security and comfort have also increased and the conditions for the customer became more attractive (e.g. battery warranty). The market expanded quickly to 3% of new vehicle sales at the end of 2012 and first half of 2013. The role of NEVA (The Norwegian Electric Vehicle Association) became increasingly important as it served as a means of transferring knowledge on the internet between users and it also recruited new drivers through test drives. All buyers of new EVs received one-year free membership in this organisation. In 2009 the governmental agency Transnova was established to support technologies which contribute to reducing greenhouse gas emissions from transportation sector. The organization supports financially the installation of charging stations throughout the country. It also supports organizations such as Green Car/Grønn bil and Norwegian Association of Local and Regional Authorities who promote the EV technology (Figenbaum et al., 2015a).

The market expansion phase (2013-) brought further development of EV market in Norway. The number of models offered increased and the number of EVs passed 13 000 in the first half of 2013. There is also a higher interest in EVs among the municipalities who gradually upgrade their fleet with zero-emission cars. (Figenbaum et al., 2015a). Figure 4 presents the development of EV sales from 2000 to 2012 and some important events which are related to the market situation in Norway.

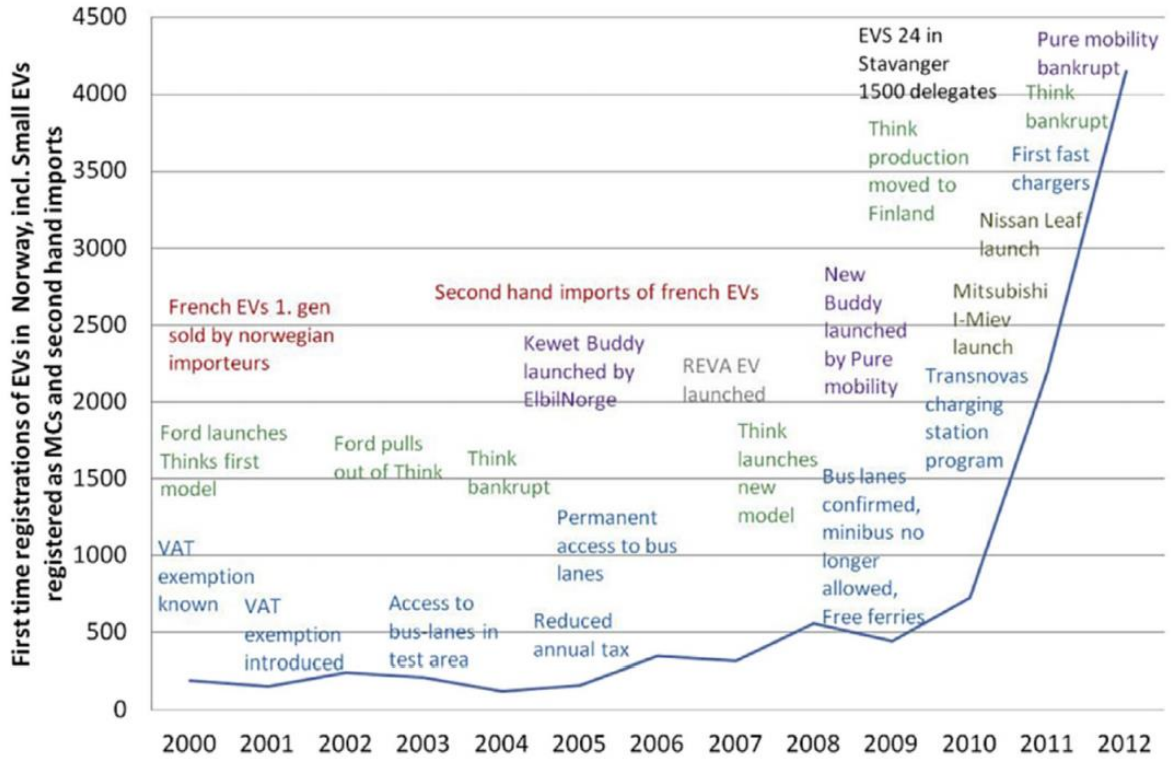

Figure 5. Estimate for BEV sales in Norway 2000e2012 and timeline for the introduction of incentives (Figenbaum et al., 2015a).

3 Literature Review and Theoretical Framework

The adoption of EV around the world has been an important and interesting field that researchers often tried to examine in numerous articles. However, given the fact that EV proliferation is still moderate, the comprehensive research on the topic is still hard to find. Nevertheless, there is an abundance of scholars and theories that try to explain the process the innovation undergoes, from its development, through gradual market penetration, until its natural death and replacement by another innovation.

3.1 Rogers' diffusion of innovations

One of the pioneers of innovation research is Everett M. Rogers who developed a term "diffusion of innovations" and described the rules that govern this diffusion in the social structure. He sees diffusion as the process in which an innovation is communicated through different communication channels over time in the social system (Rogers, 2003). These four elements are the backbone of most diffusion researches. An innovation is an object or idea that is perceived as new by individual or other unit of adoption. It does not have to be new, it is more important how this newness is perceived subjectively by adopter (Rogers, 2003). Every innovation possesses certain characteristics that determine its rate of adoption. Since different innovations proliferate in different pace, these elements might help understand which factors act as facilitators and which pose a barrier in the diffusion process:

- **Relative advantage** – it determines the degree to which an innovation is perceived as better than other ideas available for individual. The word "relative" indicates that the idea does not have to be objectively advantageous, it is rather a subjective opinion that matters. If individuals perceive the innovation as advantage for them, it might diffuse more rapidly among potential adopters.
- **Compatibility –** it determines the degree to which an innovation is perceived as consistent with existing ideas, technologies, believes and needs of individuals. If the innovation is compatible with existing values, it can be adopted faster. On the contrary, incompatible innovation might require change of the value system which is usually a slow process and this might seriously slow down the diffusion process.

- **Complexity –** it determines the degree to which an idea is perceived as difficult to understand and use. Complex innovations diffuse slower than innovations easy to comprehend by the members of a social system.
- **Trialability –** it determines the degree to which an innovation might be tested without full adoption. In general, innovations that give a potential adopter possibility to test it on a limited basis are adopted faster than innovations that does not give such a chance. The high trialability of an innovation allows an adopter to learn it without risk.
- **Observability –** it determines the degree to which the results of an innovation are visible to others. If an innovation surrounds the potential adopter, it stimulates discussion, evaluation and learning. Adopters who can easily spot the innovation and its usability are more likely to adopt.

3.1.1 Communication channels

In order to reach potential adopter, the information about the innovation must be transmitted through certain communication channels. Rogers (2003) distinguishes two main means of disseminating knowledge about the innovation:

- **Mass media channels** – it is the most rapid means of spreading the knowledge about the innovation. It usually does not persuade individuals to adopt, but plays an important role in raising awareness about the innovation.
- **Interpersonal channels** – involve personal, direct information exchange. These channels are usually peer-to-peer networks where individuals can pass on their experiences and opinions about the innovation. These channels usually play more important role in persuading an individual to adopt the innovation.

3.1.2 Time

Rogers (2003) includes time as an important variable in diffusion research. In his theory, the time plays an important role in three aspects of diffusion: **innovation-decision process** (the time from first knowledge about an innovation until its adoption or rejection), **innovativeness** of an individual or other unit of adoption (how early an individual adopts the innovation) and innovation's **rate of adoption** (how many members of a social system adopted in a given time period).

3.1.3 Social system

According to Rogers (2003) diffusion occurs in a social system. Its structure defines the circumstances under which the innovation diffuses. Rogers (2003) defines social system as a set of interrelated units that try to accomplish a common goal. Each social system has structure, which determines the roles of individuals and their place in it. With regards to diffusion process, the structure of social system affects the speed the innovation requires to reach potential adopters.

An important aspect of social system is the presence of opinion leaders, who are perceived as the most innovative members of a system. Opinion leadership is the degree to which an individual is able to influence other individuals' attitudes and behaviour in a desired way (Rogers, 2003). Opinion leaders play an important role in convincing other people in a system whether certain innovation is worth adopting. Their attitudes and behaviours are observed and often followed by remaining members of a social system.

3.1.4 The innovation-decision process

Rogers (2003) defines 5 stages in the process through which an individual passes from gaining initial knowledge of an innovation, to forming an attitude towards it, to making decision to adopt or reject, to implementation of the idea and to confirmation of this decision. These stages include:

- **Knowledge** – a period when an individual is exposed to the innovation and gains knowledge about it
- **Persuasion** – a period when an individual forms a fovourable or an unfavourable attitude towards the innovation
- **Decision** – in this period an individual decides whether to adopt an innovation or not
- **Implementation** – a period when an individual puts a new idea into use
- **Confirmation** – a period in which an individual seeks reinforcement of a decision made. In this stage an adopter might sustain his/her previous decision or reverse it if messages received about an innovation discourage from using it.

3.1.5 Rate of adoption

Rogers (2003) introduces the rate of adoption as a measure of number of individuals who adopt a new idea in a given time period. He points out that adoption rate is dependent on perceived attributes of innovation: relative advantage, compatibility, complexity, trialability and observability. In addition to these elements, Rogers (2003) underlines the importance of type of innovation-decision, the nature of communication channels used in diffusion, the structure of social system and effort of change agents (individuals who influence the innovation-decision in a desired way) in diffusing the innovation as important factors influencing the rate of adoption.

3.1.6 Innovativeness and adopter categories

Rogers (2003) distinguishes five adopter categories based on their innovativeness level (the degree to which an individual is relatively earlier in adopting new ideas than other members of a system). Figure 6 presents the adopter categories together with their distribution in the diffusion process.

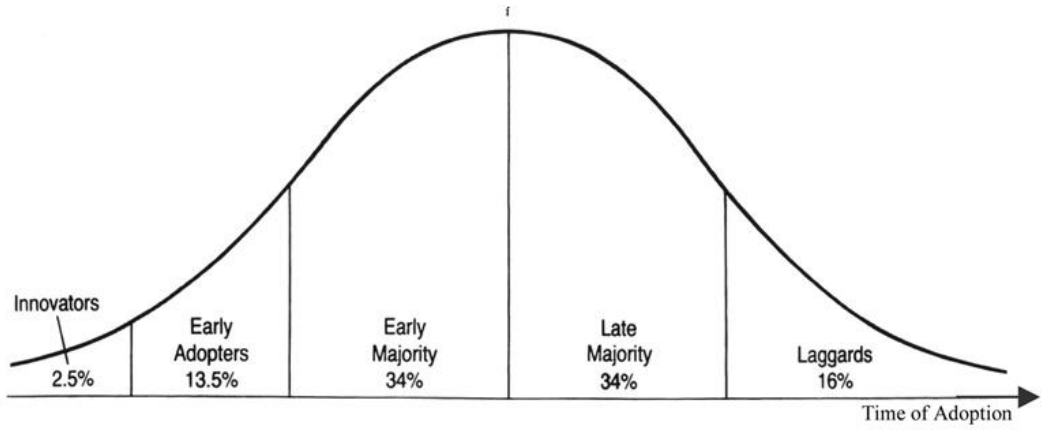

Figure 6. Adopter categorisation in the diffusion process (Rogers, 2003).

Innovators

These individuals are first to adopt an innovation in the social system. Rogers (2003) defines their characteristics as: interest in new ideas, cosmopolite relationships, control of substantial financial resources, technical knowledge, ability to cope with uncertainty and venturesomeness. These individuals are less respected by other members of a system, but act as gatekeepers in the flow of new ideas into a system (Rogers, 2003).

Early adopters

Early adopters are a more integrated part of the social system, as opposed to innovators (Rogers, 2003). They act as opinion leaders and reference point for other potential adopters who respect them. Their innovation-decisions often lead to spreading the knowledge about the innovation and change agents often try to reach them as a means of speeding up the diffusion process (Rogers, 2003).

Early Majority

This group, together with late majority is the most numerous adopter category. Early majority act as a link between those who are more optimistic towards innovation and those who are pessimistic, but they are not perceived as opinion leaders. These individuals usually need some time before deciding to adopt an innovation (Rogers, 2003).

Late majority

Late majority are sceptical about innovation and adopt only from necessity. They are not interested in adoption until society puts pressure on them. Furthermore, their scarce resources discourage them from adopting the innovation and they prefer to wait until the uncertainty about it is minimized (Rogers, 2003).

Laggards

Laggards occupy the last 16% of the adopter distribution in the diffusion process. Their traditional beliefs do not allow them to adopt the innovation before they are 100% sure that it works as intended. They are rather focused on past experiences. Their interpersonal relations restrict to other laggards who present the same belief system. Therefore, laggards need the longest innovation-decision period before adoption of the idea (Rogers, 2003).

3.1.7 The effect of incentives in the rate of adoption

A diffusion of innovation usually requires certain actions in order to stimulate the adoption rate. As seen by Rogers (2003), both different communication channels and change agents play an important role in speeding up the adoption process. However, some innovations might not present satisfactory degree of characteristics such as relative advantage, compatibility, complexity, trialability and observability. Therefore, many change agencies (e.g. governments or companies) decide to award incentives or subsidies to individuals in order to boost the adoption process (Rogers, 2003). Incentives might be served in variety of forms:

1. Adopter versus diffuser incentives – incentives may be awarded to an adopter to encourage him/her to adopt the innovation or to diffuser who may be paid for encouraging another individual to adopt.
2. Individual versus system incentives – the benefits might be directed to individual or to the system to which he or she belongs.
3. Positive versus negative incentives – most incentives are positive and reward a certain behaviour, but policy makers might also impose certain restrictions or penalties for those who do not adopt an innovation or decide to use other ideas.
4. Monetary versus nonmonetary incentives – sometimes policy makers decide to propose other benefits than just monetary/economic incentives.
5. Immediate versus delayed incentives – some incentives may be paid together with adoption, while some might be paid at a later time

Depending on the type of innovation, different incentives might be considered to speed up the diffusion process. However, incentives as a means to boost the rate of adoption might also have less positive influence on diffusion process. Rogers (2003) points out that adopter incentives might lead to adoption of individuals different from those who would otherwise adopt. In classical setting, earlier adopters have better socioeconomic status and these individuals are first to adopt. In the context of incentives, people who are characterized as later adopters (lower socioeconomic status, lower education etc.) might be also encouraged to use the innovation together with earlier adopters, because of the desire to take advantage of incentives. Furthermore, Rogers (2003) concludes that even though incentives increase the quantity of adopters, the quality of such adoption remains relatively low. It might turn out that withdrawing from incentives will lead to lower relative advantage of an innovation and thus discourage adopters from continuing using the innovation.

3.2 Diffusion of EVs in the lens of Rogers' theory and drivers behind the adoption

The research on diffusion of innovations poses certain challenges and researchers must often take into account as broad picture as possible when trying to find answers to their questions. The emergence of electric vehicles and first attempts to sell them to the public show that this relatively new innovation is more or less ready to start its battle in the passenger car market. It

means that introduction and slow emergence of EVs in the world markets will gradually attract more researchers wanting to explain the processes related to EV market development. It is therefore important to find an appropriate way to properly examine this innovation and its context. Rogers provides a perfect tool for explaining the logic behind the innovation and its social context, especially from the moment of introduction to the market to its further proliferation in the society. His diffusion of innovations theory gives a conceptual basis for examination of relationships between innovation and individuals (potential adopters). It allows for systematic and comprehensive approach to the diffusion of innovations study. I believe that Rogers' theory is necessary to gain initial knowledge about the EV innovation context and this step is crucial before deciding to conduct a more detailed study in this matter. Furthermore, the strong focus on individual perspective in the diffusion theory fits perfectly to the purpose of this paper, which aims to determine the drivers behind the EV adoption and tries to answer what explains the reasons why individuals decide to buy an EV.

The adoption of electric vehicles in the world advances in different speed and each adopting country created its own unique context in which the diffusion would be possible. Some countries focus on creating the most favourable environment for the diffusion of zero-emission cars, whereas others focus more on natural and organic growth of EV market. As evidence shows, only few countries have managed to reach a visible (although modest) market share in 2014. When taking into account the adopter categories proposed by Rogers (2003), even though some countries are in more advanced diffusion stage, most of them are still placed in the very beginning of this process – in Innovators phase. Norway is the only country that was able to leave the Innovators phase, penetrate Early Adopters in 2014, and gradually enter the Early Majority phase.

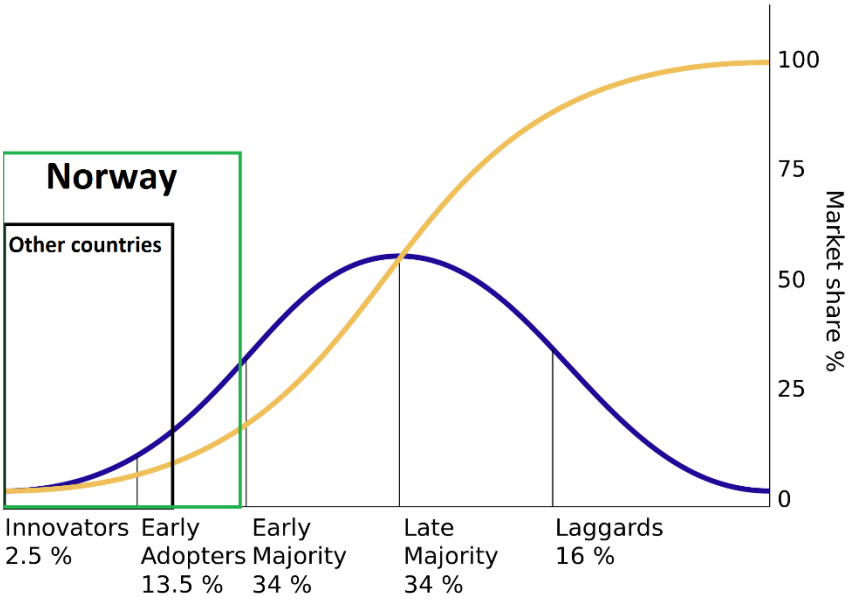

Figure 7. The EV diffusion process in Norway and other countries. Source: Own development.

Figenbaum et al. (2014) also used Rogers' adopter categories to identify the innovativeness level of individuals in Norway based on their characteristics (e.g. type of car they own, their beliefs and situation). They tried to predict and conceptualize the possible distribution of potential EV adopters in the diffusion process (Figure 8). They did not use the actual market share as a reference point, but they rather focused on specific traits and presumptions that might give a basis for proposed adopter distribution. It is also important to mention that they only examined individuals who own a car.

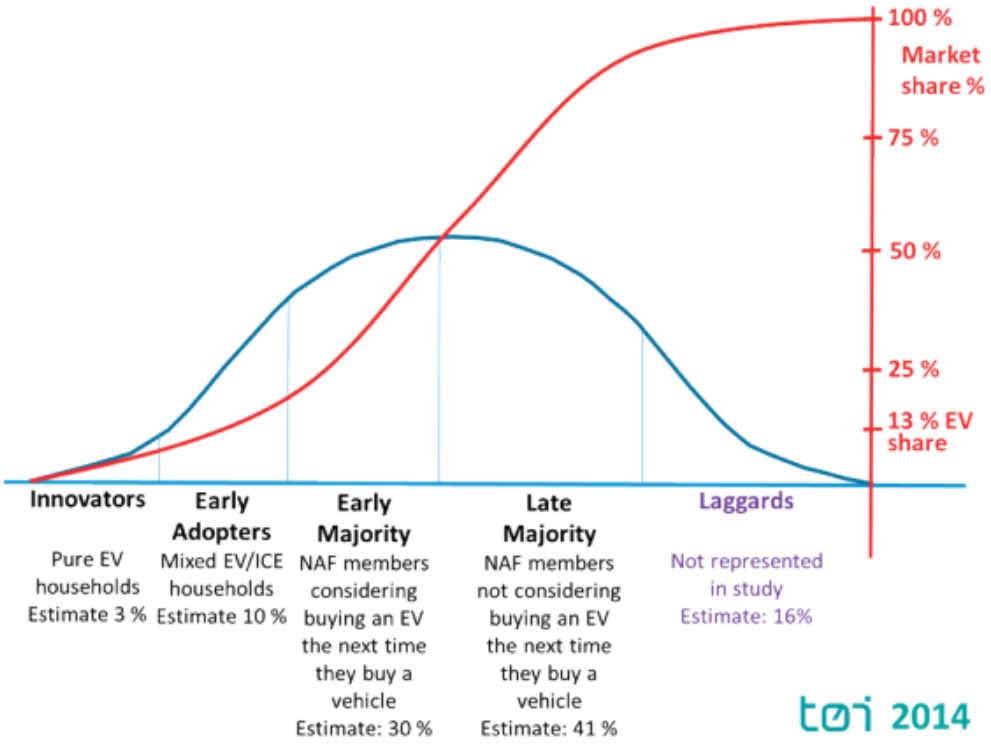

Figure 8. The adopter distribution in Norway proposed by Figenbaym et al. (2014)

When describing the diffusion process, Rogers (2013) used a term "critical mass" to indicate the threshold after which the diffusion becomes more robust, dynamic and self-sustaining (moment to "take-off"). Figenbaum et al. (2014) claim that Norway has already reached the critical mass around 2011/2012 when the adoption rate of EVs increased dramatically (as presented by Figure 5 in Introduction). It is therefore very likely that EV market will continue to grow. Other countries are still struggling to diffuse the EV to the considerable level. Except Sweden, U.S. and Netherlands whose market shares range between 2-4% in 2014, most other countries are still far behind with market share around or less than 1%. It is therefore evident that there must be underlying drivers that facilitate or hinder the diffusion process. Scholars differ in their opinions about the reasons for such differences in adoption, but certain conclusions converge.

First of all, the product which is introduced to the market must be innovative enough. It does not necessarily has to be objectively newer or better technologically, but it must be perceived subjectively as an innovation by potential adopters (Rogers, 2003). In the case of EV innovation, it is rather easy to see and understand the "newness" of electric vehicles. The battery-powered cars which do not produce greenhouse gases and lower the demand for fossil fuels in transportation sector seem to be a clear innovation in two dimensions – technological

and environmental. However, the innovation cannot be understood solely as product that is innovative. The innovation is a process in which the communication plays an important role. Rogers (2003) claims that communication process is an inherent part of innovation. He adds that success of diffusion depends on the degree of knowledge among the potential adopters and how this knowledge is distributed through certain channels to reach the appropriate adopter category. According to Figenbaum et al. (2015a), the lack of knowledge about EV technology hinders the adoption of EV. He also points out that the negative attitude towards EVs usually stems from lack of knowledge. In Norway, the problem was quickly understood and active work of organizations has contributed to an increased mass media coverage and growing number of press articles about EVs (Figenbaum et al., 2015a). However, the mass media usually matter only in the initial (knowledge) stage in the innovation-decision process, when an individual becomes aware of an innovation (Rogers, 2003). In addition to mass media channels, Rogers (2003) also underlined the importance of interpersonal channels which act as a direct trigger for an individual to adopt the innovation, and this happens in the persuasion and decision stage of the innovation-decision process. In the Norwegian context, the availability of organizations such as Norsk Elbilforening and abundance of EV forums created a possibility to share experiences between adopters and non-adopters and thus make it possible to directly exchange information and discuss the issues related to EV. The use of communication channels makes the electric vehicles visible and more accessible, which automatically affects the observability and trialability – important factors influencing the success of diffusion of innovation (Rogers, 2003). In Norway, for example, the use of special number plate with the letter "EL" (elbil - electric car) makes the distinction of e-car from average car very easy thus increasing the observability factor (Figenbaum et al., 2015b; van Sloten, 2015). When it comes to trialability, most car dealers offer a test drive before buying an EV for free, so everyone who wants to try the EV without risk is able to do it. In the Swedish context, Sloten (2015) uses Rogers' diffusion of innovations theory to examine the Sweden's EV and PHEV policy. He pointed out that the main barrier in the Swedish policy is that the relative advantage for EV does not make up for the higher complexity and lower compatibility compared to the equally subsidized PHEV. He concluded that current policy is ineffective due to equal incentives for both plug-in hybrid and battery electric vehicles.

As it can be seen, the diffusion of innovations theory is a comprehensive tool that covers many aspects of the diffusion process and can be used in different contexts. But there are also

other aspects pointed by scholars that, together with Rogers (2003) might explain the reasons for EV adoption.

3.2.1 CO2 emissions from transportation sector as a main reason for introducing EVs

Electric vehicles are environmental innovation. The electricity-driven, zero-emission cars are designed to fulfil the needs of transportation without polluting the atmosphere. They seem to be a perfect alternative for traditional gasoline/diesel cars. According to Zhang et al. (2014), EVs provide a way to solve the problem of CO2 emissions and air pollution. They point out that this technology can be applied to different countries with different energy sources. Governments who are interested in the diffusion of EVs place an environmental concerns as a main problem that can be solved by EVs. It is therefore evident that the main reason for EV diffusion stimulation by policy makers (change agents) is the desire to protect the environment and replace polluting cars with more eco-friendly solutions. In the Norwegian context, Holtsmark et al. (2014) confirm that the reduction of local emissions and reduction of GHGs to fulfil the country's emission reduction goals are important in short-term story. They add that the main reason behind the Norwegian EV policy is global environmental issue and curbing GHGs. But it is also important to know to what degree environmental advantages are valued by potential adopters as the receivers of the innovation. Jenn et al. (2013) claim that individuals who are predisposed to favour environmental good will have more benefit from environmental products. On the contrary, Zhang et al. (2014) point out that while consumers might value environmental friendliness of EV, but they are not willing to pay for social benefits that would do not directly benefit themselves in the short time. This is in line with Figenbaum et al. (2015b) who point out that environmental advantages of e-vehicles are important, but there are also other factors that influence the decision to adopt. Taking into account the nature of EV innovation, it is likely that environmental benefits of EVs are important for individuals to some degree, but there are also other factors that influence the adoption rate.

3.2.2 Relative advantage of EVs as a main barrier for adoption

When theorizing on the diffusion of innovation, Rogers (2003) distinguished five characteristics of innovation that affect its diffusion speed: relative advantage, compatibility,

complexity, observability and trialability. As mentioned in the previous section, the two last elements are related to the availability of EVs in the market, thus influencing the EV diffusion process. The relative advantage of electric vehicles (which is explained by compatibility and complexity to some extent) has been an important issue among researchers. van Sloten, 2015 states that relative advantage is seen as the most important attribute of innovation and therefore Norway focused solely on this attribute when developing its EV incentives and policies. In his opinion, Norway's example confirms that all five attributes do not necessarily have to be addressed in order to speed up the adoption rate. This is probably related to the fact that electric cars are compatible with past experiences (most people had contact with cars in general) and they do not differ much from traditional cars in their functionality and complexity.

However, despite the similarities with ICE cars, it is evident that electric cars impose certain limitations. Therefore, their relative advantage over traditional cars might be questionable. Zhang et al. (2014) state that the biggest limitations for EVs are driving range and charging time, which is not the case with ICE cars. Aasnes et al. (2015), van Sloten (2015) and Kihm & Trommer (2014) add high price of an EV as a considerable barrier for adoption, which is mainly the effect of high cost of battery. Aasnes et al. (2015) also underlines the fact that these limitations led to low EV sales volumes in the world. However, while the investment costs for EV are higher than for conventional cars, the operating costs are lower, which positively impacts its relative advantage (van Sloten, 2015). The relative advantage of EV is also leveraged thanks to various incentives granted to adopters and compensating for drawbacks (Figenbaum et al., 2015a). They also proposed that the growth of EV sales is possible through technological developments that secure a longer EV range, installation of more charging stations and more information about the EVs energy efficiency disseminated through the media and social networks (interpersonal channels). Zhang et al. (2014) proposed that the prices and progress rate of batteries also have a great impact on EV adoption.

In sum, the relative advantage might be an important factor influencing the decision to buy an EV for potential adopters.

3.2.3 Incentives as a valuable tool for mitigating drawbacks of the technology and attracting potential EV adopters

When an innovation enters the market, it is usually imperfect and requires support in order to reach potential customers. The environmental technology, especially in early development phase, might imply some disadvantages for the users and it is often necessary to put compensatory measures to help the diffusion process such as large subsidies and political commitment (van Sloten, 2015; Steinhilber et al., 2013; Figenbaum et al., 2015a). This is in line with Steinhilber et al. (2013) who highlight that new technology might require effective police support as this new technology might not be cost-efficient. These policies often include incentives, which aim at speeding up the diffusion process. Rogers (2003) points out that some innovations might not present satisfactory degree of relative advantage, compatibility, complexity, trialability and observability. As mentioned in previous section, EVs are still far from perfection when it comes to their functioning and price. There are also problems external to the innovation itself, such as availability and density of charging stations or electricity prices which might influence the adoption rate. In order to mitigate for drawbacks, governments try to increase the attractiveness of electric cars by establishing certain regulatory environment that favours electric vehicle purchase and use. In the lens of Rogers (2003) diffusion of innovations theory, these governments act as change agents, since they are the decision-making body who develop incentives aiming at speeding up the EV diffusion process. The types of policies (incentives) introduced in different countries are described in the EV landscape section.

Before the electric vehicles came to the market, the first semi-electric (hybrid) cars were available and Jenn et al. (2013) tested how Energy Policy Act influenced the sales of hybrids in US. They concluded that EPA had a positive effect on the sales of hybrid cars and sales increased by 0.0046% per dollar of incentive, on average. In the Norwegian context, Figenbaum et al. (2015a) conclude that the successful EV proliferation was a result of massive, expensive and combined policies, which cover a broad spectrum of fiscal, direct incentives and those compensating for drawbacks of EV use. This is in line with Aasnes et al. (2015) and Holtsmark et al. (2014) who point multiple economic incentives as the reason for tremendous increase in the use of EV. When measuring the importance of incentives in China, Zhou et al. (2014) came to similar conclusions and pointed incentives as a main factor influencing the EV market penetration. In US, Zhang et al. (2014) pointed financial incentives and charging infrastructure as significantly and positively correlated with a country's EV

market. In Chinese context, where incentives are scarce and do not have desired effect, Zhang et al. (2014) admit that introduction of policies such as financial incentives, technology support or charging infrastructure should be made by government to promote the use of EVs. Figenbaum et al. (2015b) however, assert that fiscal incentives are important for EV market growth, but they are not the only factor that influences it. The elements such as high battery price development and gasoline prices might also have an impact on sales of EVs (Zhang et al., 2014). This confirms that the relative advantage and other characteristics of EV are equally important as incentives and all these factors usually go in tandem in supporting the diffusion process. Steinhilber et al. (2013) confirm that this assumption by stating that new technologies need to be enhanced in order to meet producer and customer needs. Also, they point out that the infrastructure and another technology that harmonise its production and use might be required. They give an example of ADAC club in Germany which has put up 25 free charging stations and perceive them as an important indicator for supporting EV technology.

It also important to underline that the benefits achieved through incentives are not free from costs. Figenbaum et al. (2015b) claim that costs of subsidies and revenue loss to local and central governments can produce a substantial budgetary stress. They also blame incentives as a reason for reduced fuel tax revenues, congested bus lanes, reduced parking availability, reduced walking and cycling etc. In addition to that, Holtsmark et al. (2014) claim that incentives encourage households to purchase a second car. Furthermore, buses will face more congestion in the bus lanes, as EVs are allowed to use it which will discourage from using public transport (Holtsmark et al, 2014; Aasnes et al., 2015. van Sloten (2015) found out that people in Norway who bought an EV reduced the frequency of public transport use by 80%. He also claims that subsidization not only encourages EV use but also encourages car use in general, which leads to more traffic and more congested cities. Figenbaum et al. (2015b) state that the numerous adverse effects of incentives led to the decision to keep them until fixed future date, until certain goals are reached or until the earmarked budget is depleted. They also suggest that inefficient and costly policies, which also harm other parts of the society, should be avoided and cost-effective policies should be maintained. Holtsmark et al. (2014) go even further and propose complete shutdown of all incentives, since they are ineffective, have several unintended consequences and they are in many cases counterproductive. It is also important to underline the fact that before the take-off in Norwegian market, incentives were available as well, but the market did not respond well. van Sloten (2015) asserts that the

low range of EV models available was the reason for that situation and when more EVs came to the market, the adoption rate began to speed up.

Apart from unwanted side effects, the incentives might also have a negative impact on the structure of diffusion process and its sustainability. According to Rogers (2003) incentives attract individuals who otherwise would not adopt or adopt later and as a result the natural diffusion process might be altered. He concludes that although the quantity of adopters increase, the quality of such adoption remains relatively low. In Norway, for example, the diffusion process was in Early Adopters phase in 2014, which means that both innovators and early adopters should be the main to adopt. They are characterized by Rogers (2003) as wealthier, more educated and able to cope with higher degree of uncertainty. However, the existence of incentives might have attracted later adopters who might have bought EVs mainly to obtain incentive and if these incentives disappear, they might for example sell the car, because they do not possess the same traits as earlier adopters and might not afford to keep an innovation they are not ready for. This is in line with van Sloten (2015) who claims that Norwegian EV incentives cause disturbance in adoption process and they attract buyers who buy for financial reasons without taking into account the relative advantage, compatibility and complexity of the technology. He asserts that when the EV policy is ended or lowered, it might lead to rejection of EVs in the market. Apart from that, the amount of opinion leaders who should be present in the early phase of natural diffusion process, might be lower in incentivized context, which might lead to the situation that later adopters do not have reference in their persuasion and decision stage. van Sloten (2015) confirms that the disturbed adoption process might cause a lower amount of opinion leaders. Fortunately, since the diffusion of EVs in Norway reached “critical mass” and EVs become an important part of passenger transport, the chances that the diffusion will continue after incentives are ended, are high. Furthermore, the prices of electric cars go down and driving range increases. Moreover, in their study of EV adoption in Norway, Figenbaum et al. (2015b) conclude that both Norwegian and international studies find that EV early adopters in Norway are usually younger men with high income, highly educated and in contact with scientific communities. This is partially in line with Rogers (2003) definition of early adopters and shows that EV diffusion structure in Norway is not necessarily strongly affected by incentives. But this assumption requires further research in the more advanced stage of the diffusion process. Since the Norwegian diffusion process might be sustainable, policymakers might consider stopping the incentives that cause an economic stress. But is important to find the right time

to do it. It would be beneficial to conduct a study analysing the structure of diffusion process in Norway and analyse the context such as infrastructure, EV technology advancement and prices of electric cars. Only when the full picture is measured, the decision when to withdraw from incentives will be less risky and more sensible.

All in all, the incentives are important element which encourages potential consumers to buy an EV. However, the low adoption in most countries does not allow for deeper analysis of diffusion process in different parts of the world. As of 2016, Norway is the only country where diffusion climbed from innovators phase to Early Adopters and slowly Enters Early majority.

3.2.4 Popularity of EV as a stimulus for further adoption

The innovations that are ubiquitous are more likely to be seen and understood by more people and thus the adoption rate might be higher. As Rogers (2003) stated, the existence of the innovation in mass media channels stimulates the discussion and interest among people. The relatively high EV adoption rate in Norway created a situation in which more and more individuals have an electric car and thus other individuals might be interested in adopting as their friends did. In their study of EVs in Norway, Figenbaum et al. (2015b) found that on average 36% of the EV owners have friends who bought an EV after they had told them about their experience and 34% consider buying an EV. This shows that both the proximity of EV owners and probably the high degree of opinion leaders in the society contribute to the growing popularity of this technology among potential adopters. The network externalities might also play an important role in EV diffusion process. As seen by Rogers (2003), network externalities describe the situation in which the quality of innovation increases when more people use it. It is evident that higher number of electric cars contributes to the degree of observability and trialability, as mentioned earlier. Furthermore, the existence of electric cars pushes municipalities and governments to invest in better infrastructure and this, again, increases the network externalities factor and popularity of EVs that pose a more attractive solution for potential adopters.

3.2.5 Interest in new technologies

As mentioned in previous sections, the EV diffusion process in most countries who focus on EV market stimulation is still in Innovators or Early Adopters phase. It allows us to presume

that most individuals who adopted an EV possess characteristics that match earlier adopters. Rogers (2003) defines them as individuals who have better socioeconomic status, higher education, more frequent contact with scientific world, higher resistance to uncertainty and higher technical knowledge. Furthermore, he states that earlier adopters seek information about innovations more actively than do later adopters. Therefore it is very likely that in social systems where individuals actively educate themselves about new technologies, the EV technology will be better understood and widely accepted, which will reflect on adoption rate.

3.3 Individual characteristics and decision to adopt an EV

Most scholars measured the reasons for EV adoption on a country or regional level, but few of them looked at individuals' characteristics who adopt the innovation. The purpose of this thesis is to find what can explain the reasons for buying an EV by individuals. The aforementioned factors influencing the EV adoption rate might be perceived differently by different individuals and therefore it would be interesting to see what can explain this variation.

The social system, in which an innovation diffuses is composed of individuals who adopt it in different speed. Earlier adopters are usually first to put an innovation into use, whereas later adopters wait until certain signs are sent from the market and society. During the diffusion process, individuals who value different things, respond differently to the information about the innovation. Furthermore, as Rogers (2003) shows, the existence of incentives might also alter the structure of earlier adopters, which raises a question of applicability of marketing activities and regulations to the profile of potential EV customers. They may differ in values and characteristics, which is a very interesting topic to examine. The drivers behind their decision process might stem from individual's perception of the innovation and its applicability (e.g. relative advantage or complexity). It is also important to add that all motivations and barriers for EV adoption fall into the persuasion stage of decision process proposed by Rogers (2003) (Gazdowicz (2015)).

Norway is a good example of EV market, where the diffusion reached an Early Adopters phase and still advances. The broad package of incentives, which, according to theories, are the main reason for such a high adoption rate in Norway, might have contributed to the greater heterogeneity of EV adopters, which is in line with Rogers (2003), who sees

incentives as a reason for greater variety of adopters in the earlier stages of diffusion process. Furthermore, it also worth mentioning that Norway is a geographically diversified country, which raises question for applicability of incentives in certain regions. The weather is also important, since the temperatures are lower and winters are colder, which severely affects the lifetime of battery. Taking into account relatively high number of EV owners, quite significant regulatory context and diversified geography, it is very likely that different individuals might be inclined to adopt an electric vehicle for different reasons. Furthermore, as Rogers (2003) points out, individuals tend to evaluate the innovation subjectively, regardless of its objective characteristics (the degree of "newness") and this confirms that EV might be perceived differently by potential adopters and they might adopt it for different reasons. Therefore, taking into account both the complex and developing EV market in Norway and different perception of innovation by individuals, this is a perfect place to examine what drives potential adopters to buy and use an EV.

3.3.1 Adoption speed

According to Rogers (2003), individuals adopt the innovation at different speed, depending on their innovativeness level. Since the situation in Norway is affected by many factors, it is hard to predict what EV owners really value when deciding to buy an EV and how these values differ across their adopter profiles (or innovativeness level). The main purpose of EV introduction to the Norwegian market was the concern about the environment. Sierzchula et al. (2014) confirm that EVs might help address the environmental concerns. It is therefore very likely that first consumers might share the view of government and buy an e-car to be more eco-friendly. Furthermore, given that earlier adopters are usually more educated and have better socioeconomic status (Rogers, 2003), they are more likely to choose an EV to exhibit their care about the environment. Incentives are another factor which might influence the decision to buy an EV. As Rogers (2003) states, earlier adopters have more assets or traits that allow them to adopt an innovation, which usually requires higher financial cost in the initial phase of the diffusion process and ability to cope with uncertain relative advantage. The adoption of EV was very slow in the early phase, despite the incentives available, and it then took off dramatically in 2010 (Gazdowicz, 2015). When it comes to relative advantage, it is usually uncertain in the initial phase of diffusion process and earlier adopters are those who can afford the risk. It is therefore very likely that both incentives and relative advantage are not an important reason for earlier adopters when deciding to buy an EV. Earlier adopters also

have better knowledge about innovations and they are more interested in new technologies (Rogers, 2003), which might positively impact their attitude to EVs. Thus, based on the logic above, it can be theorized that:

> ***H1a**: Earlier adopters will put more importance on environmental friendliness of EV when deciding to buy an EV.*
>
> ***H1b**: Earlier adopters will put less importance on incentives when deciding to buy an EV.*
>
> ***H1c**: Earlier adopters will put less importance on relative advantage of EV when deciding to buy an EV.*
>
> ***H1d**: Earlier adopters will put less importance on popularity of EV when deciding to buy an EV.*
>
> ***H1e**: Earlier adopters will put more importance on their degree of interest in new technologies when deciding to buy an EV.*

3.3.2 Income

Electric vehicle technology includes battery, which largely impacts the overall price of EV. According to and Kihm & Trommer (2014), the high battery prices reduce the profitability of EVs due to high upfront premium payment. It means that the price of EV might be a considerable barrier for adoption and may require that potential adopter has sufficient funds to commit. Rogers (2003) adds that one of the main factors influencing the adoption rate is the socioeconomic status of potential adopters, which is largely dependent on income level. The differences in income level among adopters might influence the reasons which lead them to adoption of EV. For example, individuals with higher income are perceived to be more concerned about environment and thus might be more interested in the EV eco-friendliness than individuals with lower income. When it comes to incentives, Norwegian fiscal incentives are perceived to have the greatest impact on EV sales (Figenbaum et al, 2015b), because they make EVs affordable and their price is comparable to traditional cars. It is therefore very likely that these financial benefits given by incentives are valued more by people with lower income. Rogers (2003) also includes income as a one of the factors defining earlier adopters and it is likely that individuals with higher income are early adopters. This means that they might also have a higher degree of interest in new technologies. Furthermore, thanks to larger financial assets, they might be less concerned about the relative advantage of EV. It can be therefore theorized that:

***H2a**: Individuals with higher income will put more importance on environmental friendliness of EV when deciding to buy an EV.*

***H2b**: Individuals with higher income will put less importance on incentives when deciding to buy an EV.*

***H2c**: Individuals with higher income will put less importance on relative advantage of EV when deciding to buy an EV.*

***H2d**: Individuals with higher income will put less importance on popularity of EV when deciding to buy an EV.*

***H2e**: Individuals with higher income will put more importance on the degree of their interest in new technologies when deciding to buy an EV.*

3.3.3 Environmentalism

Environmental innovations are usually important for environmentalists as they are concerned about the environment and reflect this attitude by different activities. Sierzchula et al. (2014) point environmentalism as an important factor influencing the purchase of EV. This is also the case with PHEVs (plug-in hybrid electric vehicles) where Jenn et al. (2013) found that environmentalism is a characteristic that affects purchasing behaviour. Carley et al. (2013) add that those who express early interest in adopting electric vehicles are usually environmentally sensitive. It is therefore possible that people who value environment are usually earlier adopters. Thus, it can be theorized that:

***H3a**: Environmentalists will put more importance on environmental friendliness of EV when deciding to buy an EV.*

***H3b**: Environmentalists will put less importance on incentives when deciding to buy an EV.*

***H3c**: Environmentalists will put less importance on relative advantage of EV when deciding to buy an EV.*

***H3d**: Environmentalists will put less importance on popularity of EV when deciding to buy an EV.*

***H3e**: Environmentalists will put more importance on degree of their interest in new technologies when deciding to buy an EV.*

3.3.4 Opinion leadership

According to Rogers (2003) opinion leadership is the degree to which an individual is able to influence other individuals' attitudes and behaviour in a desired way and they are usually found among early adopters in the diffusion process. In the example of General Motors, which tried to target opinion leaders when introducing their first electric cars, Rogers (2003) mentioned that they looked for individuals with high degree of interest and expertise in cars. They were also very curious about every innovative solutions used in cars. Rogers (2003) concluded that these people largely contributed to speeding up the diffusion of the product and were properly gauged as opinion leaders. This means that opinion leaders might decide to buy an EV based on their interest in new technologies. Taking into account the nature of opinion leaders as early adopters, it can be predicted that:

> ***H4a**: Opinion leaders will put more importance on environmental friendliness of EV when deciding to buy an EV.*
>
> ***H4b**: Opinion leaders will put less importance on incentives when deciding to buy an EV.*
>
> ***H4c**: Opinion leaders will put less importance on relative advantage of EV when deciding to buy an EV.*
>
> ***H4d**: Opinion leaders will put less importance on popularity of EV when deciding to buy an EV.*
>
> ***H4e**: Opinion leaders will put more importance on degree of their interest in new technologies when deciding to buy an EV.*

3.3.5 The ability to take advantage of incentives

The incentives are usually designed to serve entire nation. However, the Norwegian example shows that incentives are not necessarily usable in every part of the country. Norway is a mountainous country with long distances and cold winters (Figenbaum et al., 2015b), which poses a certain limitation with regards to applicability of incentives. While fiscal incentives are easy to obtain nationwide, non-fiscal incentives such as access to bus lane, free public parking or free toll road might not be relevant in sparsely populated areas or in smaller cities where bus lanes and public parking spots do not exist. Furthermore, the free ferry incentive is relevant only for people living close to the coastline (Figenbaum et al., 2015b). In Chinese

context, Zhou et al. (2014) confirm that some EV policies might not be relevant in certain regions and thus pose a barrier for adoption. Therefore, EV owners who have limited access to non-fiscal incentives might have been more interested in other EV features, such as environmental friendliness, relative advantage and popularity when making the purchase than people having direct access to incentives. Furthermore, if they adopt an EV without full access to incentives, it is very likely that they have higher degree of interest in new technologies and this makes them more ready to adopt and innovation.

> ***H5a**: Individuals who can take advantage of incentives will put less importance on environmental friendliness of EV when deciding to buy an EV.*
>
> ***H5b**: Individuals who can take advantage of incentives will put more importance on incentives when deciding to buy an EV.*
>
> ***H5c**: Individuals who can take advantage of incentives will put less importance on relative advantage of EV when deciding to buy an EV.*
>
> ***H5d**: Individuals who can take advantage of incentives will put less importance on popularity of EV when deciding to buy an EV.*
>
> ***H5e**: Individuals who can take advantage of incentives will put less importance on degree of their interest in new technologies when deciding to buy an EV.*

4 Methodology

This section will provide an information about the methods used in the analysis. The main goal of the research is to find what can explain the reasons for buying an EV by individuals in Norway. The methodology begins with research philosophy, followed by approach and strategy. Then the empirical setting, together with sample description is explained. Later, the dependent, independent and control variables are described and the section ends with the summary of data analysis.

4.1 Research philosophy

When conducting the research, I took a positivist approach, which, according to Wilson (2010) is a belief that researcher is independent of the research and therefore it can be truly objective. The scientific, structured and quantitative approach I took in this work corresponds with positivist stance. Furthermore, the secondary data about EV owners which has already been gathered allows me to conduct the research without being biased by any interactions with participants of the study. The independence of the analysed context and structured scientific approach allowed me to conduct a research which produced results that are objective and applicable to the whole population. From the axiological point of view, I perceive the research as value free and my own beliefs do not matter, which is important in conducting an entirely independent study. From the ontological standpoint, I took an objectivist stance which assumes that social phenomena are external to social actors and they are beyond their control (Wilson, 2010). I assumed that the importance of different factors when buying and EV are tangible objects external to everyday interactions between actors.

4.2 Research approach and strategy

In the research, the deductive approach was applied. It began with revisiting theories regarding EV adoption in the world, with special attention to Norway. As a result of the theoretical research, a set of hypotheses was developed. Then, the hypotheses were tested using quantitative data about EV owners in Norway. This approach allowed me for testing the causal relationship between variables and determine the strength of these relationships. The results helped me to better understand what can explain the reasons for buying an EV by individuals.

4.3 Empirical setting

The study focuses on EV owners in Norway, so that individual level is the unit of analysis in this project. As mentioned before, most scholars focus on national or regional level and they do not try to explore individuals who might have different values and attitudes towards electric vehicles. The EV owners whose responses are evaluated in this project are located in Norway and the secondary dataset used for the analysis comes from COMPETT project conducted by Norwegian Institute for Transport Economics for their own purpose. The main goal of analysis is to evaluate what can explain the reasons for buying an EV by these adopters.

4.4 Sample

To test the hypotheses, the secondary data from the survey among 1721 EV owners in Norway were used. As previously mentioned, the survey comes from COMPETT project, conducted by Norwegian Institute for Transport Economics. The main goal of the COMPETT project was to gain knowledge about current and potential EV users and it was conducted in February 2014. For the needs of the project two surveys were designed. One survey includes 1721 EV owners – members of the Norwegian Electric Vehicle Association (NEVA) and this survey is used in the thesis. In Norway, all buyers receive a 1-year complimentary membership in NEVA, and 40% of EV owners are members (FIgenbaum et al., 2014). The 9051 potential respondents received an invitation to participate in the survey by e-mail and they account for 8% of EV members in Norway (Figenbaum et al., 2014), and 1721 responded. Another survey was designed for Norwegian Automobile Association (NAF) members who represented average car owners, but this survey is not used in this work. Only the first survey is used as it focuses solely on EV owners in Norway. The respondents include EV owners who live in in most EV-dense Oslo-Konsberg region, which accounts for 40% of all EVs in Norway and 20% of the country's population and EV owners from other parts of the country (Figenbaum et al., 2014). The respondents in the sample are 18 years or older and they belong to EV-owning households (Figenbaum et al., 2014).

The data from the survey was used in this thesis to analyse the individuals who own an electric car and live in Norway. It is also important to underline that all EV owners from the survey bought an electric car in the Innovators and Early Adopters phase and their responses probably reflect these adopter categories.

For the needs of this work, only questions that fit the research goals were extracted from the survey. Some questions were reconstructed and combined in order to obtain a variable which can answer a given hypothesis. It is also important to mention that the survey initially served for different purposes and therefore not all the questions were usable or relevant. The lack of control over questions and variables was an additional challenge that had to be overcome. However, despite the obstacles that are inevitable when working on secondary data, many interesting variables were identified and tailored to the context of current research.

The reason for choosing a COMPETT project was the fact that it includes relatively large sample of EV owners. Furthermore, this was the only representative dataset about EV owners, to my knowledge, that was conducted relatively recently (in 2014). This study also captured an important breakthrough in the diffusion speed, which happened in 2010. This allows me to assume that the dataset is still relevant to a large extent in 2016. Also, the fact that the research was conducted by TØI (Institute of Transport Economics) and financed by Research Council of Norway increases the likelihood that the data is reliable, of high-quality and it was collected and processed in professional manner. Furthermore, the data was relatively easy to obtain in manageable form (SPSS file) and it was for free. Another reason for using this dataset is the fact that it is very doubtful that I would gather similar data about EV owners by myself - it might be time-consuming and costly. It might also turn out that access to a large number of respondents is only available through organizations such as NEVA. It is doubtful that any significant number of EV owners would be possible to reach through more accessible sources like internet forums or social media.

4.5 Dependent variables

This research focuses on different reasons for buying an EV and therefore one might expect several dependent variables. The theoretical research revealed certain patterns and allowed for certain assumptions when it comes to the importance of certain factors in explaining the EV adoption rate in Norway. The first possible reason for buying and EV which is probably the most obvious and easiest to see is environmental friendliness of EV. Furthermore, the literature review revealed that many scholars underline the importance of incentives as a reason why individuals buy an electric car. Other important factors that might influence EV adoption were identified such as relative advantage of EV, popularity of EV and individual's degree of interest in new technologies. It is very likely that they explain the potential

adopters' willingness to buy an EV. It is also important to underline that all the variables represent the factor which individuals might value when deciding to buy an EV. Each factor is a measure from responses to relevant questions that were designed in five-point Likert-scale. Thus, the dependent variables in the research are as follows:

- **Environmental Friendliness of EV** – this variable was the first factor identified. It was created from the question "What factors were important for you when choosing to buy an EV? – EV is environmentally friendly". The answer was measured in five-point Likert-scale (Not important – Very important) and it reflects an EV owner's attitude towards environmental aspects of electric vehicle.
- **Incentives –** this variable measures the importance of incentives for EV owners when deciding to buy an EV. It was computed from seven five-point Likert-scale questions measuring the attitude towards aspects closely related to incentives:
    - "What factors were important for you when choosing to buy an EV?"
        - "Lower operating costs"
        - **"**Access to bus lanes"
        - "Free toll-road"
        - "Free ferry toll-road"
        - "Lower annual circulation fee"
        - "Free public parking"
        - "Attractive price"
- **Relative advantage of EV** – this variable was created from the five-point Likert-scale question "What factors were important for you when choosing to buy an EV?" – "It was the best car for my needs".
- **Popularity of EV -** this variable was created from the five-point Likert-scale question "What factors were important for you when choosing to buy an EV?" – "EV is popular".
- **Individual's interest in new technologies -** this variable was created from the five-point Likert-scale question "What factors were important for you when choosing to buy an EV?" – "I am interested in new technologies".

4.6 Independent variables

The analysis includes 5 independent variables which define certain characteristics of EV owners in Norway.

Adoption speed

The variable is recoded from two questions and measures how long respondents have had an electric car. The adoption speed is an important measure that directly tests how early the EV innovation was adopted. This gives an insight into the reasons for buying an EV for earlier and later adopters, who might differ in their characteristics and values.

Income

The income level of EV owner is measured based on the question “Household's total gross annual income”, which should reflect the economic status of the respondent. The rationale behind choosing income as independent variable is the fact that EV price is relatively high compared to its relative advantage and individuals with lower income might be less inclined to buy it. Moreover, it would be interesting to see what individuals with different economic status value when deciding to adopt this innovation.

Environmentalism

Because I am interested in how individual’s attitude towards environment affects the reasoning behind the decision to buy an EV, I constructed an “environmentalism” variable. The individual’s degree of environmentalism is determined by his/her membership in an environmental organization.

Opinion leadership

In the theoretical framework, opinion leaders are often pointed as individuals who help diffuse the innovation and they act as a reference point for other potential adopters (Rogers, 2003). They are therefore very important for researchers and marketers. Measuring the differences between opinion leaders and non-opinion leaders when it comes to factors influencing them when buying an EV will help with understanding how to approach both groups by change agents.

Ability to take advantage of incentives

Another important aspect emphasized by scholars concerns the actual access to benefits which incentives give. Apart from fiscal incentives, which are available in whole country, the non-fiscal incentives might have different degree of applicability in different regions. Therefore it would be interesting to see what drives individuals who e.g. do not have access to certain incentives to buy an EV. The variable was constructed from two questions asking if an individual uses toll road when commuting to school or work and if he/she can use a bus lane during these trips (which determines the existence of bus lane exists on the road). This variable will help determine what drives individuals to buy an EV based on the extent to which they can take advantage of incentives.

4.7 Control variables

Scholars have identified several factors that might explain the adoption rate of EVs. Also, the differences among individuals which might impact the reasons for adopting an EV were pointed. But since Norway is the first country with a considerable EV market share and relatively complex regulatory environment, it is very likely that there are other factors that might determine individuals' attitudes towards EVs. The control variable are as follows:

- **Size of living area –** as mentioned in previous sections, Norway is a geographically diversified country. There exist both densely populated cities, such as Oslo and less populated areas e.g. in the northern part of Norway. The difference in the size of living areas of EV owners might impact their values and believes when it comes to purchase and use of EV. For instance, individuals in large cities enjoy larger amount of bus lanes, free parking spots and charging stations. This might not be the case in sparsely populated areas. Therefore, controlling for the size of living area might bring additional insights and contribute to a more complete picture of the situation.
- **Education –** the education level might have implications on how individuals perceive the values when it comes to EV. This factor is often mentioned by Rogers (2003) as an important ingredient of earlier adopters who are usually better educated than later adopters. Furthermore, better educated people might see the EV landscape through different lens than those with lower education. For example, higher educated people have usually better contact with scientific communities and they usually exhibit higher level of innovativeness (Rogers, 2003). Therefore, it is very likely that EV owners

who have more years of education decide to adopt an EV for different reasons than those with lower education. The variable is constructed from the question asking about the years of formal education.

- **Age –** Scholars usually did not measure age as a factor that might influence how individuals perceive certain characteristics of EV and what is important for them. It was rather used to explain who is more likely to adopt – younger or older individuals, but without testing the reasons for adoption. In this research, age is used to investigate the differences between younger and older EV owners in their purchase decision process.
- **Number of people in household –** this variable will answer the question if EV owners who have larger families buy EV for the same reasons as other individuals. The number of people in household might determine the need for everyday commuting to school and work. In larger households, EV owners might also need to do shopping more often as the family is larger. All these potential factors might influence individual's needs and values when making an EV purchase decision.
- **Employment status –** this variable is constructed from two questions related to employment and it is coded to binary variables (employed or not). I control for employment, because it might affect the drivers behind the EV adoption among individuals.
- **Gender –** I control for gender which might be an important factor influencing the reasons for EV adoption. I assume that there might be certain differences between the men and women that lead to adoption of EV.

4.8 Data analysis

The survey questions used for the analysis have been asked at a specific point of time. Therefore, I believe that cross-sectional analysis is the most appropriate method to explain the reasons for adopting an EV by different individuals. The first step in data analysis was a summary of the dataset with descriptive statistics. Subsequently, all the variables used in the analysis were correlated using Pearson's correlation coefficient. This method allowed me to measure the strength of association between variables. Subsequently, the independent

variables were regressed on five dependent variables by using OLS regression in SPSS in order to explore the reasons for buying an EV among different individuals.

5 Results

In this section the results of analysis are presented. It begins with a summary of descriptive statistics. Then the correlations between variables are examined, which allows us to get first insights into the connections between certain aspects. The correlation table is then followed by regression tables, which explain the causal relationships between independent and dependent variables and show their direction and strength. These tables provide the most important insights into reasons why individuals in Norway buy an EV and how their characteristics determine which factors prevail in the moment of adoption.

5.1 Descriptive statistics

Table 1 presents an overview of variables used in the analysis. When looking at dependent variables which explain the reasons why individuals bought an EV, one can observe that all variables except Popularity of EV have the mean response skewed more towards maximum than minimum value. When it comes to environmental friendliness of EV, most people value this feature of EV relatively high when deciding to buy the car. This is unsurprising, because the main reason for EV introduction to the market is its environmental neutrality. Incentives are also an important reason that leads individuals to adoption, which is reflected by relatively high mean value.

Table 1. Summary statistics

	Mean	S.D.	Min	Max
Environmental friendliness of EV	3.79	1.12	1	5
Incentives	23.36	5.16	7	35
Relative advantage of EV	3.86	1.10	1	5
Popularity of EV	2.41	1.24	1	5
Individual's interest in new technologies	3.34	1.23	1	5
Adoption speed	2.07	1.43	1	6
Income	4.99	1.18	1	6
Environmentalism	0.15	0.36	0	1
Opinion leadership	7.29	1.91	2	10
Ability to take advantage of incentives	0.95	0.82	0	2
Size of living area	2.89	1.04	1	4
Education	3.17	0.81	1	4
Age	46.46	11.17	20	91
Number of people in the household	3.24	1.35	1	14
Employed	0.91	0.28	0	1
Gender	0.76	0.43	0	1

However, taking into account high spending and promotion of EVs through incentives by government, the value of incentives reflected by individuals was expected to be higher. The difference in responses might be explained by the fact that some non-fiscal incentives are not relevant in some parts of Norway. The Incentives variable consists both of fiscal and non-fiscal incentives. The EV owners also point relative advantage of EV as an important feature that led to purchase of EV. This is in line with Rogers (2003) who points out relative advantage as one of the five characteristics of innovation that determine its adoption rate. The high relative advantage of EV pointed by EV owners is probably partially an effect of broad array of incentives and abundance of charging stations in the country. As Table 1 shows, those who decided to buy an EV were rather not convinced by its popularity. It plays a role in the decision process, but it is not a very strong reason for buying. With regards to individual's interest in new technologies, this factor was a relatively important reason for adopting an EV. This is not surprising, since the innovation, especially in its early stage of diffusion process (Early Adopters in Norway), is usually adopted by people with higher interest in innovations.

When looking at characteristics of EV owners in the sample (independent variables), most of them bought an EV around 1-2 years ago. Their income level is rather high (around 800 000-1000 000 NOK annually) and around 15% are members of environmental organization which reflects their concern about environment. An important measure defining the stage of

diffusion process is opinion leadership. From the dataset, it can be concluded that EV owners have traits that show high degree of their opinion leadership. This is in line with Rogers (2003) who states that earlier adopters have higher degree of opinion leadership than later adopters. Given that EV diffusion in Norway goes through Early Adopters phase, the high degree of opinion leadership shows that, despite the incentives which could have attracted later adopters, those who adopt are rather earlier adopters. The vast majority of EV owners are men, have up to 4 years of higher education and they are in their 40s. From the number of people in household, it can be derived that most EV owners live in families probably with children, who have not left home yet. The employment rate among EV owners in the sample is rather high and roughly 9 % are out of work.

5.2 Table of correlations

Table 2. Pairwise correlations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Environmental friendliness of EV	1															
2. Incentives	.048*	1														
3. Relative advantage of EV	.108**	.196**	1													
4. Popularity of EV	.234**	.159**	.110**	1												
5. Individual's interest in new technologies	.195**	-.068**	.101**	.283**	1											
6. Adoption speed	.092**	-.058*	-.080**	-.030	.030	1										
7. Income	-.075**	-.096**	-.004	-.033	.009	-.008	1									
8. Environmentalism	.255**	-.030	.022	.034	.073**	.138**	-.071**	1								
9. Opinion leadership	-.131**	-.047*	-.059*	.083**	.356**	.048*	.045	-.052*	1							
10. Ability to take advantage of incentives	-.077**	.160**	.101**	-.071**	-.084**	.044	.202**	-.025	-.013	1						
11. Size of living area	.045	.046	.025	.010	.038	.029	.150**	-.005	-.053*	.134**	1					
12. Education	.141**	-.079**	.021	-.040	-.029	.083**	.288**	.073**	-.100**	.067**	.151**	1				
13. Age	.172**	.020	-.003	.169**	-.053*	.165**	-.085**	.029	.002	-.156**	-.069**	.036	1			
14. Number of people in the household	-.082**	-.021	.017	-.070**	-.018	-.050*	.321**	-.061*	.031	.107**	-.044	.056*	-.257**	1		
15. Employment status	-.065**	-.067**	-.039	-.055*	-.017	-.073**	.409**	-.072**	.005	.237**	.048*	.046	-.389**	.212**	1	
16. Gender	-.122**	-.124**	-.137**	.016	.259**	.039	.056*	-.004	.405**	-.070**	-.020	-.077**	.023	.080**	.021	1

*p< 0.05 (2-tailed), **p< 0.01 (2-tailed).

Table 2 presents the pairwise correlations between measured variables. As we can see, most variables are statistically significant, thanks to the high number of observations. It is interesting to see that people who bought an EV due to its environmental friendliness also value the popularity of EV and, what is expected, they are environmentalists. They are also

interested in new technologies. The negative correlation between environmental friendliness of EV factor and opinion leadership is a surprising result and indicates that opinion leaders are might be less interested in EV's positive impact on environment when deciding to buy it. The positive correlation between incentives and relative advantage shows that people who point incentives as an important reason for their purchase decision also tend to mark relative advantage higher. This is understandable, since the relative advantage of EV depends heavily on incentives which mitigate for drawbacks of EV technology and price. Similarly, individuals who value incentives are also inclined to buy an EV because of its popularity, which is reported by positive correlation between the corresponding variables. Incentives are also important when buying an EV for those who have ability to take advantage of them, which is expected. Another positive correlation between the relative advantage and individual's interest in new technologies shows that people who buy an EV because of its relative advantage also decide to buy, because they are interested in new technologies. However, this correlation is moderate. There is also a positive and significant correlation between relative advantage of EV and its popularity, which indicates that individuals who buy an EV are usually convinced by both factors. Furthermore, the individuals who buy because of EV's relative advantage are usually women, which is an interesting finding. Another positive correlation between individual's interest in new technologies and popularity is found, which means that individuals who are interested in innovations are also interested in popular innovative products. This correlation is understandable, since the more popular the innovation becomes, the higher the probability that curious individuals will begin to research the topic. Another strong correlation is found between interest in new technologies factor when buying an EV and degree of opinion leadership. This is unsurprising and confirms that opinion leaders are usually those who act as reference point for the population, because of their competence and interest in the innovation (Rogers, 2003). The strong positive correlation between opinion leadership and gender indicates that opinion leaders are usually men. There is also a moderate correlation between individual's interest in new technologies and gender. This means that men buy an EV more often partially because of their interest in innovations. A positive correlation between income and ability to take advantage of incentives means that EV owners who have higher income enjoy greater benefits from incentives. This might be partially explained by a positive correlation between income, education and size of living area, which indicates that wealthier and better educated people tend to live in larger cities and thus have more access to bus lanes, toll roads and free public parking spots. The moderate

positive correlation between income and education is expected as better educated people tend to earn more. The EV owners who earn more are also more likely to have larger families (r = 0.321). The strong positive correlation between income and employment status is also expected as employment is the main source of income. Another positive correlation between ability to take advantage of incentives and employment status shows that individuals who have job tend to buy an EV partially because of incentives. From purely demographic point of view, the moderate negative correlation between age and number of people in household shows that older EV owners tend to live with smaller number of family members, which is expected, since they are usually in their 40s (as reported in Table 1) and might have adult children who have already moved out and study or live on their own. The results also indicate that older EV owners are less likely to work (r = -0.389). This might be due to the fact that older EV owners are more likely to be pensioners. The moderate positive correlation between employment status and number of people in household indicate that those EV owners who have job are more likely to have larger family with children still living with them.

5.3 Regression analysis

This section will provide more information about the relationship between EV owners' characteristics and reasons for buying an EV. Since the study aims at finding factors explaining the reasons why individuals buy an EV, the independent and control variables are regressed on 5 dependent variables. These 5 regression models will provide a more comprehensive answer on the topic and they allow us to better understand the drivers for EV adoption from many perspectives, as different individuals might buy an EV for different reasons.

Table 3. Regression analysis of independent and control variables

Variable	M1	M2	M3	M4	M5
Independent variables					
Adoption speed	0.052* (0.019)	-0.046 (0.091)	-0.094** (0.020)	-0.048 (0.022)	0.016 (0.020)
Income	-0.090** (0.027)	-0.097** (0.129)	-0.003 (0.028)	-0.004 (0.031)	0.026 (0.029)
Environmentalism	0.237** (0.074)	-0.020 (0.352)	0.042 (0.076)	0.049 (0.086)	0.087** (0.079)
Opinion leadership	-0.075** (0.015)	-0.006 (0.072)	-0.006 (0.016)	0.094** (0.017)	0.312** (0.016)
Ability to take advantage of incentives	-0.077** (0.034)	0.174** (0.163)	0.106** (0.035)	-0.058* (0.040)	-0.086** (0.037)
Control variables					
Size of living area	0.052* (0.026)	0.049 (0.125)	0.021 (0.027)	0.033 (0.030)	0.059* (0.028)
Education	0.123** (0.034)	-0.067* (0.165)	0.006 (0.036)	-0.048 (0.040)	0.000 (0.037)
Age	0.165** (0.003)	0.021 (0.013)	0.009 (0.003)	0.153** (0.003)	-0.098** (0.003)
Number of people in household	0.008 (0.021)	0.037 (0.100)	0.034 (0.022)	-0.016 (0.024)	-0.041 (0.023)
Employment status	0.061* (0.109)	-0.072* (0.522)	-0.071* (0.113)	0.027 (0.127)	-0.044 (0.117)
Gender	-0.086** (0.068)	-0.100** (0.327)	-0.129** (0.071)	-0.028 (0.080)	0.128** (0.073)
R^2 (adj)	0.140	0.055	0.036	0.033	0.162
N	1721	1721	1721	1721	1721

** $p < 0.01$ (2-tailed), * $p < 0.05$ (2-tailed)

Note: Standard errors in parentheses

Environmental friendliness of EV

In Model 1, where the environmental friendliness of EV is a dependent variable, the results show many significant relationships. As indicated in the theory, the adoption speed of individual is and positively associated with his/her attitude towards environmental friendliness of EV during purchase ($\beta = 0.052$, $p < 0.05$). The finding confirms H1a, which asserts that earlier adopters will put more importance on environmental friendliness of EV when deciding to buy an EV. As Rogers (2003) points out, earlier adopters are usually better educated, have higher income and more contact with scientific environment, therefore their concern about environment and, as a result, purchase of environmental innovation are

behaviours that are likely to be seen among them. The income level, however, is strongly and negatively associated with the EV eco-friendliness factor and this finding shows that H2a is not correct and alternative hypothesis is accepted ($\beta = -0.090$, $p < 0.01$). This is a surprising finding, since people with higher income are usually more concerned about environment and they express their attitude through e.g. adopting environmental innovations. In the theoretical part, the environmentalism was defined as the degree of concern about environment and, not surprisingly, the positive relationship between environmentalism and eco-friendliness of EV factor is strong and significant ($\beta = 0.237$, $p < 0.01$), which confirms H3a. People who value environment are usually more inclined to adopt environmental innovations, which EV represents. Opinion leaders are perceived as those who put more importance on eco-friendliness of EV when deciding to buy an EV, but the regression result shows that H4a is not correct and alternative hypothesis is accepted ($\beta = -0.075$, $p < 0.01$) and it is strongly significant. This relationship is highly significant. Another significant finding revealed by the analysis indicates that individuals who have ability to take advantage of incentives value environmental friendliness of EV less when buying it ($\beta = -0.077$, $p < 0.01$) and this finding confirms H5a. It shows that those who have access to bus lanes, free parking spots and toll roads are less inclined to buy an EV solely to protect the environment and they want to take advantage of incentives and this is understandable, since incentives have been pointed by scholars as important in stimulating EV adoption rate in Norway. The analysis also revealed significant results for our control variables. The education and age of individuals are significantly and strongly associated with environmental friendliness of EV factor. This is expected as better educated and older people are more likely to be interested in environmental issues and thus more likely buy an environmental innovation.

Furthermore, the employment status is also positively associated with dependent variable, which indicates that people who work actively are more inclined to buy an EV to protect the environment. The negative and highly significant relationship between gender and dependent variable show that women value environmental friendliness of EV more than men when deciding to buy an EV.

Incentives

In Model 2, where incentives are dependent variable, adoption speed is negatively associated with attitude to incentives, but this result is not significant and H1b is not supported. The individual's income level is negatively and strongly associated with attitude to incentives and

shows that more affluent EV owners are less interested in benefits coming from incentives, which confirms H2b ($\beta = -0.097$, $p < 0.01$). As mentioned in the theory, the fiscal incentives play an important role in attracting potential adopters and mitigates drawbacks when it comes to the price of EV. But people with higher income are usually able to invest more to adopt an innovation and lower price or operating cost is not a crucial factor when adopting the innovation. Independent variables such as environmentalism and opinion leadership are not statistically significant in explaining the causal relationship between dependent variable, thus H3b and H4b are not supported. The EV owner's ability to take advantage of incentives is positively and strongly associated with incentives factor when buying an EV ($\beta = 0.174$, $p < 0.01$), which is expected and supports H5b. It means that those individuals who can enjoy the benefits coming from incentives (especially non-fiscal) buy an EV mainly for this reason. From the control variables, education and employment status are statistically significant and negatively associated with attitude to incentives. This indicates that higher educated EV owners who have work buy an EV for other reasons than incentives. This is in line with other findings and indicates that people who have good socioeconomic status and higher education are more innovative and thus are more ready to adopt an imperfect innovation, which usually imposes certain cost and risk. Furthermore, the strong negative relationship between gender and incentives shows that women tend to be more inclined to buy an EV as a result of incentives than men.

Relative advantage of EV

In Model 3, where relative advantage of EV is a dependent variable, earlier adopters tend to be less inclined to buy an EV as a result of its relative advantage and H1c is strongly supported ($\beta = -0.094$, $p < 0.01$). This confirms the assumption that earlier adopters might not be able to evaluate the true relative advantage of EV, since at the adoption time they are one of the first individuals who test the innovation and the information about the true relative advantage is usually hard to find during the early stage of diffusion process. Furthermore, according to Rogers (2003) earlier adopters have more funds to adopt an innovation and they might be not too much concerned about its relative advantage when adopting. Income, environmentalism and opinion leadership are statistically insignificant, therefore H2c, H3c and H4c are not supported in this model. Relative advantage of EV seems to be a strong reason for adopting an EV for those who have ability to take advantage of incentives ($\beta = 0.106$, $p < 0.01$), which shows that H5c is not correct and alternative hypothesis is accepted.

This is a surprising finding due to the fact that incentives mitigate for lower relative advantage and it was expected that those who enjoy benefits of incentives will be less likely to buy an EV because of its relative advantage (and focus more on incentives factor when buying as shown in Model 2). However, it turns out that incentives and relative advantage of EV are equally important when buying an EV for those who can benefit from incentives. Favourable policies are probably perceived as a part of EV relative advantage, and therefore both variables go hand in hand. Among the control variables, only employment status and gender regressed on relative advantage of EV give statistically significant results. They are both negatively associated with dependent variable, which indicates that for women and unemployed EV owners relative advantage of EV is an important factor when deciding to buy an EV.

Popularity of EV

In Model 4, where popularity of EV is a dependent variable, the adoption speed, income and environmentalism are not significant in predicting the popularity of EV as a reason for EV adoption, thus H1d, H2d and H3d are not supported. Another strongly significant result indicates that opinion leaders buy EV more often because of its popularity ($\beta = 0.094$, $p < 0.01$), which shows that H4d is not correct and alternative hypothesis is accepted. The hypothesis 5d predicted that individuals who can take advantage of incentives will put less importance on popularity of EV when buying it. This hypothesis was supported ($\beta = -0.058$, $p < 0.05$). With regards to control variables, age is the only significant variable and it is positively and strongly associated with popularity of EV factor when buying an EV. This means that older individuals are more likely to buy an EV because of its popularity.

Individual's interest in new technologies

In Model 5, where individual's interest in new technologies is a dependent variable, the adoption speed and income are not statistically significant and therefore H1e and H2e are not supported. Environmentalists are more likely to buy an EV as an effect of their interest in new technologies ($\beta = 0.087$, $p < 0.01$), thus hypothesis 3e is strongly supported. Opinion leaders are also more inclined to buy an EV based on the degree of their interest in new technologies, which strongly supports H4e ($\beta = 0.312$, $p < 0.01$). Furthermore, the hypothesis 5e predicted that individuals who can take advantage of incentives are less likely to buy an EV based on

their interest in new technologies. The result affirms this assumption and H5e is supported ($\beta = -0.086$, $p < 0.05$). The size of living area is positively associated with the dependent variable which indicates that individuals who live in larger cities are more likely to be interested in new technologies and buy an EV for this reason. Gender is also positively and strongly associated with the dependent variable, which means that men put more importance on their interest in new technologies when deciding to buy an EV. Results also indicate that younger individuals buy EV more often as a result in their interest in new technologies.

6 Discussion

The analysis revealed many findings that add to our understanding of how individuals decide to adopt an electric vehicle. Table 4 shows all the hypotheses, together with the results from regression analysis.

Table 4. Support status for the hypotheses

Hypothesis	Support?
H1a: Earlier adopters will put more importance on environmental friendliness of EV when deciding to buy an EV.	**Supported**
H1b: Earlier adopters will put less importance on incentives when deciding to buy an EV.	**Not supported**
H1c: Earlier adopters will put less importance on relative advantage of EV when deciding to buy an EV.	**Supported**
H1d: Earlier adopters will put less importance on popularity of EV when deciding to buy an EV.	**Not supported**
H1e: Earlier adopters will put more importance on their degree of interest in new technologies when deciding to buy an EV.	**Not supported**
H2a: Individuals with higher income will put more importance on environmental friendliness of EV when deciding to buy an EV.	**Alternative hypothesis accepted**
H2b: Individuals with higher income will put less importance on incentives when deciding to buy an EV.	**Supported**
H2c: Individuals with higher income will put less importance on relative advantage of EV when deciding to buy an EV.	**Not supported**
H2d: Individuals with higher income will put less importance on popularity of EV when deciding to buy an EV.	**Not supported**
H2e: Individuals with higher income will put more importance on the degree of their interest in new technologies when deciding to buy an EV.	**Not supported**
H3a: Environmentalists will put more importance on environmental friendliness of EV when deciding to buy an EV.	**Supported**
H3b: Environmentalists will put less importance on incentives when deciding to buy an EV.	**Not supported**
H3c: Environmentalists will put less importance on relative advantage of EV when deciding to buy an EV.	**Not supported**
H3d: Environmentalists will put less importance on popularity of EV when deciding to buy an EV.	**Not supported**
H3e: Environmentalists will put more importance on degree of their interest in new technologies when deciding to buy an EV.	**Supported**
H4a: Opinion leaders will put more importance on environmental friendliness of EV when deciding to buy an EV.	**Alternative hypothesis accepted**
H4b: Opinion leaders will put less importance on incentives when deciding to buy an EV.	**Not supported**

H4c: Opinion leaders will put less importance on relative advantage of EV when deciding to buy an EV.	**Not supported**
H4d: Opinion leaders will put less importance on popularity of EV when deciding to buy an EV.	**Alternative hypothesis accepted**
H4e: Opinion leaders will put more importance on degree of their interest in new technologies when deciding to buy an EV.	**Supported**
H5a: Individuals who can take advantage of incentives will put less importance on environmental friendliness of EV when deciding to buy an EV.	**Supported**
H5b: Individuals who can take advantage of incentives will put more importance on incentives when deciding to buy an EV.	**Supported**
H5c: Individuals who can take advantage of incentives will put less importance on relative advantage of EV when deciding to buy an EV.	**Alternative hypothesis accepted**
H5d: Individuals who can take advantage of incentives will put less importance on popularity of EV when deciding to buy an EV.	**Supported**
H5e: Individuals who can take advantage of incentives will put less importance on degree of their interest in new technologies when deciding to buy an EV.	**Supported**

There have been a number of scholars that try to explain the underlying factors behind the EV adoption rate in many countries. But as pointed previously in the paper, most of them do not focus on the drivers explaining the reasons why individuals adopt an innovation such as electric vehicle. The results of the analysis contribute to the understanding of the variation between EV owners and how certain traits and believes determine their attitude to the factors pointed by scholars.

6.1 The adoption speed and drivers for buying an EV

One of the pillars of Rogers (2003) diffusion of innovations theory is adoption speed of individual. Based on how early the person adopts the innovation, he or she represents a specific adopter category. The adoption speed also reveals many characteristics of the individual and it determines the attitude of adopter to the innovation. Results indicate that earlier adopters are concerned about the environment and they value this feature of EV when deciding to buy it, but simultaneously they are not too worried about the relative advantage of the car. The main purpose of introducing an EV, as seen by many scholars, was its eco-friendliness and benefit for the environment. As results indicate, early adopters properly gauge this purpose and they identify with it. This has several implications for both policy

makers and companies trying to enter the market. In countries, where diffusion is still in the initial phase, it might be wise for companies and governments to highlight the benefits electric cars give to the environment. Since earlier adopters do not worry too much about the relative advantage of EV and they have financial assets to risk for the uncertain innovation (Rogers, 2003) such as EV, governments should try to focus more on informational campaigns among first potential adopters and make sure that all the ecological benefits of using an EV are properly emphasized. The results also confirm that earlier adopters who are usually better educated and have better socioeconomic status (Rogers, 2003) are more likely to exhibit their concern about environment. Furthermore, the environmental friendliness of EV as an important reason for buying partially contradicts the statement of Zhang (2014) who believe that the sole environmental benefits are insufficient to encourage potential adopters if they do not get direct benefits in a short time. There are probably other reasons for buying as well, but the strong evidence that environmental features of EV are important for first buyers shows that environment might be a good factor to communicate in the social network and might highly contribute to speeding up the initial phase of the diffusion.

6.2 Income level and adoption of EV

Theories have underlined the high price of EV and its uncertain relative advantage as factors negatively contributing to its adoption rate. It is unsurprising that expensive innovations are usually discarded by people who have average socioeconomic status. Therefore governments decided to establish certain policies and incentives in order to encourage people to adopt the innovation. This is also a case in Norway, which stands out with its broad range of incentives. The results of regression analysis show that individuals with higher income are usually less inclined to buy an EV in order to obtain incentive. However, what is surprising, they also do not care too much about EV eco-friendliness when deciding to make a purchase. This contradicts the theory which states that people with higher income are more interested in environmental issues and they are more likely to choose environmental innovations to exhibit their care about the planet. A reason for lower interest in EV eco-friendliness might be the fact that people with higher income often adopt many innovations first, not necessarily environmental ones. Their high socioeconomic status is something they want to exhibit in the society and they can simply buy an EV for this reason. Curiosity might be also a factor that influences the decision to adopt. Unfortunately, the dataset used in the analysis did not cover

every possible reason that could play a role in the purchase process and other variables used in the analysis are not significantly correlated with the dependent variables.

6.3 EV as a way for expressing concern about the environment

The findings suggest that environmentalists buy an EV because of its eco-friendliness, which is understandable and expected. Interestingly, these individuals are also interested in innovations and regression analysis indicates that this is an important reason why they decide to use an electric car. This shows that people in Norway who value environment, also possess other traits that might be important in explaining the diffusion process. As correlation table shows, environmentalists in Norway are also earlier adopters, which partially explains why they might be interested in new technologies. This finding is another evidence that governments should focus on communicating the benefits EVs bring to the environment when EV market is in very initial phase, which is the case in most countries.

6.4 The drivers for buying an EV as seen by opinion leaders

Opinion leaders are the important link in the diffusion process, since they are strongly embedded in the social system and they act as a reference point for other individuals considering adoption (Rogers, 2003). The main concern in the Norwegian context was the fact that the broad range of incentives might have disrupted the natural diffusion process by attracting those who would otherwise not adopt (Rogers, 2003; Sloten, 2015). However, the descriptive statistics show that most EV adopters in Norway are opinion leaders, which does not confirm the concerns of Sloten (2015) and Rogers (2003). Norway is in Early Adopters phase of diffusion process and high degree of opinion leaders indicates that incentives have not altered the structure of diffusion much and it is very likely that later adopters will have a strong reference point when making their own adoption decision. The regression reveals that opinion leaders are not too much interested in EV's environmental friendliness when making purchase decision. Taking into account that earlier adopters are often opinion leaders (as shown in correlation table), the low interest in ecological benefits of EV is a finding that is not found in scholars and might require further research. Another result reported indicates that

opinion leaders adopt EV because of its popularity, which is in contradiction to theories stating that opinion leaders usually adopt when innovation does not have a high degree of observability yet. As the Norwegian example shows, the popularity of innovation plays its role among opinion leaders as well. One can conclude that not all individuals defined as opinion leaders in Norway have a point of reference, for example among other opinion leaders. Furthermore, taking into account a very rapid diffusion process in Norway, it might have turned out that this quick diffusion led to increase in observability and popularity, so that even opinion leaders have a reference such as other opinion leaders, innovators and mass media. The results also show that opinion leaders buy an EV as the result of their interest in new technologies. It is expected, since the opinion leaders are usually highly focused on innovations, they have expertise in the field and are therefore are a credible reference for the society (Rogers, 2003).

6.5 The ability to take advantage of incentives and drivers behind the adoption

The regression results indicate a strong relationship between the ability to take advantage of incentives and all the dependent variables. This means that incentives are an important factor that influences the EV diffusion process, as stated by many scholars. The descriptive statistics also confirm that most individuals who own an EV adopted because of incentives. As their impact on the diffusion process is highly emphasized, it is also important to add that non-fiscal incentives (which are important part of Norwegian package) are not possible to use in every part of Norway. The results allow us to better understand what individuals, who have different access to certain incentivized benefits, value when buying an EV. As the regression results point, those who can take advantage of incentives are less interested in EV's environmental friendliness and more interested in incentives. This is understandable, taking into account the high importance of incentives in attracting potential adopters, which might overweigh other factors. However, it turns out that relative advantage of EV is an important factor when buying for those who have full access to incentives. This can be explained by the fact that incentives highly contribute to increasing the relative advantage of EV. Moreover, as governments plan to phase out the incentives, it is crucial that the EV technology and infrastructure are improved, since the relative advantage without incentives is much lower. This conclusion is in line with scholars, which underline that price, technology and charging

infrastructure should be improved in order to stimulate the diffusion of EVs. Other results indicate that people who have more access to benefits from incentives are less interested in popularity of EV, which is expected. Besides, they are also less interested in new technologies when making a purchase decision.

The results also reveal that individuals who cannot fully enjoy incentives, adopt for reasons such as eco-friendliness of EV, popularity and as a result of their interest in innovations. However, what is surprising, they do not pay too much attention to relative advantage when buying an EV. This has also another implication. The lack of interest in relative advantage among people without full access to incentives confirms that incentives largely contribute to relative advantage of EV and these two factors are interconnected. Again, phasing out incentives will severely affect the perceived relative advantage of EV and this must be addressed before favourable policies are ended.

7 Conclusion and recommendation

The study aimed to answer the question: “What can explain the reasons for buying an EV by individuals?” It tried to examine the underlying drivers for EV adoption among different individuals in Norway. The findings suggest that environmental friendliness of electric cars is a very important factor when deciding to adopt, especially for those who buy an EV in the very initial phase of diffusion process. Furthermore, another interesting finding reveals that environmentalists buy an EV not only because it is eco-friendly, but also as an effect of their interest in innovations. This finding shows that people in Norway, who care about the environment are also highly focused on innovations. These people are also early adopters, as indicated by correlation coefficient.

All these factors can be used by policy makers and companies to approach potential customers in a right way. Since the diffusion process is in initial phase in most countries, informing early adopters about environmental benefits of EV might be a right way to go. Also, disseminating information about the technology in mass media channels might attract more early adopters who are looking for any news about innovations.

The study also confirmed that incentives are important for most individuals who adopt an EV. However, even though individuals can benefit from incentives, they are also focused on relative advantage of the car. This means that Norwegian government should consider keeping the same package of incentives as long as the relative advantage of EV is lower compared to traditional cars, since phasing them out might affect the relative advantage and lead to rejection by the current and potential adopters. Also, in countries where the EVs are produced, policy makers might try to encourage companies to put more effort on research and development, which might result in better and cheaper electric vehicles.

Also, as results show, despite broad incentives, the Early Adopters phase of diffusion in Norway consists of many opinion leaders. This means that incentives do not necessarily have to be a wrong decision, since they do not affect the structure of diffusion process to a large degree. Other countries might consider developing incentives as they are not harmful to the diffusion process.

7.1 Limitations and further research

This study, as many other projects, has certain limitations. As mentioned in Methodology, the dataset used in this work comes from a secondary source, which gathered the data for its own purpose. Not all the questions were suited to address the problems highlighted in the thesis. There might be also many other underlying factors explaining the decision to buy an EV, but the limited number of variables did not allow for testing every possibility. When it comes to the nature of the research, the diffusion process is not always easy to explain with cross-sectional data. The innovation diffuses across time and the situation might change over time. In order to capture all the phenomena in the diffusion process, a longitudinal study would be more appropriate.

Furthermore, this research was limited to one country – Norway, which means that there is only one market examined. Evaluating other countries might reveal new interesting findings.

Also, a comparative study between countries might be considered as it can reveal similarities and differences when it comes to reasons for buying an EV and define certain patterns that work universally. However, given that EV market shares in most countries are rather moderate and, in most cases, they are in initial phase, it might be challenging to conduct a comparative study. It is also important to add that every country has its own unique set of incentives, regulations and culture and comparison of such a complex scenarios might be difficult.

Moreover, this study focuses solely on individuals who have already adopted the innovation, thus leaving those who may consider it but are not convinced yet. People who have not adopted an EV yet would also give valuable insights into the topic. Therefore, it would be interesting to see other studies that try to better understand both EV owners and other individuals.

Also, as the diffusion process reached only Early Adopters phase in Norway and still advances, it might be not possible to understand all the drivers behind the adoption until diffusion reaches later phases.

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