

COMPETT



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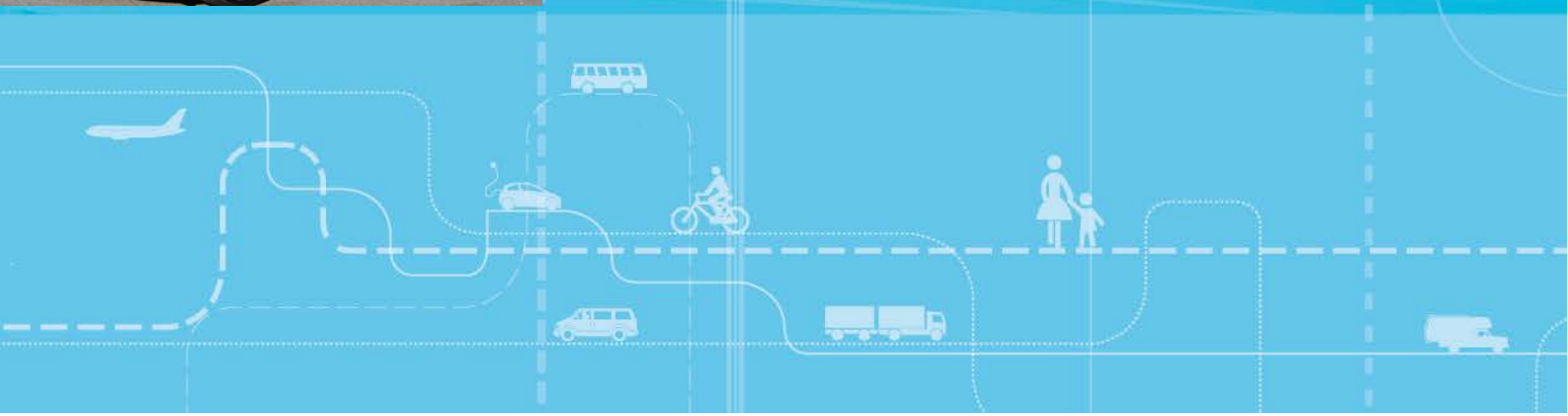
Electromobility+



Institute of Transport Economics
Norwegian Centre for Transport Research



Everyday mobility and potential use of Electric Vehicles



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Summary:

The aim of this report is by the help of available data to do a comparable analysis of the potential use of EVs in Austria, Denmark and Norway. Analysis of car based trip chains in Norway and Denmark shows that most trips and trip chains are short. In Norway there are 4 percent of the trips, 6 percent of the chains and 12 percent of the days during a year where the distance is over the range limit for EVs. In Denmark the corresponding figures are, 5 percent, 14 percent and 16 percent. But even if there are a number of days that either have too long single trips or too long chains there are stops during the day making it possible to recharge.

Sammendrag:

Basert på data fra de nasjonale resievaneundersøkelsene i Norge og Danmark er det gjort analyser for å undersøke potensialet for bruk av elbiler. Resultatene viser at både enkeltreiser og reisekjeder er relativt korte. I Norge er det 4 prosent av enkeltreisene, 6 prosent av kjedereisene og 12 prosent av dagene som har reiseavstander som overstiger elbilens rekkevidde. I Danmark er de tilsvarende andelene 5 prosent, 14 prosent og 16 prosent. Selv om det er en del dager som enten har for lange enkeltreiser eller reisekjeder, har mange stans/opphold i løpet av dagen hvor det er mulig å lade.

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Preface

This report is a part of the project COMPETT (Competitive Electric Town Transport), which is a project financed by national funds which have been pooled together within ERA-NET-TRANSPORT. The report is written by Randi Hjorthol and Liva Vågane, Institute of Transport Economics, Norway, Jens Foller, Danish Road Authorities and Bettina Emmerling, The Austrian Energy Agency. Trude Rømming has been responsible for the finishing of the report. Erik Figenbaum, Institute of Transport Economics, has been Project Manager.

In January 2011 ERA-NET-TRANSPORT initiated a range of projects about electric vehicles under the theme ELEKTROMOBILITY+ concerning topics from the development of battery and charging technology to sociological investigations of the use of electric vehicles.

20 European project consortia have now been initiated including the COMPETT project. COMPETT is a co-operation between The Institute of Transport Economics in Norway, The Austrian Energy Agency, The University College Buskerud in Norway, Kongsberg Innovation in Norway and the Danish Road Directorate. The objective of COMPETT is to promote the use of electric vehicles, particularly with focus on private passenger cars. The main question to answer in the project is “How can e-vehicles come in to use to a greater degree?”

Read more about the project on. www.compett.org

The COMPETT project is jointly financed by Electromobility+, Transnova and The Research Council of Norway, FFG of Austria and The Ministry of Science, Innovation and Higher Education (Higher Education Ministry) in Denmark.

Oslo, Oktober 2014
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Summary:

Everyday mobility and potential use of Electric vehicles

TOI Report 1352/2014

*Author(s): Randi Hjorthol, Liva Vågane, Jens Foller, Bettina Emmerling
Oslo 2014, 58 pages English language*

Analysis of car based trip chains in Norway and Denmark shows that most trips and trip chains are short. In Norway there are four percent of the trips, six percent of the chains and 12 percent of the days during a year when the distance is over the range limit for EVs (80 km in the winter and 120 km in the summer). In one year this means that the average number of days that are over the limit (without recharging) is 43 days. In Denmark the corresponding figures are, 5 percent, 14 percent and 57 days. But even if there are a number of days that either have too long single trips or too long chains there can be stops during the day making it possible to recharge. On the rather few travel days with a travel length longer than 80 km respective 120 km, 29 percent (80 km) and 24 percent (120 km) in Norway have a stop at home between 1-5 hours, which gives a possibility for recharging (partly or nearly full). In Denmark the shares are nearly the same.

Objective and data

The aim of this report is, by the help of available data, to do a comparable analysis of the potential use of EVs in Austria, Denmark and Norway. In this context primarily data from Denmark and Norway are used. We have been interested in examining for what purposes, travel lengths and different social groups the EVs are a good solution. The institutional and other contextual conditions for purchase and use of EVs are different in the three countries. What is found in one country can therefore not necessarily be transferred to one of the others, which also means that it is difficult to generalize the findings to other (European) countries.

Our main data has been the national travel survey in Denmark and Norway. Unfortunately Austria has not this type of survey, so we have to rely on the results from the two other countries.

The incentives for buying and using EVs in the three countries are very different. Norway has the most beneficial incentives of the three, which has resulted in a high level of penetration of EVs in the country and with the world's highest number of EVs relative to the population (Figenbaum and Kolbenstvedt 2013).

The number of cars per 1000 inhabitants is high in all three countries, highest in Austria and lowest in Denmark. There is also about one third of the households that have more than one car, which means that there is a rather large potential of changing one of the cars with combustion engine in the household to an EV if conditions (mainly the possibility for charging at their home) for an electric car are present.

Trip chains by car are short

When analyzing single car trips it is obvious that a great majority of them are within the limit of an Electric vehicle. In Norway only three percent of the single car trips are longer than 80 km. In Denmark the percentage is four. The characteristics of those who have more long trips than other are:

- living in sparsely populated areas and small villages
- high income
- working full time
- men
- on business and leisure trips
- have more than one car

The single trip must be seen in connection with the total travel pattern of the day. The single trip can be part of a longer chain. A trip chain in these analyses is defined as the following: A car based chain starts and ends at home, and the car is used at one or more trips. Total travel distance is calculated as distance by car, and trips with other modes in between are ignored. If the respondent does not use the car on one or more of the trips in the chain, we assume the car is parked and that no other persons are using it.

The analysis of chains is based on respondents with driving licence, car in the household and those who drove the car at the registration day.

Similar to the length of single trips, also the length of car based chains is relatively short. In Norway 85 percent of them are shorter than 50 km, and in Denmark 75 percent is shorter, indicating that car based trip chains are somewhat longer. It is only 8 percent of the chains in Norway that are longer than 80 km, in Denmark this share is 14 percent. Looking at all the chained trips in general 95 percent of them don't need recharging in Norway, about 90 percent in Denmark.

But even if there are a number of days that either have too long single trips or too long chains there can be stops during the day making it possible to recharge. On days with travel length longer than the range, between 24 and 29 percent have a stop at home between 1-5 hours, which gives a possibility for recharging (partly or nearly full) in both Norway and Denmark.

When doing the same analysis, but restrict it to stops longer than five hours, between 20 and 40 percent have such long stops at work at the weekdays in Norway, a little higher in Denmark.

On those days that exceed the limit, the home and the workplace are important for recharging; the home for stops shorter than five hours and work for the longer stops. There is however several other places people stops. A large part of the car trips is related to shopping and service. Recharging stations located at shopping centres gives these drivers a possibility to manage the total trip chain.

Little knowledge of and interest for buying EVs in Denmark

Special questions about different aspects of electric cars were added to the Danish national travel survey. As many as about 80 percent of the Danish respondents

would not consider buying an EV. The knowledge about electric cars is low, as many as 33 percent say that they have no knowledge. Two different groups stand out as potential buyers. The first group is characterized as following:

- Middle aged
- High income
- Well educated
- Pretty good knowledge about electric cars
- Access to more than one car
- Have good parking and recharge facilities at home
- Concerned about the environment

The second type of potential buyer is quite different:

- Young
- Relatively low income
- Have no access to a car, or maybe just one car.
- Live in a big city
- Have relatively bad parking/recharge facilities at home
- Relatively little knowledge about electric cars
- Few long trips
- Concerned about the environment

This indicates that the motives for buying probably are different in these two groups, and that incentives for buying also should be different.

Long trips to leisure homes in Norway

The limited range of the electric vehicles has been used as an argument against purchase of an EV. People do long car trips for holiday, leisure or business that exceed the upper range, and recharging may not always be possible for different reasons. A question is, also, how often do people carry out these long car trips, how long are they, for what purposes are they carried out, and what are the characteristics of those who do these trips?

The analyse of the long trips (100 km+) from the Norwegian travel survey from 2009 shows that the majority of these trips are connected to holidays and leisure activities, and most of them are done by car.

People living in the surrounding municipalities of Oslo are those who have the highest number of long car trips in the country. Men have more long car trips than women. People in their middle ages, 45-54 years, those with high household income, those with three or more cars, and work more than 40 hours per week have most frequent long car trips.

About 40 percent of the Norwegian population own or have access to a leisure home/cottage/summer house. People living in the large cities and the surrounding areas have the highest ownership, but few of them have a cottage within the home county. They have to travel further to visit their holiday house than people living in smaller cities and sparsely populated areas. The estimated average distance to the holiday houses is 150 km, but one third have less than 50 km to the cottage, and further 20 percent have a distance between 50 and 100 km. This is within the

range of most EV in the summer season. But not all cottages have access to electricity, about 40 percent have not electricity installed.

In the metropolitan area of Oslo about 20 percent of the cottage owners have a distance shorter than 100 km to their cottages. In the next three biggest cities and the surrounding municipalities about 50-60 percent have a cottage within their reach. In the other parts of the country this is even higher. For most EVs this is within the range of the batteries in the summer season, but in the winter season this (upper) distance is a problem for most electric vehicles without recharging on the way. This result shows the dilemma - those who take EV in use in the larger cities, where the climate and environmental benefits are greatest, have the longest distances to the holiday houses, which makes it difficult to manage with an EV as a single car.

A substitution of a traditional car with an EV considering transport to the holiday house is primarily a problem for a majority of those living in the metropolitan area of Oslo, and first of all in the winter time. Recharging on the way can solve the problem, but one question is the willingness to spend extra time on the way to and from the cottage if this is a weekend trip, which in average takes place a little more than once a month, 14 times a year. In connection with vacation seasons many will be on the way at the same time and create a capacity problem on charging stations.

End comments

The analysis above is valid for the typical EVs available in the market in 2014. Next generation vehicles coming on the market 2017-2020 will probably be equipped with batteries allowing longer range, reducing the number of days the range is insufficient. Tesla Model S is already capable of delivering a range compatible with almost all travel needs analysed in this report.

Sammendrag:

Potensialet for bruk av elektriske biler på de daglige reisene

TØI rapport 1352/2014

Forfatter(e): Randi Hjorthol, Liva Vågane, Jens Foller, Bettina Emmerling
Oslo 2014 58 sider

Analysen av bilbaserte kjedereiser i Norge og Danmark viser at de fleste enkeltreiser og kjedereiser er korte. I Norge er fire prosent av enkeltreiser, seks prosent av kjedereisene og 12 prosent av årets dager hvor reisene er lengre enn rekkevidden for en elektrisk bil (80 km om vinteren og 120 km i sommerhalvåret). I løpet av ett år betyr det 43 dager hvor reiselengden er lengre enn elbilens rekkevidde (uten ladning). I Danmark er de tilsvarende tallene fem prosent, 14 prosent, 16 prosent og 57 dager. Men selv om det er en del dager som enten har enkeltreiser eller kjedereiser som overskrider rekkevidden til en elbil, kan det være pauser i løpet av dagen som gjør det mulig å lade. På de relativt få dagene som har en samlet reiselengde med bil over 80 km respektivt 120 km, er det 29 prosent (80 km) og 24 prosent (120 km) i Norge som har et stopp/en pause hjemme på 1-5 timer, som gir mulighet for hel eller delvis oppladning. Andelene er omtrent de samme i Danmark.

Problemstilling og data

Målet med denne delen av prosjektet er å undersøke potensialet for elektriske biler i Østerrike, Danmark og Norge ved hjelp av tilgjengelige data. I denne sammenhengen er det først og fremst brukt data fra Danmark og Norge på grunn av datatilfanget. Vi har vært interessert i å undersøke for hvilke formål og for hvilke grupper elektriske biler passer. Betingelsene for kjøp og bruk av elbiler er svært forskjellige i de tre landene, og også andre europeiske land. Hva man finner av resultater i ett land, kan dermed ikke overføres til et annet, noe som også betyr at det er vanskelig å generalisere. Norge har de mest gunstige insentivene for å kjøpe og bruke elbiler av disse tre landene, noe som har ført til at antallet elbiler per 1000 innbyggere er det høyeste i verden.

Grunnlaget for analysene i rapporten er først og fremst de nasjonale reisevaneundersøkelsene i Norge og Danmark. Østerrike har dessverre ikke den typen nasjonale undersøkelser.

Antallet biler per 1000 innbyggere er høy i alle tre land, høyest i Østerrike (529) og lavest i Danmark (390). Det er også omtrent en tredel av alle husholdningene som har mer enn én bil, noe som betyr at det er et ganske stort potensial for å bytte en av de bensindrevne bilene med en elbil hvis det er lade muligheter der de bor.

Reisekjeder med bil er korte

Hvis man ser på de daglige reisene enkeltvis, er det store flertallet innenfor rekkevidden for en elbil. I Norge er bare tre prosent av enkeltreisene med bil lengre enn 80 km. I Danmark er andelen fire prosent. Kjennetegnet ved de som har lange reiser er: de bor i spredtbygde strøk, de har høy inntekt, arbeider heltid, er menn, det er enten tjenestereiser eller fritidsreise og de har flere enn én bil.

Enkelreisen må i imidlertid sees i sammenheng med det totale reisemønsteret i løpet av dagen. Enkelturen kan være del av en lengre reisekjede og kanskje være den korteste (eller lengste) delen av kjeden. I denne analysen er en kjedereise definert som: En bilbasert kjede starter og ender i boligen, og bilen er brukt på en eller flere reiser. Den totale reiselengden er beregnet som distanse reist med bil, reiser med andre transportmidler er ikke tatt med. Hvis respondenten ikke bruker bilen på en eller flere deler av kjeden. Forutsetter vi at den er parkert.

Analysen av reisekjeder er basert på respondenter med førerkort, bil i husholdet og bilbruk på registeringsdagen.

På samme måte som enkeltreisene er bilbaserte reisekjeder ganske korte. I Norge er 85 prosent av dem kortere enn 50 km, og i Danmark er 75 prosent kortere enn 50 km. Det er bare åtte prosent av kjedene i Norge som er lengre enn 80 km. I Danmark er denne andelen 14 prosent. Se vi på alle kjedene i Norge er det 95 prosent av dem som ikke trenger ladning, i Danmark er andelen 90 prosent.

Men selv om det er et visst antall reiser eller kjeder som er for lange, har mange stopp/pauser i løpet av dagen som gjør det mulig å lade. På dager der reiselengden er lengre enn rekkevidden for elbilen, vil mellom 24 og 29 prosent ha en stopp hjemme, som gjør det mulig å lade helt eller delvis både i Norge og Danmark.

Ser vi på pauser/stopp som er lengre enn fem timer, er det mellom 20 og 40 prosent som har så lange pauser på hverdagens i Norge, og litt høyere andeler i Danmark.

På de dagene som overskrider rekkevidden, er bolig eller arbeidsplass viktige steder for ladning. Det er imidlertid mange andre steder folk stopper. En stor del av bilreisene har innkjøp og service som formål. Ladning ved kjøpesentre gir en del av disse muligheter til kortere ladning.

Liten kunnskap om og interesse for elbiler i Danmark

I tilknytning til den nasjonale reisevaneundersøkelsen i Danmark ble det stilt spørsmål om elbiler. Så mange som 80 prosent sa at de ikke ville være interessert i å kjøpe elbil. Kunnskap om elbil er liten, så mange som 33 prosent sa de manglet kunnskap.

To ulike grupper kan sees på som potensielle kjøpere av elbil:

- Middelaldrende
- Høy inntekt
- Høy utdanning
- Relativt god kunnskap om elbil
- Har flere enn én bil
- Har gode parkerings- og lademuligheter hjemme
- Miljøbevisst

Den andre gruppen er ganske forskjellig:

- Unge
- Relativt lav inntekt
- Dårlig tilgang til bil
- Bor i storby
- Har dårlige parkerings- og lademuligheter hjemme
- Relativt liten kunnskap om elbil
- Har få lange reiser
- Miljøbevisst

Dette viser at motivene for å kjøpe elbil i disse to gruppene er forskjellige og dermed bør også insentivene muligens være det.

Reiser til hytta i Norge

Et argument mot å kjøpe elbil er at folk trenger bil med lengre rekkevidde til ferier og fritid, og ladning kan være vanskelig av forskjellige grunner. Et spørsmål er imidlertid hvor ofte folk har slike bilturer, hva reisemålet er hva som kjennetegner disse som har slike reiser.

En analyse av reiser som er 100 km eller lengre basert på den norske nasjonale reisevaneundersøkelsen fra 2009, viser at mesteparten av disse reisene er knyttet til ferie og fritid, og de aller fleste foregår med bil.

Bosatte i omegnskommunene til Oslo har flest slike reiser, 1,2 per måned. Menn har flere slike reiser enn kvinner. Middelaldrende, folk med høy husholdsinntekt, med flere biler og lang arbeidstid er de som har flest slike reiser.

Omtrent 40 prosent av landets befolkning har tilgang til hytte/fritidsbolig. Bosatte i de store byene og i deres omegnskommuner har oftere hytte enn bosatte andre steder, og hytta ligger sjelden i bostedsfylket. De har lengre vei til hytta enn bosatte i andre områder. Den gjennomsnittlige avstanden til hytta er 150 km, men en tredjedel har kortere enn 50 km og 20 prosent har en reiselengde mellom 50 og 100 km. Dette er innenfor rekkevidden til elbilen på sommerstid. Ikke alle hytter har innlagt strøm.

I Oslo-området har omtrent 20 prosent av hytteeierne kortere enn 100 km til sine hytter. I de tre neste største byområdene er det omtrent 50-60 prosent som har hytte innenfor denne rekkevidden. I andre deler av landet er andelen enda høyere. For de fleste elbiler er dette innfor rekkevidde i sommerhalvåret, men om vinteren vil det være behov for ladning av de fleste elbiler. Dette viser et dilemma – de som tar i bruk elbiler i de større byområdene, hvor klima- og miljøgevinstene er størst, har samtidig de lengste avstandene til sine fritidshus, noe som kan gjøre det vanskelig å klare seg med elbil som eneste bil.

En utskifting av en tradisjonell bil med en elbil med tanke på hyttetransport er i første rekke et problem for dem som bor i Oslo-området, og først og fremst på vinterstid. Ladning underveis kan løse dette problemet, men spørsmålet er om folk er villig til å bruke ekstra tid til dette på en helgetur. I gjennomsnitt har de 14 slike turer i løpet av et år. I tilknytning til ferienesongene vil det være mange på reise på samme tid og strekninger, noe som kan skape kapasitetsproblemer på ladestasjonene.

1 Introduction

1.1 Objectives and data

This report is part of the Competitive Electric Town Transport (COMPETT) project funded by ERA-net transport. COMPETT's objective is reduction of CO₂ emissions by increased use of electrified vehicles – this to be done through better knowledge of the barriers against and potentials for electrified vehicles, including reduced road traffic noise. Fully electric vehicles (EVs), plug-in hybrid electric vehicles (PHEVs), fuel-cell hydrogen vehicles and electric two-wheelers have different functionalities and may face different barriers and potentials. Austria, Denmark and Norway are participating in the project with a total of five partners representing research, local authorities and businesses. COMPETT will shed new light on the appropriate role of the government in the take-off stage and on the creation of a self-sustainable market for e-vehicles.

The aim of this report is by the help of available data to do a comparable analysis of the potential use of EVs in the different countries as far as the data are comparable. In this context primarily data from Denmark and Norway are used. It turned out that the data from Austria had another form making it less suitable for comparing with the other two countries. The questions stated in the original project description were as follows:

- For which purposes can e-vehicles be used and for which purposes are such vehicles not suitable?
- For which travel lengths are electrified vehicles preferable? It is important to know whether the trip is a single trip or part of a trip-chain.
- Which social groups will be the potential users?
- How many of the daily car trips can be substituted by electric/hybrid vehicles?
- In which types of residential areas will electric/hybrid vehicles be most favourable?

The data basis for the empirical analysis are the National travel surveys in Norway and Denmark, and "Transport in Figures 2011" in Austria (the surveys from Denmark and Norway are described in Appendix 1). In this report results from the different surveys and statistics are presented and comparison between the countries is done according to the possibilities in the data. In addition to this comparative analysis between countries, analyses of special data from Denmark and Norway are presented.

Since the project plan was written in 2011/2012 there have been changes in the technical quality of electric vehicles and composition of the fleet of the vehicles, especially in Norway, where there has been a rapid increase in the number of EVs from 2010 an up to 2013 (see Figenbaum and Kolbenstvedt 2013). However, the questions raised in the original plan have still relevance.

The “Range anxiety” (the fear of being stranded due to a depleted battery) is still ubiquitous (Hjorthol 2013), but the range of new EVs has increased and the intervals of travel distances used in the analyses in this report reflect this changes. In Norway the users of el-vehicles now use 85 % of the range of the battery. We apply a range of 80 km in winter time (October- March) and 120 km during summer (April-September) for analysis of potential EV use. The range of new models is expected to increase in the years to come.

The results of this report will be used as input to Work Package 5, Economic assessment of incentives for e-vehicles and implementation.

1.2 A short review of literature

1.2.1 Owners, use and motives for buying an EV

Studies of early adopters of electric vehicles (EVs) indicate common socio-demographic characteristics across countries. The early adopters are relatively young, a majority are men, they have high education and income, and belong to households with more than one car (Econ analyse, 2006; Rødset 2009; Transport for London 2010; Pierre et al. 2011; Campell et al. 2012; Hagman et al. 2011; Ozaki and Sevastyanova 2011). The majority also lives/lived in, or in the vicinity, of larger cities.

Travelling from one’s home to place of work is the most often cited reason for using EVs in most countries. And in Norway the special conditions that apply (no VAT, free parking, permitted driving in bus lanes, free driving on toll roads, reduced annual vehicle tax and tax on company cars) have a major bearing on the decision to buy.

Environmental considerations, lower operation costs and simply the convenience and fun it is to drive these vehicles also influence the buyers (Cocron et al. 2011; Caparello and Kurani 2012; Davis and Kurani 2010; Williams et al. 2011).

Adjustments which drivers have to make when driving an EV include better planning of journeys – due to battery limitations – and adoption of a smooth (non-erratic) driving style (Gjøen and Hård 2002; Turrentine et al. 2011), and turning off accessories such as air-conditioning and heaters (Figenbaum et al. 2014).

1.2.2 The potential of EVs and incentives for purchase

Since electric vehicles are a relatively new technology under continuous development and with greatly reduced direct GHG emissions, studies have been carried out to evaluate the potential ownership and to promote initiatives that would increase their number on the roads. The methods and data used to calculate or evaluate this potential are very different, and so the results cannot be compared directly, although in Paris (Windish, 2011) and Birmingham (Campbell et al. 2012); a potential of about 10 percent of car owners has been estimated. In the USA (California), the share of owners who could recharge at home has been estimated at about one-third. Surveys of people’s interest in buying an EV also show variations between countries, i.e. between those with and without knowledge of the technology and survey methods (Erdem et al. 2010; Transport for London 2010; Axen and Kurani 2012; Bandhold et al. 2009; Hanappi et al. 2012; Sentio Research Norway 2012; Jensen 2011; Baptista 2011).

Reduced taxes, other benefits (parking), appreciated convenience over public transport and environmental benefits were areas of interest in surveyed studies. Knowledge of the technology and practical experience of driving an EV are likely to raise one's interest in buying one.

1.2.3 Positive and negative attitudes

Attitudes towards and perception of EVs, both positive and negative, vary by experience, knowledge and the everyday context. In many of the surveys and studies of people's opinions of different aspects of EVs, there is little or no information about the respondent's level of knowledge and experience. Questions can vary and therefore answers can be difficult to compare. However, two negative aspects of the EV mentioned in many studies are: range and battery charging (Boulangier et al 2011). "Range anxiety", i.e. the fear of being stranded due to a depleted battery, was not uncommon, but with knowledge and increased range this is probably reduced. Size, price, safety and distrust of the technology are also mentioned as negative factors. Praiseworthy aspects of the EV found in several studies are that it is environmentally friendly, easy to park, low on noise, is well regarded and economically advantageous (Sentio Research Norway 2012; Mathiesen et al 2010; Rødseth 2009; Lieven et al 2011, Hjorthol 2013; Figenbaum and Kolbenstvedt 2013).

1.3 Incentives in the three countries

The incentives for purchase and use of EVs vary between the three countries. In Norway there are a range of incentives to promote EVs.

The following measures are the most important in Norway:

- VAT exemption
- Access to bus lanes
- Exemption from registration tax
- Free parking (at a limited number of places)
- Public charging stations
- Free toll roads
- Reduced annual vehicle license fee
- Reduced rates on ferries
- Financial support for charging stations.

Of these measures free toll roads, access to bus lanes and VAT exemption seems to be most important (Figenbaum and Kolbenstvedt 2013).

In Denmark the following incentives are in use:

- Thru a temporary law (always spanning a few years forward, and extended a few times since the first implementation), EVs are exempt from the general registration tax. This tax can span from 20.000 DKK. (3.000 €) for a small vehicle to more than a half million DKK. (70.000 €) for an expensive car, so this incentive is very significant for the high-end cars like a Tesla.
- Hybrid cars pay registration tax based on their expected fuel consumption, so the registration tax on hybrid cars will vary depending on the car. The

government claims to have plans for a general change in the registration tax setup in Denmark, but no details are certain.

- Some cities/counties have had free parking for EVs but found out it probably was not legal. Currently legalization thru national law is expected in late 2014, and several larger cities are expected to make use of it. Parking spaces with charging stations are for EVs only. At some places it is allowed to park for a longer time, if the area is normally time restricted. In the current situation with few EVs, this can be a nice advantage.

In Austria the following incentives are in use:

- EVs are excluded from the “Standard fuel consumption tax (NOVA)”. This is a tax, to be paid when a vehicle is registered in Austria for the first time, with a maximum rate of 16% of the net price.
- EVs are excluded from the monthly tax on motor vehicles, based on the engine power. The minimum tax rate for passenger cars is EUR 60,- per month.
- Many insurance companies offer a 10 – 20% discount on the monthly insurance premium.
- Some federal States offer financial subsidies for private passenger cars, up to EUR 3.000,-
- In some cities electric cars are exempted from parking fees.

1.4 Content of the report

Chapter two shows the car ownership in the three countries, and in chapter three we take a closer look at the length of the car trips. In chapter four the trips are analysed in connection, in trips chains. In addition the time, place and stop patterns of the chains are presented to examine to which degree there are possibilities for recharge when the trips length or the chain length exceeds the limits that are defined for the range of an EV, 120 km in the summer (April-September) and winter (October-March) seasons.

In chapter five a special analysis of attitudes towards EVs in Denmark is presented. Attitudinal questions were added to the ongoing Danish national travel survey and information from the survey about the respondents were connected with these additional questions.

In TØI report 1329/2014 *Electrical Vehicles – environmental, economic and practical aspects. As seen by current and potential users*, Norwegian data on attitudes toward EVs are presented. The authors are Erik Figenbaum, Marika Kolbenstvedt and Beate Elvebakk.

In chapter six long trips (100 km +) by car is analysed for Norway. The analysis is based on data from the Norwegian national travel survey.

In chapter seven the results from the preceding chapter is discussed. What can we say about the potential use of EVs based on these results?

2 Car ownership

The average number of cars per 1000 inhabitants is increasing in all three countries, but the level is highest in Austria and lowest in Denmark, Figure 2.1.

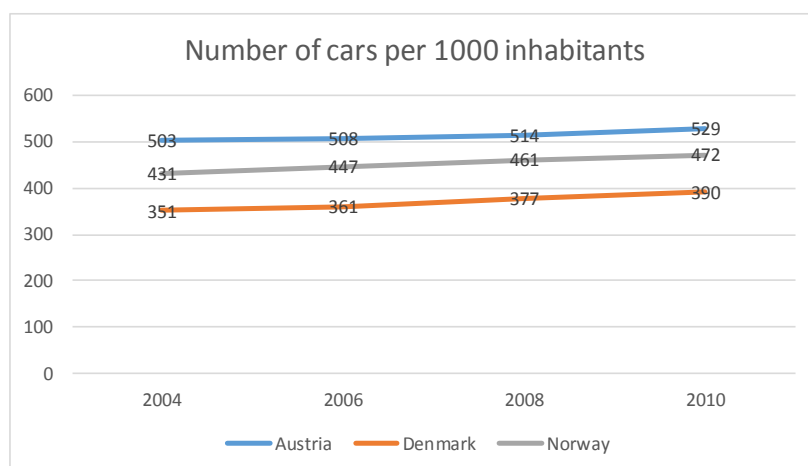


Figure 2.1 Number of passenger cars per 1000 inhabitants (Vågane 2013).

The number of cars per household in the three countries is shown in Table 2.

Table 2.1 Car per household in Austria, Denmark and Norway. Percent

Number of cars	Lower Austria 2003	Vorarlberg 2008	Denmark 2010-2013	Norway 2009
0 cars	5	7	17	15
1 car	49	62	51	43
2 cars	35	27	32 ¹	34
3 or more cars	11	4		8

Comparing these three countries we see that the Austrian areas have a higher level of multicar household than Denmark, but these areas are more rural than urban. The Austrian areas also have fewer household without a car than Denmark and Norway. Table 2.1 also show that the share of multicar household is lowest in Denmark.

¹ Two cars and more

Table 2.2 Number of cars in the household in Denmark (2010-2013) and Norway (2009) by gender, age, type of household and employment. Percent

	Number of cars in the household			Sum
	0 car	1 car	2 or more cars	
All Denmark	17	51	32	100
All Norway	15	43	42	100
<i>Gender Denmark</i>				
Male	15	51	34	100
Female	19	52	30	100
<i>Gender Norway</i>				
Male	11	43	46	100
female	19	43	39	100
<i>Age Denmark</i>				
18-24 yrs	35	34	31	100
25-34 yrs	28	46	25	100
35-44 yrs	11	48	41	100
45-54 yrs	10	48	43	100
55-66 yrs	11	59	30	100
67-84yrs	22	69	9	100
<i>Age Norway</i>				
18-24 yrs	32	28	30	100
25-34 yrs	21	43	36	100
35-44 yrs	6	42	52	100
45-54 yrs	6	38	56	100
55-66 yrs	7	49	43	100
67-74 yrs	13	66	20	100
75 + yrs	41	51	8	100
<i>Type of household Denmark</i>				
Single	50	44	6	100
Single with children	24	61	15	100
Couple	11	61	28	100
Couple with children	4	46	50	100
<i>Type of household Norway</i>				
Single	46	49	5	100
Single with children	13	67	21	100
Couple	9	52	39	100
Couple with children	2	34	64	100
<i>Employment Denmark</i>				
Full time	11	49	40	100
Part time	13	50	37	100
Not in paid work	23	54	23	100
<i>Employment Norway</i>				
Full time	13	42	45	100
Part time	16	36	47	100
Not in paid work	24	48	29	100

Even if the level of car ownership is higher in Norway than in Denmark the same tendencies are found in both countries, Table 2.2. Men have more cars than women. Those who belong to multicar households are in their middle ages, are couple with children and are employed full or part time.

Table 2.3 shows the differences related to income and place of living.

Table 2.3 Number of cars in the household in Denmark (2010-2013) and Norway (2009) by income and place of living. Percent

	Number of cars in the household			
	0 car	1 car	2 or more cars	Sum
<i>Own income DKK Denmark 1€=7.4 DKK</i>				
< kr 200 000	26	51	23	100
Kr 200 000-300.000	14	55	31	100
Kr 301.000-400.000	11	53	36	100
Kr 401.000-500.000	8	50	42	100
> Kr 500.000	5	44	51	100
<i>Own income NOK Norway 1€=7.9 NOK</i>				
< kr 100.000	21	34	44	100
Kr 100.000-199.999	30	46	24	100
Kr 200.000-299.999	15	49	35	100
Kr 300.000-399.999	9	46	45	100
Kr 400.000-499.999	7	45	49	100
Kr 500.000 og over	3	43	54	100
<i>City size Denmark</i>				
<i>Copenhagen (central)</i>				
> 50 000 inhab.	50	43	7	100
30-50 000 inhab.	22	55	23	100
20-30 000 inhab	17	56	27	100
10-20 000 inhab	16	61	23	100
2-10 000 inhab.	13	57	30	100
< 2000	8	56	36	100
5	51	44	100	
<i>Place of living Norway</i>				
Oslo	38	46	16	100
Surrounding municipality of Oslo	10	39	51	100
Bergen/Trondheim/Stavanger	19	49	32	100
Surrounding municipality of B/T/S	10	41	50	100
Next six cities	12	46	42	100
Smaller cities	10	45	45	100
Rest of the country	10	39	52	100

In general table 2.3 indicates a rather strong relationship between ownership of car and income in both countries. The table also shows that the car ownership is much lower in Copenhagen and Oslo than in the other parts of the countries. In Denmark the multicar households are increasing when the city size is decreasing. The Norwegian variable “place of living” is not the same as the Danish, but also here we see that multicar household are more typical outside the cities, in rural areas and small towns/villages.

3 Car trips

In this chapter we first take a closer look at the use of the car as a driver/chauffeur; what the car is used for, the purpose of the trips, if there is a difference in use in household with one car compared with households with two or more cars.

Table 3.1 Trips by car as a driver by purpose in household with one car and two or more cars in Norway, Denmark and Austria. Percent

Purpose	Norway		Denmark		Lower Austria 2003
	1 car	2 cars or more	1 car	2 cars or more	Car in the household
Work	17	24	21	29	24
School/education	0	0	1	2	11
Business	2	5	4	6	9
Shopping/service	34	28	45 ^c	39 ^c	17
Accompany	17	17			8
Leisure	11	11	29*	24*	22*
Visits	13	10			
Other	6	5			10
Sum	100	100	100	100	100

^c Including accompany trips

* Including visits

In Denmark and Norway shopping is the most frequent purpose of car trips, more so in single car households than in multicar households (In Denmark accompany trips are included in shopping/service). In Lower Austria work is the most frequent purpose. In both Denmark and Norway work is a more frequent purpose in multicar households than in single car households.

Table 3.2 Distance of car driver trips by place of living, household income, education, household, gender, employment, age, cars in household, purpose, season, Norway 2009. Percent and km.

	0-4.9 km	5-49 km	50-79 km	80-119 km	120 km +	Sum	Mean
Norway	47.0	47.8	2.6	1.3	1.4	100	13.6
<i>Place of living</i>							
Capital (Oslo)	46.0	50.2	1.3	0.9	1.7	100	12.6
Three next largest cities (Bergen, Trondheim and Stavanger)	45.4	52.0	0.8	1.0	0.9	100	10.5
Surrounding municipalities of Oslo, Bergen, Trondheim and Stavanger	43.5	52.1	2.7	0.6	1.1		13.7
Other cities	49.8	44.6	2.7	1.3	1.6	100	13.4
The rest of the country	46.6	46.7	3.2	2.1	1.4	100	15.0
<i>Household income</i>							
< NOK 200 000	50.6	44.7	3.0	0.6	1.2	100	12.0
NOK 200 000 - 399 999	46.4	49.4	2.0	1.0	1.2	100	13.0
NOK 400 000 - 599 999	46.5	47.8	3.1	1.3	1.2	100	13.8
NOK 600 000 - 799 999	46.0	48.6	2.6	1.6	1.2	100	13.5
NOK 800 000 - 999 999	47.8	47.4	2.3	1.1	1.4	100	13.3
NOK 1 000 000 +	46.7	46.4	3.0	1.8	2.1	100	15.7
<i>Education</i>							
Primary education	46.1	49.0	2.8	0.7	1.3	100	12.6
Secondary education	44.8	49.5	2.8	1.5	1.5	100	14.6
Higher education	49.0	46.0	2.3	1.3	1.3	100	12.9
<i>Type of household</i>							
Single	46.8	48.5	2.2	1.3	1.2	100	13.2
Single with children	49.7	46.6	2.1	0.6	0.9	100	11.2
Couple without children	45.2	48.1	3.1	1.5	2.0	100	15.5
Couple with children	48.9	46.6	2.3	1.1	1.0	100	12.4
Adults	42.4	51.3	2.8	1.7	1.8	100	15.2
<i>Gender</i>							
Man	43.4	49.9	3.2	1.7	1.9	100	15.9
Woman	52.1	44.8	1.6	0.8	0.7	100	10.2
<i>Employment</i>							
Fulltime	45.2	49.1	2.7	1.5	1.5	100	14.5
Part-time < 30 h/week	48.8	47.1	2.3	1.1	0.7	100	11.1
Not employed	52.6	43.1	2.2	0.8	1.3	100	11.5
<i>Age</i>							
18-24 years	40.1	54.6	3.1	1.1	1.1	100	14.5
25-34 years	46.6	47.6	2.7	1.9	1.2	100	14.4
35-44 years	49.1	46.4	2.2	1.1	1.2	100	12.6
45-54 years	44.9	49.7	2.5	1.4	1.4	100	13.9
55-66 years	47.5	46.5	2.7	1.2	2.1	100	14.6
67 years+	50.9	44.2	3.0	0.9	1.1	100	11.5
<i>Cars in the household</i>							
One	50.8	44.5	2.3	1.1	1.3	100	12.6
Two or more	44.2	50.1	2.8	1.5	1.4	100	14.4
<i>Purpose</i>							
Work	30.8	63.5	3.7	1.2	0.9	100	16.4
Education	41.5	54.2	0.8	3.2	0.4	100	13.2
Business travel	34.0	51.5	6.4	3.4	4.6	100	25.9
Shopping	58.2	39.1	1.4	0.8	0.6	100	8.8
Accompany	58.9	38.5	1.3	0.8	0.5	100	8.4
Leisure	41.5	50.4	3.4	2.0	2.8	100	18.2
<i>Season</i>							
Summer (April-Sept.)	46.1	48.8	2.5	1.3	1.3	100	13.7
Winter (Oct.-March)	49.0	45.6	2.5	1.3	1.5	100	13.0

Table 3.2 shows the distance of car driver trips by a range of background variables in Norway 2009. As the table indicates, about half of the car trips are shorter than 5 km and about the same is between 5 and 50 km. Only 5.3 percent are 50 km or longer. If we relate this to the critical range of an EV, we see that 2.7 percent of the car trips

are longer than 80 km (winter limit), and only 1.4 percent longer than 120 km (summer limit). This is the fact when we study the trips as single activities, not as part of activity patterns or a trip chain, as we will look closer at in the next chapter.

If we concentrate on the variations on these higher distances, the table reveals some differences:

- the longest trips are in smaller cities and sparsely populated areas
- people with the highest household income have a larger share of long trips
- couples without children have more longer car trips than other types of families
- men have more longer car trips than women
- full time workers have more longer car trips than part time workers and people not in the work force
- in households with two or more cars the car trips are longer than in households with one car
- Business and leisure trips have a larger share of trips longer than 80 km than other travel purposes.

The table also shows that there is small differences between summer and winter seasons. The tendency is that summer trips are a little longer.

Table 3.3 shows the distance of car driver trips in Denmark for the years 2010-2013. The average car driver trip is longer in Denmark than in Norway, 17.3 km compared to 13.6 km in Norway.

The characteristics of those who have longer trips are similar to those in Norway:

- They have high household income
- Are men
- Working full time
- Are on business trips

And there is a tendency that car driver trips are longer in the summer than in the winter.

Table 3.3 Distance of car driver trips by place of living, household income, education, household, gender, employment, age, cars in household, purpose, season Denmark 2010-2013. Average distance 17.3 km.

	< 5km	5-49 km	50-79 m	80-119 km	120 + km	Sum
<i>Denmark</i>	34.9	57.3	4.2	3.0	0.6	100
<i>City size</i>						
< 2.000 inhab.	25,0	67,1	4,7	2,7	0,5	100
2-10.000 inhab.	37,2	54,2	5,1	2,9	0,6	100
10-20.000 inhab.	45,2	47,5	3,3	3,3	0,7	100
20-30.000 inhab.	49,1	42,3	5,4	2,2	0,9	100
30-50.000 inhab.	42,5	49,7	3,9	3,4	0,6	100
> 50.000 inhab.	40,7	52,7	3,4	2,7	0,5	100
Copenhagen (central)	32,8	60,2	3,1	3,0	0,9	100
<i>Household income</i>						
< 200.000 kr.	41,3	52,9	3,0	2,2	0,6	100
201-300.000 kr.	38,0	56,8	2,9	2,0	0,4	100
301-400.000 kr.	36,3	57,4	3,7	2,4	0,3	100
401-500.000 kr.	34,6	57,9	4,1	3,0	0,4	100
501-600.000 kr.	34,4	58,8	3,6	2,8	0,4	100
601-700.000 kr.	33,6	59,1	4,5	2,3	0,4	100
701-800.000 kr.	34,6	55,7	5,0	3,7	1,0	100
801-900.000 kr.	36,0	55,0	5,1	3,4	0,5	100
901-1.000.000 kr.	35,5	54,2	4,7	4,5	1,0	100
> 1.000.000 kr.	33,7	55,6	5,0	4,7	0,9	100
<i>Education</i>						
Ground education	32,4	61,0	3,6	2,5	0,5	100
Short education	34,1	58,3	4,2	2,9	0,6	100
Higher education	36,7	55,1	4,3	3,2	0,7	100
<i>Type of household</i>						
Single	34,4	57,3	4,4	3,3	0,7	100
Single w. kids	37,7	55,8	3,3	2,4	0,7	100
Couple	33,2	58,7	4,1	3,2	0,7	100
Couple w. kids	35,9	56,6	4,2	2,8	0,5	100
<i>Gender</i>						
Men	31,4	58,8	5,0	3,9	0,9	100
Women	39,4	55,5	3,1	1,8	0,2	100
<i>Employment</i>						
Full time	32,8	58,4	4,7	3,4	0,7	100
Part time	36,5	58,9	2,5	1,8	0,3	100
Not working	39,9	54,4	3,1	2,1	0,4	100
<i>Age</i>						
18-24 years	29,7	63,3	4,3	2,2	0,5	100
25-34 years	34,4	57,1	4,9	3,1	0,5	100
35-44 years	36,8	55,7	4,0	2,9	0,6	100
45-54 years	33,0	59,1	4,3	3,1	0,5	100
55-66 years	32,2	59,0	4,4	3,6	0,9	100
> 66 years	44,0	50,8	2,7	2,2	0,4	100
<i>Cars in the household</i>						
1 car	38,6	54,5	3,6	2,8	0,6	100
> 1 car	30,8	60,6	4,8	3,2	0,6	100
<i>Trip purpose</i>						
Work	18,1	72,8	5,9	2,9	0,2	100
Education	19,9	71,4	6,2	2,5	0,1	100
Shopping	51,3	46,0	1,6	1,0	0,2	100
Leisure	28,8	60,1	5,2	4,8	1,1	100
Business	15,7	59,1	11,1	10,7	3,3	100
<i>Season</i>						
Winter	36,4	56,6	3,8	2,8	0,4	100
Summer	33,5	58,1	4,5	3,2	0,7	100

Unfortunately the same type of data is not found in Austria, but Table 3.4 gives an indication of the distribution of car trips. Like in Norway and Denmark a small share of the trips is longer than 50 km, in Austria respectively 6 percent and 2 percent in the two areas, in Norway 5.3 percent and Denmark 7.8 percent.

Table 3.4 Distance of car driver trips on workdays. Austria. Percent

Austria	< 0,5 km	0.5-1 km	1-2.5 km	2.5-5 km	5-10 km	10-20 km	20-50 km	>50 km
Lower Austria 2003	2	6	14	19	18	18	18	6
Vorarlberg 2008	2	6	13	26	22	17	12	2

Like in Norway and Denmark the average distance of car driver trips of women are shorter than those of men, Table 3.5. This is found in Austria as a whole in 1995 and in two areas in 2003 and 2008.

Table 3.5 Average distance of car driver trips by gender. Austria. Km

Gender	Austria 1995	Lower Austria 2003	Vorarlberg 2008
Female	7,1	12,1	7,7
Male	12	17,5	11,5

4 All trips are connected

The single trips should not be considered as isolated entities. The trips during the day adds up, and while a trip itself may be short, it could be part of a longer trip chain, with a possible need of recharging. A short chain might also be preceded by a long chain, with too little time between for recharging. We therefore go through all car trips during the day, and calculate whether charging is necessary and/or possible.

4.1 Car travel in total

In Norway one third of those with access to a car and driving license did not drive a car on the specified day, Table 4.1. In Denmark the share was 38 percent. In Norway nearly half of the respondents walked or cycled and around 20 percent used public transport and was passenger in a car. In household with one car a larger share was passengers and also used the public transport more than those in households with two or more cars. The same tendency is found in Denmark. The relatively high share of walking and cycling indicates that many trips are short.

Table 4.1: What persons who did not drive did on the specified day. Persons with car and driver's license Percent. Norway 2009. Denmark 2010-2013. (Sum can be more than 100)

	Did not travel at all	Walked/cycled	Used public transport	Was car passenger	Other
All Norway	33	46	17	22	2
All Denmark	38	39	9	20	7
<i>Cars in household:</i>					
One car Norway	32	50	21	30	2
One car Denmark	35	43	19	19	5
Two or more cars Norway	36	41	12	24	2
Two or more cars Denmark	45	27	7	22	10

Table 4.2 shows the total distance as a car driver in an average day. When we see all the drivers as a group as many as 88 percent have no need for recharging in an average day presuming that the car can drive up to 80 km in the winter, and 120 km in the summer before recharging. The average distance by car per day is 48.9 km.

Table 4.2 also shows some differences between groups. The differences are more or less the same as can be seen for the single car driver trips. The need of recharging during a day in Norway (within 120 km's range in the summer and 80 km in the winter) is highest:

- In small cities and sparsely populated areas
- Among those with highest household income
- Among men
- Among full time employed
- In household with two cars
- In the winter season

Table 4.3 shows the distribution of the total travel length by car in Denmark. As many as 80 percent have a daily travel length shorter than 80 km in total, and nearly 90 percent have a daily travel length shorter than 120 km. The results are almost similar in the two countries.

In Denmark the need of recharging during a day is found most often:

- In small cities, less than 10 000 inhabitants
- Among those with high household income
- Among those with high education
- More among men than women
- Among full time employed
- Among young- middle aged people
- More in household with two cars than in those with one car
- More in the winter season than in the summer

The need of recharging is found in almost the same groups in Denmark and in Norway.

Table 4.2 Total travel length by car as driver by place of living, household income, education, household, gender, employment, age, cars in household, season Norway 2009. Persons with car and driver's license who did drive. Percent.

	0,1-49 km	50-79 km	80-119 km	120 km +	Sum	Mean	Percentage who can travel without recharge	N (persons)
All car drivers	71	12	7	10	100	48,9	88	13 400
<i>Place of living</i>								
Capital (Oslo)	82.0	5.2	5.7	7.2	100	41.9	91	931
Three next largest cities (Bergen, Trondheim and Stavanger)	78.2	10.7	5.8	5.4	100	38.5	93	1364
Surrounding municipalities of Oslo, Bergen, Trondheim and Stavanger	66.5	14.0	10.4	9.0	100	50.6	87	2536
Other cities	72.7	11.1	6.3	9.9	100	48.6	88	4689
The rest of the country	65.9	13.2	8.5	12.3	100	53.4	85	3875
<i>Household income</i>								
< NOK 200 000	75.5	10.6	4.7	9.3	100	42.4	90	1305
NOK 200 000 - 399 999	72.9	11.7	7.7	7.7	100	43.7	90	1622
NOK 400 000 - 599 999	70.3	12.1	7.5	10.1	100	48.1	87	2181
NOK 600 000 - 799 999	68.6	12.6	8.0	10.8	100	50.9	87	2628
NOK 800 000 - 999 999	70.7	12.3	8.3	8.7	100	49.3	88	2190
NOK 1 000 000 +	65.5	12.5	9.1	12.9	100	59.9	84	2095
<i>Education</i>								
Ground school	73.2	10.9	7.3	8.6	100	44.4	89	1477
Short education	67.8	13.4	8.1	10.6	100	41.3	93	5726
Higher education	72.9	10.5	7.3	9.3	100	38.2	88	6152
<i>Type of household</i>								
Single	73.2	11.5	6.7	8.6	100	45.1	90	1840
Single with children	72.9	9.7	8.7	8.7	100	46.2	90	608
Couple without children	72.2	10.9	6.8	10.2	100	49.8	88	4035
Couple with children	69.5	12.5	8.5	9.6	100	49.2	88	5386
Adults	67.9	13.7	7.7	10.8	100	50.5	87	1450
<i>Gender</i>								
Man	65.2	13.0	9.2	12.6	100	57.6	85	7807
Woman	78.6	10.2	5.4	5.8	100	36.7	93	5588
<i>Employment</i>								
Fulltime	67.7	12.8	8.6	10.9	100	53.3	87	9027
Part-time < 30 h/week	74.3	12.5	6.4	6.9	100	41.3	91	1442
Not employed	79.1	8.4	5.0	7.5	100	38.2	91	2764
<i>Age</i>								
18-24 years	67.5	15.8	5.9	10.8	100	52.5	88	1031
25-34 years	65.4	14.3	8.4	11.9	100	54.2	86	2146
35-44 years	70.9	11.0	8.8	9.3	100	48.6	88	3359
45-54 years	68.9	12.7	8.2	10.3	100	51.3	87	2944
55-66 years	72.8	10.5	7.3	9.4	100	48.1	88	2532
67 years+	81.3	7.9	4.2	6.6	100	34.7	93	1383
<i>Cars in the household</i>								
One	75.9	10.0	6.2	7.9	100	42.3	90	5966
Two or more	66.6	13.3	8.8	11.2	100	53.9	86	7423
<i>Season</i>								
Summer	70.1	12.0	8.5	9.3	100	48.5	91	6321
Winter	72.0	11.4	6.6	10.0	100	48.3	84	5921

Table 4.3 Total travel length by car per day as car driver by place of living, household income, education, household, gender, employment, age, cars in household, purpose, season Denmark 2010-2013. Persons with car and driving licence. Percent

	< 50 km	50-79 km	80-119 m	120 + km	Sum	Percentage who can travel without recharge
<i>Denmark</i>	64.6	14.9	9.4	11.1	100	90,2
<i>City size</i>						
< 2.000 inhab.	59.8	17.7	11.2	11.4	100	89.3
2-10.000 inhab.	61.4	16.1	11.2	11.3	100	89.9
10-20.000 inhab.	64.0	16.7	8.2	11.0	100	91.0
20-30.000 inhab.	63.5	14.2	9.4	12.9	100	89.6
30-50.000 inhab.	65.3	13.9	9.8	11.0	100	90.6
> 50.000 inhab.	73.4	10.9	6.8	8.8	100	93.0
Copenhagen (central)	73.8	10.8	6.5	8.9	100	94.9
<i>Household income</i>						
< 200.000 kr.	75.6	11.3	6.0	7.1	100	94.3
201-300.000 kr.	73.8	12.6	7.2	6.4	100	94.8
301-400.000 kr.	68.6	14.7	8.4	8.4	100	92.2
401-500.000 kr.	66.5	14.1	9.0	10.4	100	90.9
501-600.000 kr.	63.8	15.6	9.9	10.6	100	89.9
601-700.000 kr.	61.5	17.1	10.6	10.7	100	89.8
701-800.000 kr.	60.1	14.6	11.3	14.0	100	87.4
801-900.000 kr.	61.2	14.5	10.9	13.4	100	88.0
901-1.000.000 kr.	57.4	15.9	10.4	16.3	100	85.6
> 1.000.000 kr.	54.0	16.9	11.3	17.8	100	83.6
<i>Education</i>						
Ground school	69.9	13.6	8.0	8.6	100	93.8
Short education	65.4	15.1	9.0	10.5	100	90.6
Higher education	61.9	15.2	10.3	12.6	100	89.2
<i>Type of household</i>						
Single	67.4	13.5	8.4	10.7	100	90.9
Single w. kids	61.4	16.1	11.1	11.4	100	88.4
Couple	67.3	13.9	8.5	10.3	100	92.3
Couple w. kids	62.0	16.0	10.2	11.8	100	88.9
<i>Gender</i>						
Men	61.2	14.8	10.0	14.0	100	87.4
Women	69.2	15.1	8.6	7.2	100	93.9
<i>Employment</i>						
Full time	60.3	16.2	10.4	13.1	100	95.0
Part time	68.0	15.2	8.9	7.9	100	92.8
Not working	74.1	11.8	7.1	7.0	100	87.7
<i>Age</i>						
18-24 years	63.3	17.8	10.1	8.7	100	92.8
25-34 years	61.0	15.9	10.7	12.4	100	88.3
35-44 years	60.6	16.7	10.3	12.4	100	87.9
45-54 years	62.6	16.0	9.6	11.7	100	89.0
55-66 years	66.9	12.9	8.5	11.6	100	91.2
> 66 years	77.7	9.7	6.6	6.0	100	96.0
<i>Cars in the household</i>						
1 car	69.3	13.2	8.0	9.5	100	92.9
> 1 car	59.0	17.0	11.0	13.0	100	86.7
<i>Season</i>					100	
Winter	66.2	14.7	9.1	10.0	100	88.4
Summer	63.0	15.2	9.7	12.1	100	92.7

4.2 Car based trip chains

In this report we define a trip chain as follows:

- A trip chain is a series of trips where the first one starts and the last trip ends at home.
- We only analyse chains where the car is used at one or more trips.
- Total travel distance is calculated as distance by car, and trips with other modes in between are ignored.
- If the respondent does not use the car on one or more of the trips in the chain, we assume the car is parked and that no other persons are using it.

Table 4.4 and Table 4.5 show the distribution of travel length for car based chains in Norway and Denmark. In both countries only a small percentage of the chains are longer than 80 km, in Norway 8 percent and in Denmark 14 percent. This indicates however that the car trip chains are somewhat longer in Denmark than in Norway. As few as 4 percent of the Norwegian car based trips chains are longer than 120 km, the corresponding number in Denmark is 8 percent.

In both countries work related trip chains are longer than the average trip chain. But also this type of car based chains is longer in Denmark than in Norway.

The tendency both in Norway and Denmark is that we find the shortest trips chains in the larger cities. The longest car based trip chains is found in households with high income (Denmark), among men, in households with two or more cars and during the summer season.

In general the patterns and the distribution in different socio-demographic groups are very similar in the two countries.

Table 4.4 Distance by car for car based trip chains by purpose, place of residence, household income, education, type of household, gender, employment, age, cars in the household and season. Norway 2009. Persons with car and driving licence. Percent

	< 50 km	50-79 km	80-119 km	120 km +	Sum	Mean	Percentage of chains that don't need recharge	N (chains)
All chains	85	7	4	4	100	28.0	95	16 888
<i>Work related trip chain</i>	76	10	8	5	100	37.6	92	5 194
<i>Place of living</i>								
Capital (Oslo)	93	2	3	3	100	22.3	96	380
Three next largest cities (Bergen, Trondheim and Stavanger)	92	5	2	1	100	20.5	98	3 032
Surrounding municipalities of Oslo, Bergen, Trondheim and Stavanger	82	9	6	3	100	29.4	95	2 037
Other cities	86	6	3	4	100	27.1	95	8 889
The rest of the country	81	8	5	6	100	31.9	93	2 550
<i>Household income</i>								
< NOK 200 000	87	6	3	4	100	25.3	96	1 517
NOK 200 000 - 399 999	86	8	4	3	100	25.8	96	1 966
NOK 400 000 - 599 999	83	7	5	4	100	28.1	94	2 867
NOK 600 000 - 799 999	84	7	4	5	100	28.6	94	3 544
NOK 800 000 - 999 999	86	6	4	3	100	26.3	95	2 846
NOK 1 000 000 +	83	8	4	5	100	32.3	94	2 631
<i>Education</i>								
Ground school	87	7	3	4	100	26.4	95	1 908
Short education	83	8	5	4	100	29.7	94	6 962
Higher education	86	6	4	4	100	26.8	95	7 973
<i>Type of household</i>								
Single	85	7	4	3	100	27.3	95	2 034
Single with children	87	6	3	4	100	27.0	95	819
Couple without children	85	7	4	4	100	28.9	95	5 526
Couple with children	85	7	4	4	100	26.7	95	6 816
Adults	82	8	6	5	100	31.9	93	1 629
<i>Gender</i>								
Man	82	8	5	5	100	32.1	93	9 867
Woman	89	6	3	2	100	22.1	97	7 021
<i>Employment</i>								
Fulltime	83	8	5	5	100	30.5	94	10 844
Part-time < 30 h/week	88	7	3	2	100	22.6	97	1 973
Not employed	90	5	3	3	100	22.2	96	3 902
<i>Age</i>								
18-24 years	83	7	5	4	100	30.8	94	902
25-34 years	81	9	5	5	100	30.2	94	1 826
35-44 years	86	6	4	4	100	27.0	95	4 200
45-54 years	84	8	4	4	100	28.8	95	3 925
55-66 years	85	6	4	4	100	29.1	94	3 942
67 years+	90	5	3	3	100	21.1	96	2 093
<i>Cars in the household</i>								
One	88	5	3	3	100	23.6	96	7 639
Two or more	82	8	5	5	100	31.2	94	9 248
<i>Season</i>								
Summer	84	8	5	4	100	28.0	97	9 929
Winter	86	6	4	4	100	27.6	93	5 321

Table 4.5 Distance by car for car based trip chains by place of living, household income, education, household, gender, employment, age, cars in household, purpose, season Denmark 2010-2013. Persons with car and driving licence. Percent

	< 50 km	50-79 km	80-119 m	120 + km	Sum	Percentage who can travel without recharge
<i>Denmark</i>	75	11	6	8	100	89,8
<i>Work related trip chain</i>	65	17	9	9	100	86,5
<i>City size</i>						
< 2.000 inhab.	73	12	7	8	100	88,9
2-10.000 inhab.	73	12	7	8	100	89,0
10-20.000 inhab.	75	12	6	8	100	89,6
20-30.000 inhab.	75	11	6	9	100	88,5
30-50.000 inhab.	75	11	7	7	100	89,3
> 50.000 inhab.	81	7	5	6	100	91,2
Copenhagen (central)	80	9	5	7	100	91,7
<i>Household income</i>						
< 200.000 kr.	82	8	5	5	100	92,7
201-300.000 kr.	82	9	5	5	100	93,2
301-400.000 kr.	78	11	6	6	100	91,6
401-500.000 kr.	76	10	6	7	100	89,9
501-600.000 kr.	75	12	6	7	100	90,3
601-700.000 kr.	75	12	6	7	100	89,5
701-800.000 kr.	74	10	7	10	100	87,2
801-900.000 kr.	73	11	6	9	100	88,4
901-1.000.000 kr.	72	11	7	11	100	86,6
> 1.000.000 kr.	68	12	8	12	100	84,0
<i>Education</i>						
Ground school	79	10	5	6	100	92,2
Short education	76	11	6	7	100	89,8
Higher education	74	11	7	8	100	88,2
<i>Type of household</i>						
Single	75	11	6	8	100	89,3
Single w. kids	75	12	6	7	100	89,9
Couple	75	11	6	8	100	89,6
Couple w. kids	76	11	6	8	100	89,5
<i>Gender</i>						
Men	72	11	7	10	100	86,9
Women	79	11	5	5	100	92,9
<i>Employment</i>						
Full time	73	12	7	9	100	93,1
Part time < 30 hours	80	11	5	5	100	92,7
Not working	82	8	5	5	100	87,8
<i>Age</i>						
18-24 years	74	14	6	6	100	91,6
25-34 years	73	12	7	8	100	88,0
35-44 years	75	11	6	8	100	89,3
45-54 years	75	11	6	8	100	89,0
55-66 years	75	10	6	9	100	88,6
> 66 years	83	7	5	5	100	93,3
<i>Cars in the household</i>						
1 car	78	10	5	7	100	90,8
> 1 car	72	12	7	8	100	88,0
<i>Season</i>						
Winter	77	10	6	7	100	87,3
Summer	74	11	6	8	100	91,7

4.3 Trips, chains and daily car travel that are longer than range

In this section we present an overview of the percentage of trips, trip chains and days over the limit, and corresponding number of days that are over the limits that are set for the use of EVs, 120 km in summer and 80 km in the winter season.

In Table 4.6 and Table 4.7 these results are presented for Norway and Denmark. In Norway the percentage of trips over the limit is four, in Denmark five. The average number of days with too long trips is 16 in Norway and 18 in Denmark. The percentage of chains over the limit is six in Norway and 14 in Denmark, and the corresponding days are 23 and 50 respectively. The percentage in all (both trips and chains) over the limit is 12 in Norway and 16 in Denmark. In total there are 43 days which exceed the limits in Norway and 57 days in Denmark. On these days it is necessary to recharge in order to use an EV.

The distribution of high average number of days over the limit is almost the same in the two countries, even if the number of days is higher in Denmark than in Norway. The high number of days that exceeds the limit is more common in small towns and sparsely populated areas, among people with high income, in households with children, among people working full time, men, young people, in household with more than one car and in the winter season.

In the next section we will take a closer look at the “stop pattern” – whether the drivers have stops during the day that can make recharging possible if the conditions are suitable.

Table 4.6 Trips and chains longer than limit and days over the limit by place of residence, household income, education, type of household, gender, employment, age, cars in the household and season. Norway 2009. Persons with car and driving license who drove a car on the registration day. Percent.

	Percentage with trip(s) over limit	Average # days with trips over the limit	Percentage with chain(s) over limit	Average # days with chains over the limit	Percentage with day(s) over limit	Average # days over the limit	N (persons)
Norway	4	16	6	23	12	43	13695
<i>Place of living</i>							
Capital (Oslo)	4	15	4	16	8	30	333
Three next largest cities (Bergen, Trondheim and Stavanger)	3	12	2	7	7	26	2535
Surrounding municipalities of Oslo, Bergen, Trondheim and Stavanger	4	15	6	23	12	43	1675
Other cities	5	17	6	22	11	41	7098
The rest of the country	5	18	9	33	14	52	2054
<i>Household income</i>							
< NOK 200 000	3	10	5	18	9	33	1285
NOK 200 000 - 399 999	4	16	4	15	10	35	1679
NOK 400 000 - 599 999	4	15	7	26	13	46	2318
NOK 600 000 - 799 999	5	18	8	28	12	44	2755
NOK 800 000 - 999 999	5	17	6	23	11	42	2213
NOK 1 000 000 +	6	22	8	28	15	56	2100
<i>Education</i>							
Ground school	4	15	6	22	10	38	1594
Short education	5	17	7	25	13	46	5631
Higher education	4	16	6	22	11	40	6423
<i>Type of household</i>							
Single	4	15	5	18	10	38	1869
Single with children	3	11	7	25	11	38	613
Couple without children	6	20	6	23	12	43	4741
Couple with children	4	13	7	24	12	43	4974
Adults	5	17	8	28	13	47	1444
<i>Gender</i>							
Man	6	22	8	31	15	54	7979
Woman	2	8	4	13	7	26	5716
<i>Employment</i>							
Fulltime	5	18	7	27	13	47	8808
Part-time < 30 h/week	2	9	4	16	9	31	1522
Not employed	4	13	4	16	9	33	3231
<i>Age</i>							
18-24 years	4	13	6	22	11	40	767
25-34 years	5	20	7	25	13	49	1532
35-44 years	4	13	6	23	11	41	3124
45-54 years	5	18	7	26	13	47	3119
55-66 years	5	20	7	25	12	42	3365
67 years+	3	11	4	14	8	28	1788
<i>Cars in the household</i>							
One	4	15	4	16	9	34	6401
Two or more	5	17	8	29	14	50	7290
<i>Season</i>							
Summer (April-Sept.)	3	12	4	15	8	31	8127
Winter (Oct.-March)	6	21	9	34	15	56	4164

Table 4.7 Trips and chains longer than limit and days over the limit by place of residence, household income, education, type of household, gender, employment, age, cars in the household and season. Denmark 2010-2013. Persons with car and driving license who drove a car on the registration day. Percent.

	Percentage with trip(s) over limit	Average # days with trips over the limit	Percentage with chain(s) over limit	Average # days with chains over the limit	Percentage with day(s) over limit	Average # days over the limit)
<i>Denmark</i>	5.0	18	13.8	50	15.6	57	
<i>City size</i>							
< 2.000 inhab.	4.6	17	14.5	53	16.8	62	
2-10.000 inhab.	4.9	18	14.4	53	16.3	60	
10-20.000 inhab.	5.7	21	13.9	51	15.2	56	
20-30.000 inhab.	5.9	22	15.6	57	17.5	64	
30-50.000 inhab.	4.5	16	14.0	51	15.6	57	
> 50.000 inhab.	4.8	18	11.3	41	12.1	44	
Copenhagen (central)	5.1	19	10.1	37	11.1	41	
<i>Household income</i>							
< 200.000 kr.	3.7	14	9.1	33	10.3	38	
201-300.000 kr.	3.3	12	8.6	31	9.8	36	
301-400.000 kr.	3.4	13	11.0	40	12.6	46	
401-500.000 kr.	3.9	14	13.2	48	14.8	54	
501-600.000 kr.	4.7	17	13.1	48	15.4	56	
601-700.000 kr.	4.7	17	14.1	51	16.0	59	
701-800.000 kr.	6.7	25	17.3	63	19.1	70	
801-900.000 kr.	5.8	21	15.6	57	18.3	67	
901-1.000.000 kr.	8.6	31	18.4	67	21.3	78	
> 1.000.000 kr.	8.0	29	21.7	79	23.8	87	
<i>Education</i>							
Ground school	3.3	12	10.0	37	11.8	43	
Short education	4.8	17	13.2	48	15.1	55	
Higher education	5.8	21	15.7	57	17.6	64	
<i>Type of household</i>							
Single	4.9	18	13.2	48	14.6	53	
Single w. kids	5.5	20	14.2	52	17.0	62	
Couple	5.2	19	12.9	47	14.1	52	
Couple w. kids	4.7	17	14.6	53	17.0	62	
<i>Gender</i>							
Men	6.7	25	17.0	62	19.0	69	
Women	2.7	10	9.5	35	11.1	41	
<i>Employment</i>							
Unemployed	3.3	12	8.8	32	10.1	37	
Part time < 30 hours	2.6	10	9.9	36	12.0	44	
Full time	5.8	21	16.2	59	18.2	67	
<i>Age</i>							
18-24 years	3.0	11	11.0	40	13.4	49	
25-34 years	5.4	20	15.8	58	18.2	67	
35-44 years	5.4	20	14.8	54	17.4	63	
45-54 years	5.0	18	14.8	54	16.6	60	
55-66 years	5.8	21	14.2	52	15.6	57	
> 66 years	3.4	12	8.0	29	8.6	31	
<i>Cars in the household</i>							
1 car	4.7	17	11.8	43	13.2	48	
> 1 car	5.3	20	16.2	59	18.6	68	
<i>Season</i>							
Winter	5.8	21	16.7	61	19.1	70	
Summer	4.1	15	10.9	40	12.1	44	

4.4 Stop pattern

Recharging can be done during the day if the stops are long enough and the conditions are suitable, which means access to at least ordinary electric contacts for normal charging.

To get an indication of the potential for recharging time we have run through all car trips and counted the number of stops during a day that are between one and five hours and stops that are more than five hours. Five hours should be enough to fully charge the car, while one hour makes it possible to charge a bit to be prepared for later trips, as we cannot assume that people charge the car only when the battery is nearly empty. In addition there are possibilities for fast charging, but in 2013 the number of such charging stations were limited, especially outside the cities (Figenbaum and Kolbenstvedt 2013), but the number is increasing. By September 2014 the total number of charging stations in Norway are 1485 with 5484 charging points (El-bilforeningen). It should however be noted that EVs are capable of being recharged from every household power outlet outside buildings, in garages, and in parking lots. This means that the possibility of charging on the go is much larger than the number of the number of public charging stations indicates.

Table 4.8 Percentage who has stops 1-5 hours on different locations by total car travel and day of travel . Persons with car and driving license. Norway 2009. Percent

	Place	At home ²	At work ³	Other places	Mean # car trips ⁴	N (persons)
Any day	All	22	7	43	3,55	12 448
	<i>Daily car travel</i>					
	0-79 km	21	6	41	3,44	10 404
	80-119 km	29	7	50	4,13	910
	120 km +	24	10	58	4,07	1 134
Monday-Thursday	<i>Daily car travel</i>					
	0-79 km	23	7	40	3,60	6 214
	80-119 km	32	10	50	4,45	574
	120 km +	27	13	63	4,51	636
Saturday-Sunday	<i>Daily car travel</i>					
	0-79 km	17	3	46	2,91	2 540
	80-119 km	22	2	57	3,36	213
	120 km +	14	2	51	3,00	315

Of the relatively few car drivers in Norway (about 16 percent) who travel more than 80 km per day, between 24 percent (120 km+) and 29 percent (80 – 119 km) stop at home between 1-5 hours during the day, and if the conditions are suitable they have the possibility to recharge at home (from one to five hours, Table 4.8). In addition about 10 percent can park at a designated parking area, and have a potential for recharging at the parking lot. The percentages are lower in the weekend than during the week (Monday to Thursday).

About 50-60 percent has stops 1-5 hours at other places (which we do not have information on).

² Not included the time before the first and after the last trip.

³ Only if employer has designated parking area.

⁴ # car trips – 1 = # stops

Table 4.9 Percentage who has stops 1-5 hours on different locations by total car travel and day of travel. Persons with car and driving license. Denmark 2010-2013. Percent

	Place	At home ⁵	At work ⁶	Other places
Any day	All	22	7	40
	<i>Daily car travel</i>			
	50-79 km	23	7	40
	80-119 km	25	8	41
	120 km +	19	8	40
Monday-Thursday	All			
	<i>Daily car travel</i>			
	50-79 km	22	7	37
	80-119 km	26	8	41
	120 km +	19	9	38
Saturday-Sunday	All			
	<i>Daily car travel</i>			
	50-79 km	24	3	50
	80-119 km	21	4	43
	120 km +	15	1	45

Table 4.9 shows the percentages who have stops between 1-5 hours in Denmark. The percentages who have stops at home are somewhat lower in Denmark than in Norway. Concerning stops at work the share is almost the same.

Table 4.10 Percentage who has stops >5 hours on different locations by total car travel and day of travel. Persons with car and driving license. Norway 2009. Percent

	Place	At home ⁷	At work ⁸	Other places	Mean # car trips ⁹	N (persons)
Any day	All	5	24	8	3,55	12 448
	<i>Daily car travel</i>					
	0-79 km	5	25	7	3,44	10 404
	80-119 km	3	30	13	4,13	910
	120 km +	2	14	12	4,07	1 134
Monday-Thursday	All					
	<i>Daily car travel</i>					
	0-79 km	6	32	8	3,60	6 214
	80-119 km	4	38	9	4,45	574
	120 km +	3	20	10	4,51	636
Saturday-Sunday	All					
	<i>Daily car travel</i>					
	0-79 km	4	5	6	2,91	2 540
	80-119 km	2	6	12	3,36	213
	120 km +	1	0	17	3,00	315

Table 4.10 shows the percentages that have longer than 5 hours stops at different locations in Norway. For those travelling 120 km or longer during the day in the

⁵ Not included the time before the first and after the last trip.

⁶ Only if employer has designated parking area (only in Norway).

⁷ Not included the time before the first and after the last trip.

⁸ Only if employer has designated parking area.

⁹ # car trips – 1 = # stops

weekday, 20 percent have this long stop at work, while among those travelling 80-119 km nearly 40 percent have this long stop at work, and a potential for recharging.

Such long stops are rare at the home location.

Table 4.11 gives the same information for Denmark. The results are almost similar.

Table 4.11 Percentage who has stops >5 hours on different locations by total car travel and day of travel. Persons with car and driving license. Denmark 2010-2013. Percent.

	Place	At home ¹⁰	At work ¹¹	Other places
All		5	37	15
Any day	<i>Daily car travel</i>			
	50-79 km	6	42	11
	80-119 km	4	40	16
	120 km +	4	28	18
Monday-Thursday	<i>Daily car travel</i>			
	50-79 km	5	53	11
	80-119 km	3	49	16
	120 km +	4	34	17
Saturday-Sunday	<i>Daily car travel</i>			
	50-79 km	8	8	17
	80-119 km	5	8	20
	120 km +	3	4	25

The analysis of stop patterns indicates that for the stops shorter than five hours “other places” are most typical. It might be everything from a shop to children’s leisure activities, and probably not suitable for recharging, at least there is no knowledge about it. But we also see that about on fifth of these persons stop at home, where the possibility for recharging is present.

On the weekdays every fourth of those who have the longer stops of more than five hours take place at work. In this case only those who have a designated parking area controlled by the employer are selected (only in Norway). In these areas recharging might be possibly or devices for recharging would not be difficult to install.

¹⁰ Not included the time before the first and after the last trip.

¹¹ Only if employer has designated parking area (only in Norway).

5 Attitudes towards electric cars in Denmark

5.1 Additional questions to the national Danish Travel Survey

The Danish Travel Survey takes place each year, with interviews being made thru out the span of the year. As a part of the project, a few special questions regarding electric cars were added. This is a very cheap and convenient way to gather a relatively large amount of data. For some preparation and a few marginal seconds of interview time, we got the process of selection and contact with the interview targets, plus a wide array of background information about them, handed to us. But the method also has some restrictions. As the standard Survey already contains quite many questions, it is only possible to add a few extra questions – and only relatively simple questions.

The EV questions were a part of the survey between April 2013 and December 2013. Only people with driver license answered the dedicated EV questions, resulting in 5152 completed interviews. A few of the questions are further restricted to people having access to car(s).

To fully understand some of the results, it is probably an advantage to describe the situation in Denmark in 2013:

- Electric cars had a very small market share in Denmark, and were to a large extent still viewed as a novelty.
- Denmark was a testing ground for the “Better Place” concept (battery swap stations), which had dominated a large part of the publicity regarding electric cars in Denmark. Better Place went bankrupt in the spring 2013, leaving some Renault Fluence owners without the battery swap option, and perhaps damaging the public image of electric cars.
- The recharge infrastructure was relatively undeveloped

Both the infrastructure and the general market has picked up pace since then.

5.2 Main findings

It is very clear from the results, that electric cars had not made a big impact in Denmark in 2013, neither in the market nor in people’s minds. The knowledge about electric cars for the potential buyers is generally lacking, and this to an extent where many people seem to judge them as something that has not matured to a level where it is worth considering yet. The results of the survey should be seen in this light; many of the answers probably reflect a gut feeling or general attitude more than a well-considered answer based on facts.

To illustrate this, Figure 5.1 and Figure 5.2 show the level of knowledge about electric cars and the general attitude about/towards electric cars:

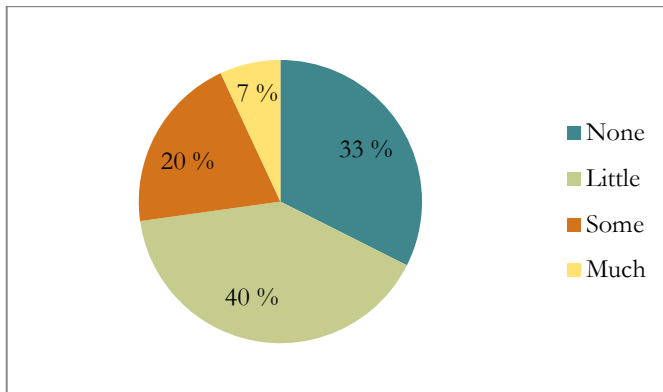


Figure 5.1 “How much do you know about electric cars”. Denmark 2013. Percent

Almost 75 percent of the people have little or none knowledge about electric cars. Only 7 percent claim to know much. This seems to be lower compared to Norwegian respondents (Figenbaum forthcoming). Earlier studies have found a positive relation between knowledge of EVs and the interest to purchase a vehicle (Hjorthol 2013) – also as seen later in figure 5.8.

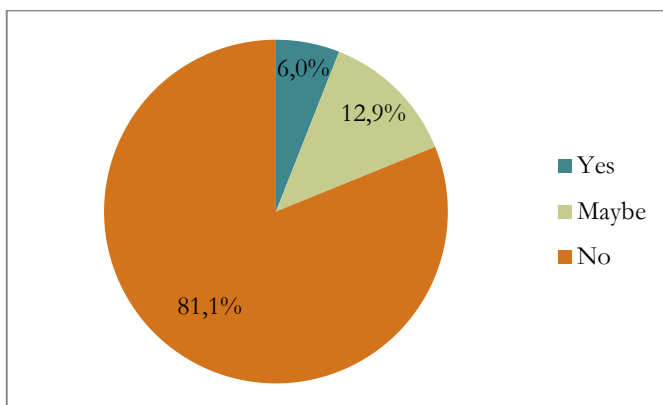


Figure 5.2 “Would you consider buying an electric car?” Denmark 2013. Percent

Only about 6 percent of the potential buyers would consider an electric car for sure at the moment. Not looking too optimistic at all regarding an increase in the electrification of the vehicle fleet.

Analysing the result of the survey, two quite different groups stand out as potential buyers.

One has these general characteristics:

- Middle aged
- High income
- Well educated
- Pretty good knowledge about electric cars
- Access to more than one car
- Have good parking and recharge facilities at home
- Not necessarily few long trips.
- Concerned about the environment

While number of long trips matter, it is no deal breaker – perhaps because they have a second car. It is possible that they have their eyes on a high-end electric car (Tesla), where the registration tax exempt in Denmark matters the most.

The other type of potential buyer is quite different:

- Young(ish)
- Relatively low income
- Have no access to a car, or maybe just one car.
- Live in a big city
- Have relatively bad parking/recharge facilities at home
- Relatively little knowledge about electric cars
- Few long trips
- Concerned about the environment

Except for the fact that they have a low travel demand, and the environmental difference has more impact in big cities, this is perhaps a bit surprising concerning the practicalities. It could be said that young people are generally known to be more idealistic, and they do (more) often give the environment as a reason to be in favour. The reason why having trouble recharging the car at home does not seem to have an impact on the attitude, could be because they have not considered the problem all the way thru. Another explanation could be, that they expect the cars and the infrastructure to develop, before the time they consider (or can afford) buying a car. It is also possible that they see themselves in another position in life (like living somewhere else and shifting from studies to a well-paid job) before a purchase is relevant.

The biggest surprise among the results of the survey is perhaps that problems with recharging at home do not have more of an impact. Whether this would hold water upon further inquiries is perhaps doubtful, but it does show a potential for alternative solutions, like a solid network of fast charging stations.

5.3 Selected results from the relevant questions

5.3.1 How much do you know about electric cars?

This question was included, because of the notion that people probably had quite poor knowledge about electric cars, and because of that would have difficulty relating to some of the rest of the questions. That notion probably had some merit. The general result shown in Figure 5.1 shows a rather low level of knowledge.

When looking at the distribution of knowledge in different groups of the population the analysis shows that:

- Men say they know more than women
- Middle aged know more than other age groups
- People with high income have a higher level of knowledge than those with lower income

There are also some tendencies regarding the impact of other variables, see Figures 5.3-5.7.

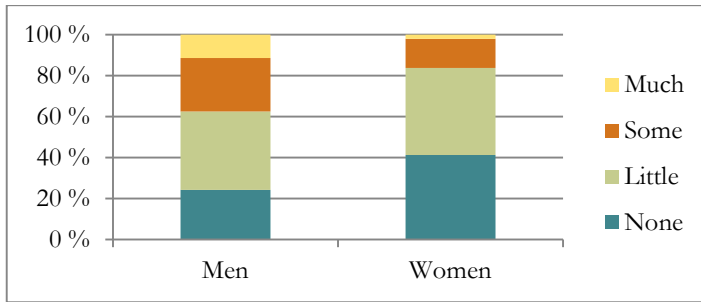
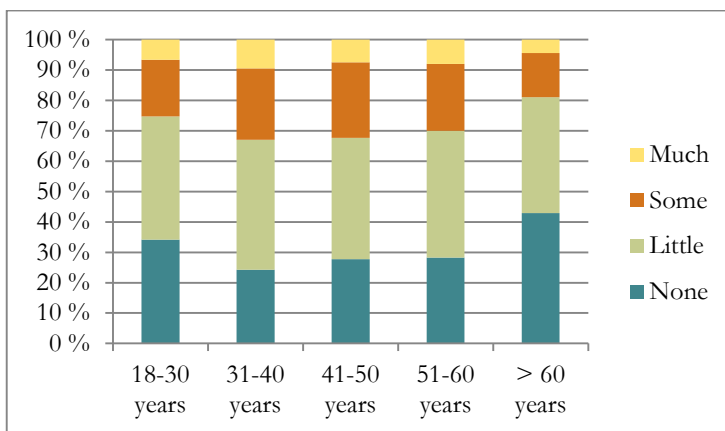


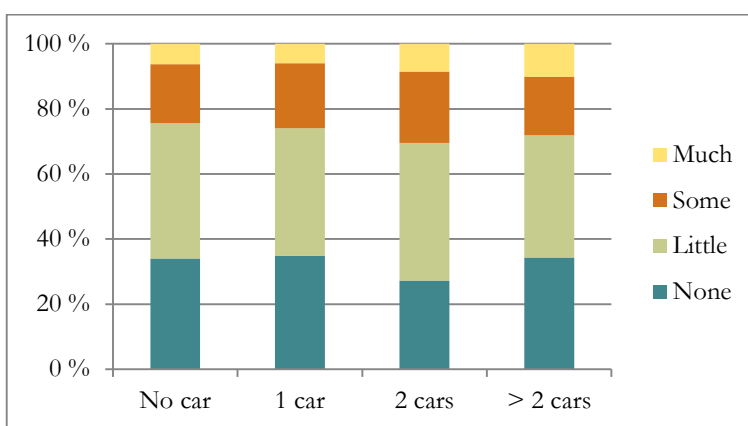
Figure 5.3 “How much do you know about electric cars” by gender. Denmark 2013. Percent

Men rate their knowledge about electric cars quite a lot higher than women, Figure 5.3. Perhaps not so surprising since men are probably more interested in cars generally.



5.4 “How much do you know about electric cars” by age. Denmark 2013. Percent

People over 60 years, and young people, are generally less informed (or perhaps less interested) in this new possibility than the people in other age groups, Figure 5.4.



5.5 “How much do you know about electric cars” by car availability. Denmark 2013. Percent

There is a small tendency that people with (more) cars know more about electric cars – but the difference is perhaps less than could be expected, Figure 5.5. The difference between people without car and with one car is marginal.

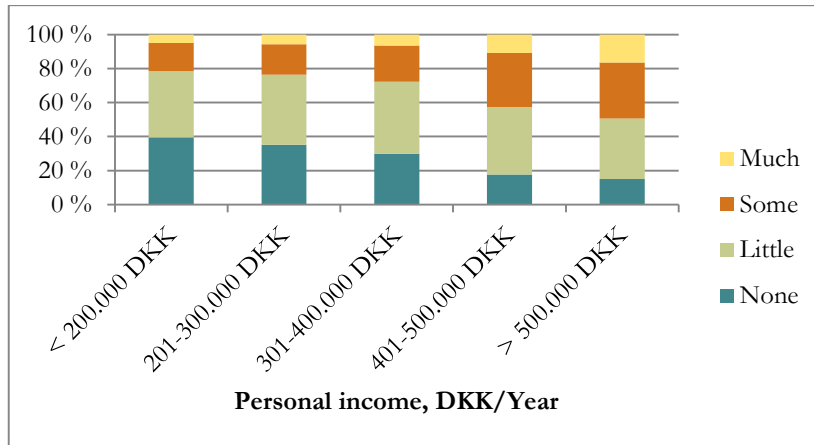


Figure 5.6 “How much do you know about electric cars” by personal income. Denmark 2013. Percent

The connection between personal income and (claimed) electric car knowledge is very clear – the more you earn, the more you know, Figure 5.6.

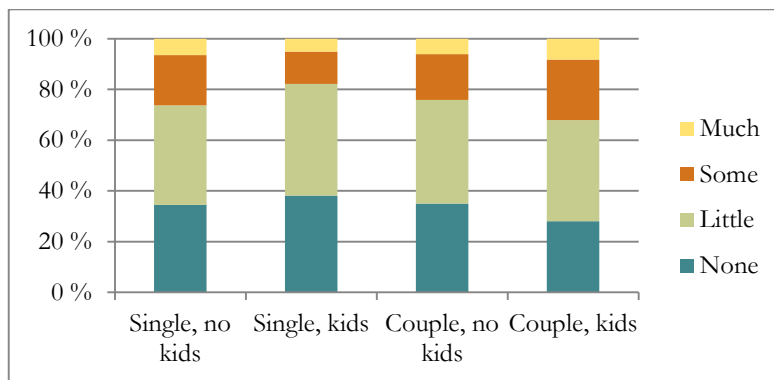


Figure 5.7 “How much do you know about electric cars” by type of family. Denmark 2013. Percent

Most knowledge is held by single people without children and couples with children, so both ends of that spectre, Figure 5.7. The difference in family-types is probably skewed in regard to other characteristics, like gender and age.

5.3.2 Would you consider buying an electric car?

The purpose of this question was trying to take the temperature on the general attitude towards electric cars. The general result in Figure 5.2 shows that a large majority of the population, 81 percent, would not consider buying an electric car at the moment. Analysis indicates that:

- There is a positive relation between considering to buy an electric vehicle and level of knowledge
- Men are a little more positive than women
- Young people, under 30 years are most positive, also when controlled for income and knowledge
- People without a car are more positive than those with a car
- People living in central Copenhagen are most positive
- Income and type of family show little impact

The results are showed in Figures 5.8 – 5. 16.

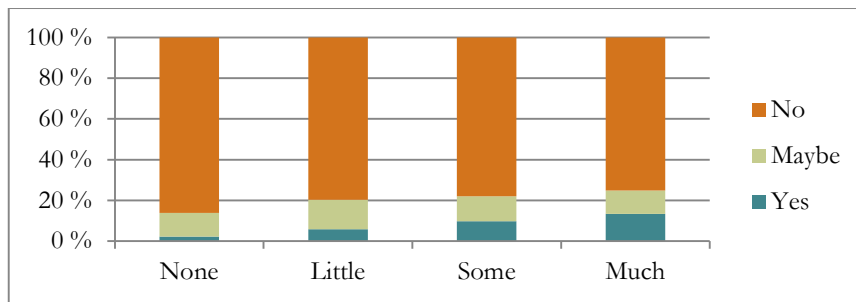


Figure 5.8 "Would you consider buying an electric car?" by knowledge about electric cars. Denmark 2013. Percent

The more likely you are to buy an electric car, the more you information you seek, Figure 5.8. Or is it the other way round? Only a very few people with no knowledge, would absolutely consider it.

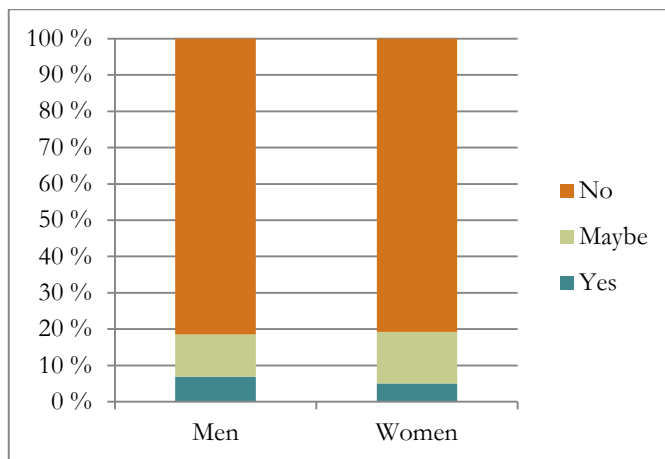


Figure 5.9 "Would you consider buying an electric car?" by gender. Denmark 2013. Percent

There is only a small difference between the genders, but men are a little more positive, Figure 5.9. A possible explanation, supported by findings later in this chapter, could be that although women are more environmental friendly in general, they are also more uncertain about what they might be getting into. Of the men who says yes, 60 percent claim to know much or some, for women the share is only 30 percent (not shown in the chart).

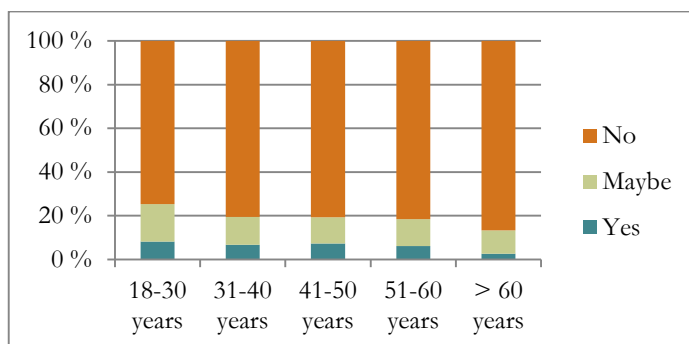


Figure 5.10 "Would you consider buying an electric car?" by age. Denmark 2013. Percent

People below the age of 30 are the most positive, while people over 60 years are the most negative, Figure 5.10.

The two next figures, 5.11 and 5.12, illustrate the impact of knowledge and income in different age groups among those who are positive to purchase an electric car.

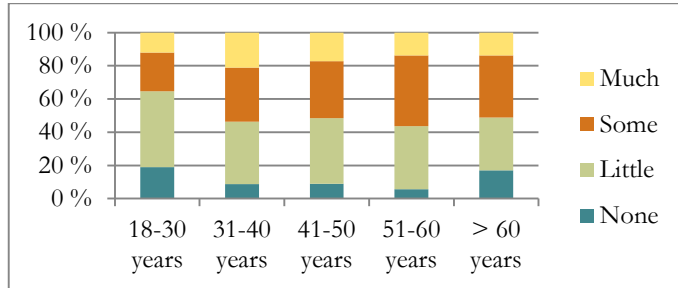


Figure 5.11 Knowledge of electric cars in different age groups among those who give a positive answer to the question - "Would you consider buying an electric car?" Denmark 2013. Percent

Of those who would consider buying an electric car, people below 30 years of age are most likely to do so with lacking knowledge, Figure 5.11. Second in line are the people over 60 years.

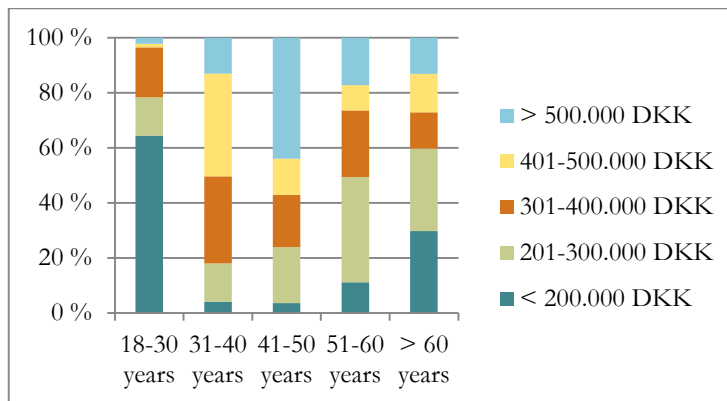


Figure 5.12 the distribution of income in different age groups among those who give a positive answer to the question - "Would you consider buying an electric car?" Denmark 2013. Percent

Again analysing the positive segment, people below 30 are likely to be positive, even if they have low income, Figure 5.12.

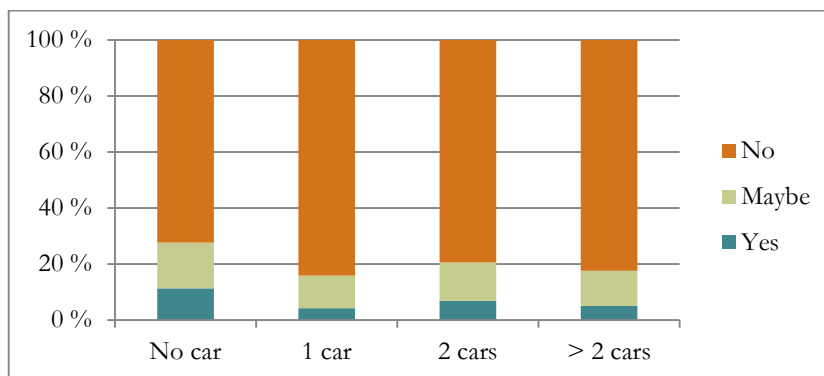


Figure 5.13 "Would you consider buying an electric car?" by car availability. Denmark 2013. Percent

People with no car are most positive by quite a lead, Figure 5.13. It is probably to some extent connected to other variables like age, but also perhaps because of the

reasoning, that if they can manage without a car, they can manage their travelling needs with an electric car.

People are only a little more positive if they have two or more cars, than if they have only one car. A larger difference was expected here, because of the option to use the other car for those occasions/trip-chains where the electric car is problematic.

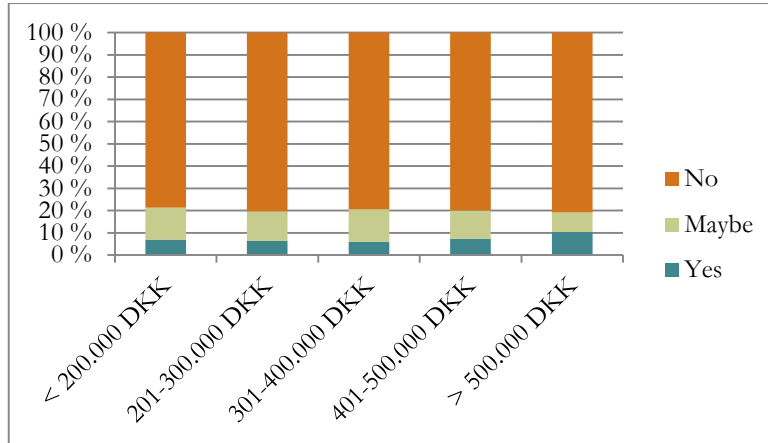


Figure 5.14 "Would you consider buying an electric car?" by personal income. Denmark 2013. Percent

People with income higher than 500.000 kr. a year are most positive, but the differences are rather small, Figure 5.14. About 80 percent would not consider the purchase, regardless of income.

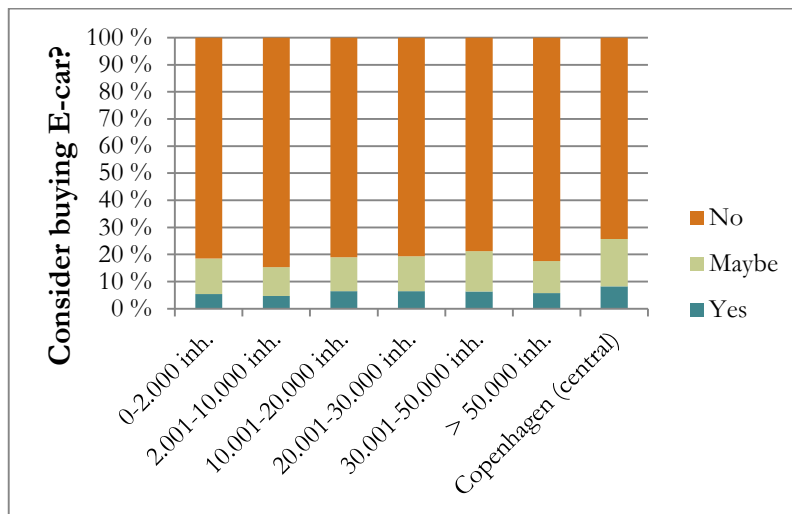


Figure 5.15 "Would you consider buying an electric car?" by size of city. Denmark 2013. Percent

A slight increase in attitude, the bigger the city you live in, can be observed. The difference is relatively small, Figure 5.15. People living in central Copenhagen are the most positive – in spite of for example a general lack of possibility to recharge at home (see later).

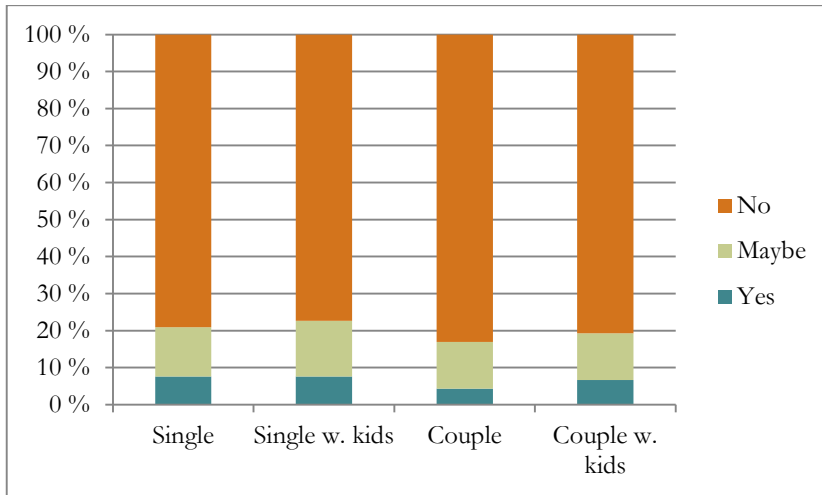


Figure 5.16 "Would you consider buying an electric car?" by type of family. Denmark 2013. Percent

Family type does not have much of an impact on the attitude, Figure 5.16. Couples without kids are the most negative.

5.3.3 Does this electric car suit your travel needs?

This question was an attempt to analyse the impact of the problems regarding range and the recharge time of an electric car, presenting the interviewed with the following three types of electric car situations:

- 1: Only charge at home, charge time 8 hours, range 100 km
- 2: Only charge at home, charge time 4 hours, range 130 km
- 3: Charge possible within 10 minute walk from any destination, charge time 4 hours, range 130 km

The overall results are illustrated in figure 5.17.

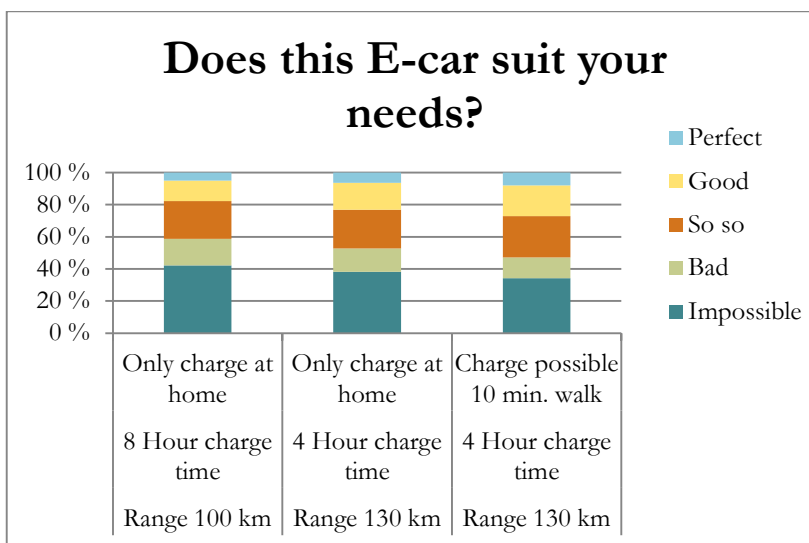


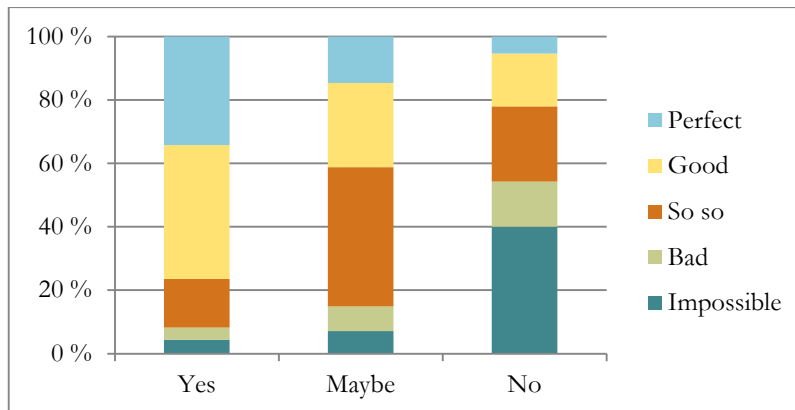
Figure 5.17 "Does this E-car suit your needs. Denmark 2013. Percent

Around 50 percent does not think that any of the presented possibilities would suit their travelling needs reasonably well. The difference between the result for the three

choices is quite small, suggesting that perhaps the question was ill suited for the setting (quick answers), or perhaps that range and recharge are not the deciding factors. It seems likely that some of the general attitude towards electric cars has played a role in some of the answers – more than just travel needs.

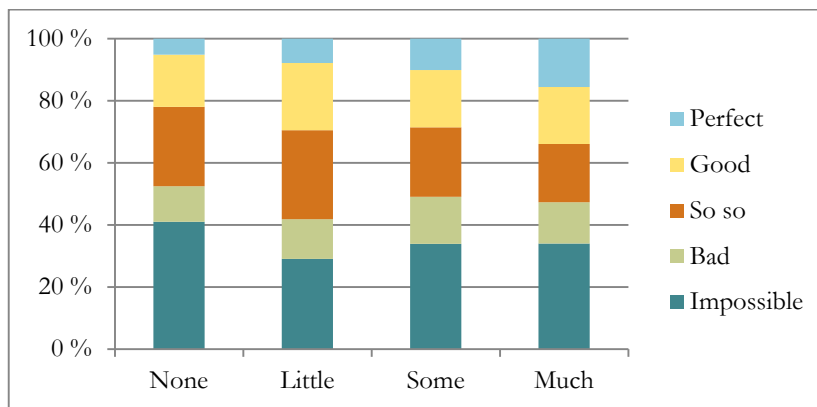
Outspread possibility to perform a “quick-charge” could of course make the question more or less void in the future, but it is unlikely that more than a few of the interviewed people would think of this.

The following analyses of the question will only show the answers regarding the most flexible car type presented (the last).



5.18 Car situation: Charge possible 10 min. walk, 4 h. charging time, range 130 km by considering buying an e-car.. Denmark 2013. Percent

The connection between liking the performance of the presented car situation, and the attitude regarding buying a real one, is very clear, Figure 5.18.



5.19 Car situation: Charge possible 10 min. walk, 4 h. charging time, range 130 km by knowledge of e-cars. Denmark 2013. Percent

The better the car suit you, the more you know – seems to be the likely explanation between this connection. With perhaps a hint of more general goodwill towards electric cars playing a role, Figure 5.19.

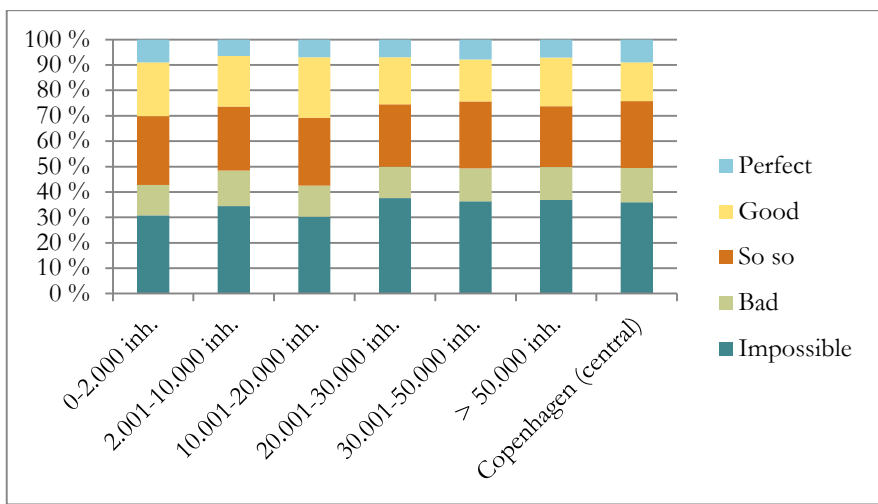


Figure 5.20 Car situation: Charge possible 10 min. walk, 4 h. charging time, range 130 km by city size. Denmark 2013. Percent

This is perhaps a bit puzzling. People from the larger cities rate the presented electric car worse than people from smaller cities, even if people from for example Copenhagen on average have fewer long trips than the rest, Figure 5.20.

5.4 Parking facilities at home

This is not actually a question introduced because of this study, but it is very relevant in the context of how easy it is to recharge at home. The general result is illustrated in Figure 5.21.

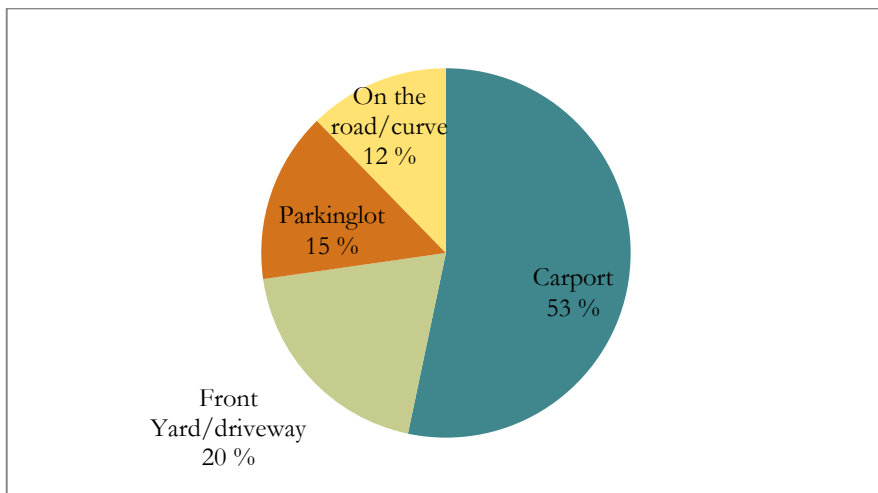


Figure 5.21 Parking facilities at home. Denmark 2013. Percent

Around half of the respondents have a carport, and further 20 percent park on own ground, Figure 5.21. The last 27 percent will have difficulty recharging at home.

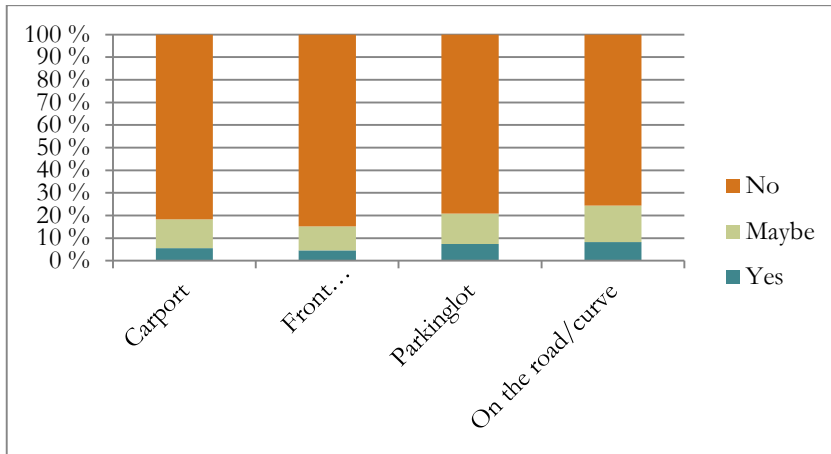


Figure 5.22 Considering buying an e-car by parking facilities at home. Denmark 2013. Percent

People with poor parking facilities are more positive than the others, Figure 5.22. Not exactly what one would expect, and probably partly because other variables play a part. The big question is, if they actually think they can manage in other ways, or if they underestimate the problems that this might lead to.

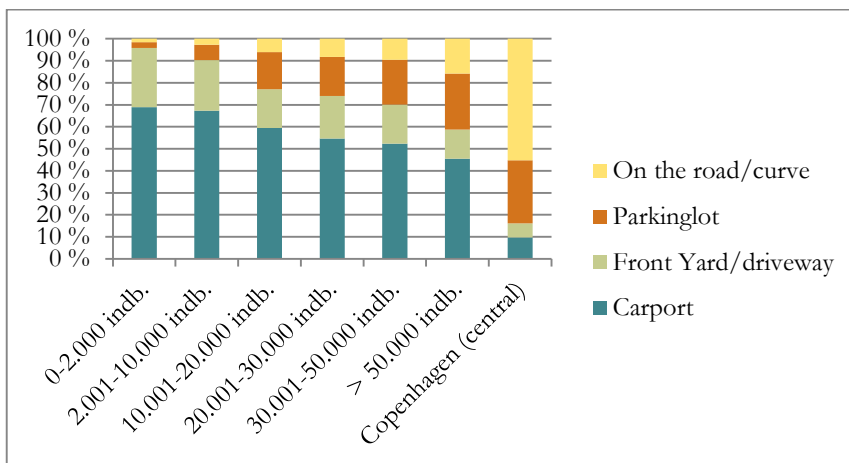


Figure 5.23 Parking facilities at home by city size. Denmark 2013. Percent

As could be expected, there's a clear inverse connection between city size and parking facilities, Figure 5.23. Note that really few have home parking reasonably suited for recharge in a large city like Copenhagen.

5.4.1 Availability of electricity at home parking?

As an expansion of the question about parking facilities, people with private parking (garage or driveway/front yard) state if they already have electricity available, and if not, how easy it would be to make. The general result is illustrated in Figure 5.24:

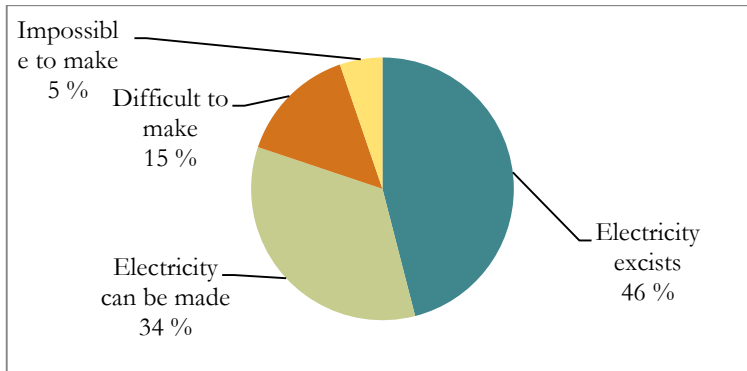


Figure 5.24 Having electricity available in private parking. Denmark 2013. Percent

About 50 percent claim to be ready to charge at the home parking. Around 20 percent says it will be difficult or impossible to make. Analysing all the potential buyers (not just those with private parking), at the moment only one out of three persons are able to recharge at home (having parking facilities with electricity available).

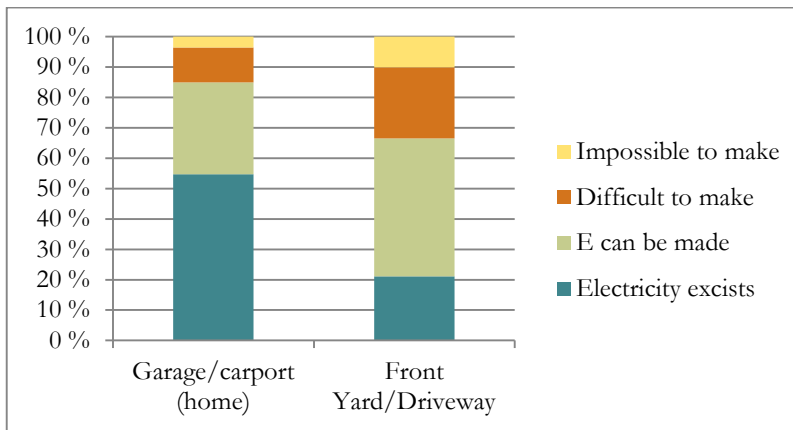


Figure 5.25 Available electricity by parking facility. Denmark 2013. Percent

As could be expected, electricity exists, or can be made, in most (85 percent) garages/car ports, Figure 5.25. Around 60 percent with front yard/driveway parking think they can get electricity with little problem.

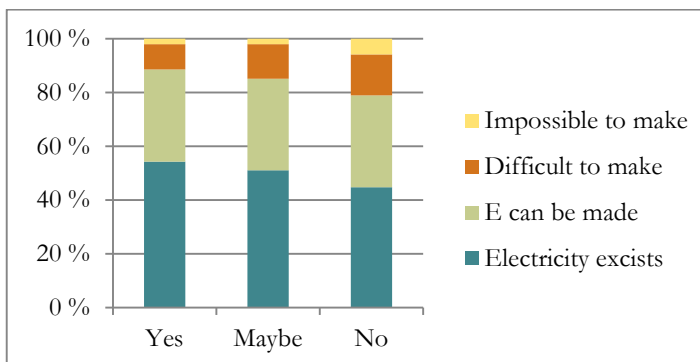


Figure 5.26 Consider buying EV by available electricity. Denmark 2013. Percent

While availability of electricity does play a role in how positive an electric car is perceived, it is not that important as perhaps could be expected, Figure 5.26.

5.4.2 Why would you consider buying an electric car?

Only people who would, or maybe would, consider buying an electric car received this question. There was no free form option for the “Other” reasons. The question was multiple choice, so several answers were possible. The general result is illustrated in Figure 5.27.

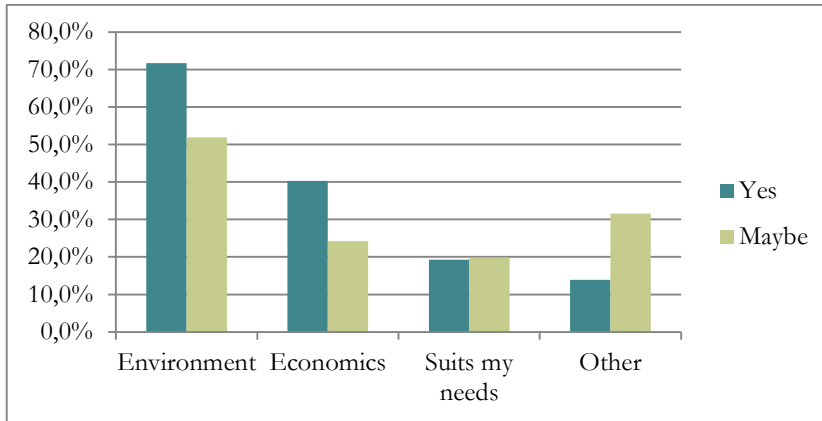


Figure 5.27 “Why would you consider buying an electric car?” by those who say Yes or Maybe. Denmark 2013. Percent.

The environment is the most selected reason for buying an electric car, by a solid margin both among those who say yes and those who say maybe, Figure 5.27.

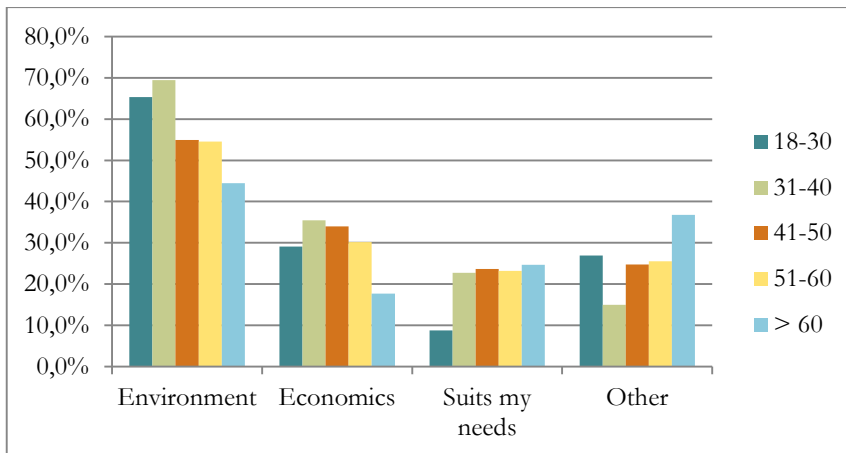


Figure 5.28 “Why would you consider buying an electric car?”. by age. Denmark 2013. Percent.

Younger people have “The environment” as a reason to be positive more often than the rest, Figure 28. In general the reasons do not vary much – for example men only say “Economics” a little more often than women. People living in big cities and the highly educated are more likely to choose the environment.

5.5 Why would you not consider buying an electric car?

Only people who would not consider buying an electric car received this question. Also multiple choice. The general result is illustrated in Figure 5.29:

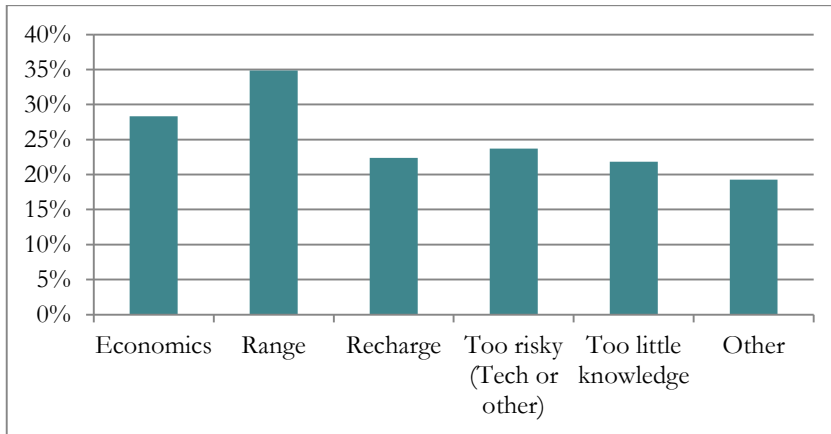


Figure 5.29 “Why would you not consider buying an electric car?”. Denmark 2013. Percent.

The reasons not to consider buying an electric car are rather evenly spread out over the possible answers, with the range of the vehicles as the most selected by 35 percent, Figure 5.29.

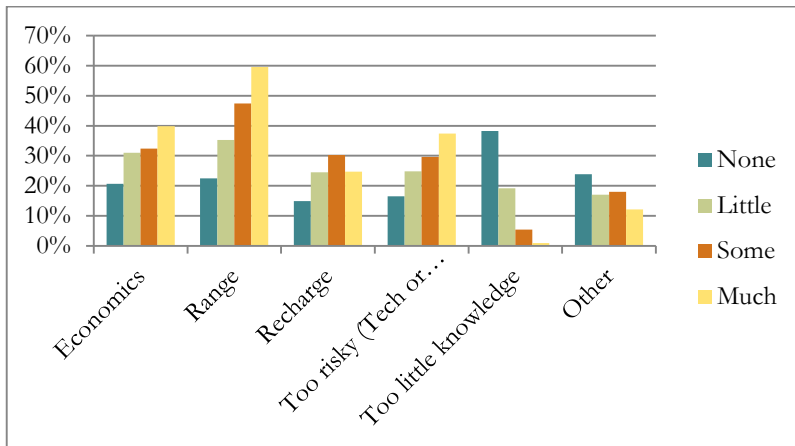


Figure 5.30 “Why would you not consider buying an electric car?” by knowledge. Denmark 2013. Percent.

The more people know about the cars, the more likely they are to choose more than one reason, Figure 5.30. Aside from that, the option “too little knowledge” is the obvious difference in the chart.

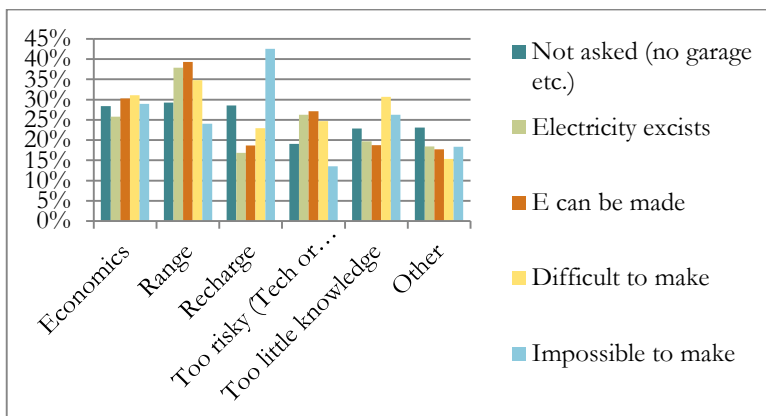


Figure 5.31 “Why would you not consider buying an electric car?” by home charging. Denmark 2013. Percent.

People with no access to private parking are not much more likely than the rest to blame recharge-problems, Figure 5.31.

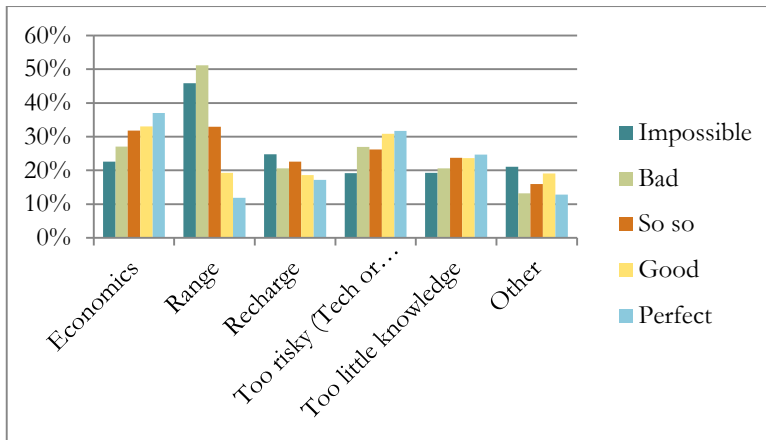


Figure 5.31 “Why would you not consider buying an electric car?” by the degree of suitability of car situation. Denmark 2013. Percent.

There is a nice connection between thinking the presented type of electric car suit their travelling needs, and not using that as the reason to be negative about a purchase. They select “Economics” or “Too risky” instead, Table 5.31.

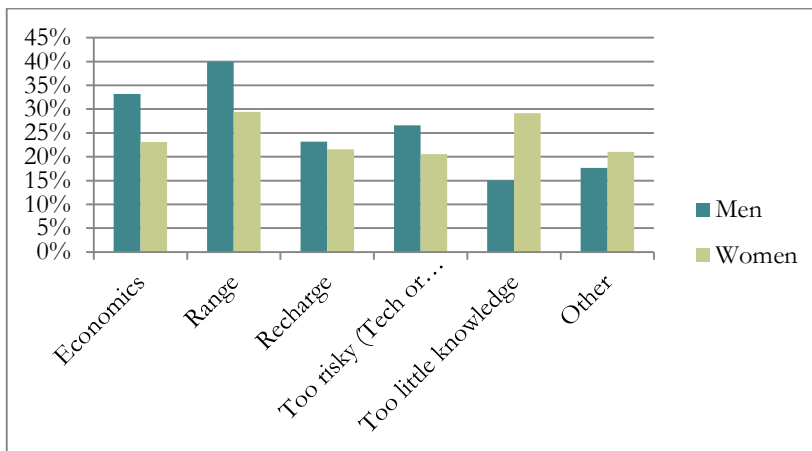


Figure 5.32 “Why would you not consider buying an electric car?” by gender. Denmark 2013. Percent.

Men tend to select “Economics” and “Range” more often than women, who select “Too little knowledge” instead, Figure 5.32.

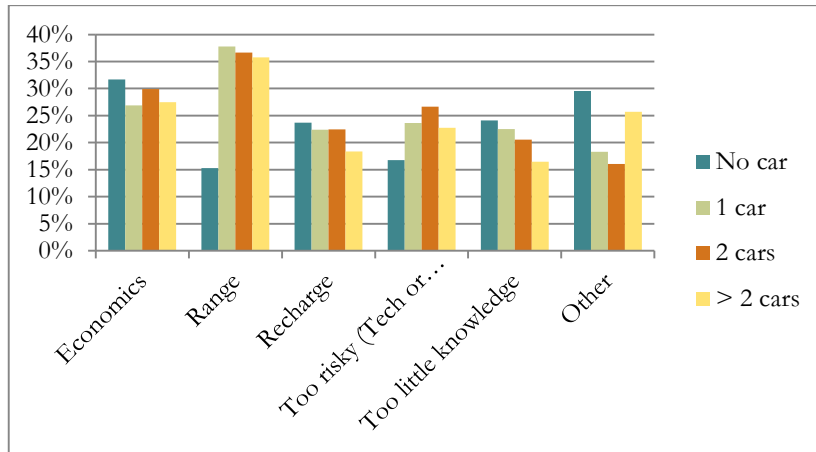


Figure 5.33 “Why would you not consider buying an electric car?” by car availability. Denmark 2013. Percent.

People with no access to cars at the moment are not so concerned about “Range” as those with car, Figure 5.33. It’s probably a bit surprising that people with access to more cars are just as concerned about range as people with access to only one car, even if they have the possibility to choose between cars when distances are longer than the range of an EV.

6 Long car trips in Norway

6.1 Introduction

In some of the preceding chapters the limited range of the electric vehicles has been used as an argument against purchase of such a vehicle. People do long car trips for holiday, leisure or business that exceed the upper range, and recharging may not always be possible for different reasons. The range of the newer EVs varies from 150 km to 200 km for normal driving in the summer season and roughly about half of this in cold winter weather with the use of heater etc. Tesla Model S is a special case with range about twice that of other electric cars, i.e. 250-500 km depending on version and driving conditions. Car drivers normally will consider a range buffer of typical 20 percent (probably 10 percent for Tesla drivers) remaining range as needed, when planning the journey. As the vehicle ages the battery capacity is slowly reduced by about 10 percent after 5 years and 20 percent after 10 years. These factors should be taken into account when investigating the possible usage areas of EVs based on travel surveys.

A question is, also, how often do people carry out these long car trips, how long are they, for what purposes are they carried out, and what are the characteristics of those who do these trips? In this chapter we will try to answer these questions by using data from the Norwegian Travel Survey from 2009 in addition to the analysis done in chapter 4.

This chapter deals with those trips defined as long trips in the Norwegian travel surveys, which people are asked specific questions about. In the surveys a long trip is defined as a trip of 100 km or longer, or if the origin/destination of the trip is abroad. In Norway it is not unusual to go shopping to Sweden, especially in the areas near the Swedish border, and these shopping trips might be shorter than 100 km.

In the survey the respondents are asked to report those trips that fit this definition, which means that it is up to the respondent to find out whether the distance to the origin is 100 km or longer. There is no question about the exact travel distance, but the respondents are asked about the address of the origin and the destination of the trip. Based on this information the distance has been calculated using 'grunnkrets' (basic statistical geographical unit dividing the country in squares of land) as geographical location unit.

It appears that about 15 percent of the trips are shorter than 100 km, which means that it don't satisfy the definition of a "long trip". In RVU 2005 this share was 18 percent (Denstadli 2006). The reasons for this are twofold. First, using grunnkrets as the basis will not give an exact distance, the calculation is based on the midpoint in the origin and the destination of this basic statistical unit (grunnkrets), which also varies in size. (In some of the cases, where the address is inaccurate, the midpoint from one municipality to the destination municipality is used). Secondly, the respondents in the survey might have exaggerated the distances to their destinations.

For the purpose of this document we have chosen to include trips ranging from 80 km and longer. Shorter trips are not included in the analysis presented.

6.2 Number of long car trips per month

The average number of long trips by car is about one per month. This varies e.g. by place of living, gender, income, number of cars in the household and employment, Table 6.1.

People living in the surrounding municipalities of Oslo are those who have the highest number of long car trips in the country. Men have more long car trips than women. People in their middle ages, 45-54 years, those with high household income, those with three or more cars, and work more than 40 hours per week have most frequent long car trips. Many of these variables go together. Households with high income also have several cars. Men have longer working hours than women.

Table 6.1 Number of long trips by car per month. Norway 2009.

	Average number per month	Total number of trips
<i>All</i>	.99	27313
<i>Place of living</i>	***	
Oslo	.95	3679
Surrounding municipalities of Oslo	1.20	3221
Bergen, Trondheim, Stavanger	.60	2418
Surrounding municipalities of Bergen Trondheim, Stavanger	.66	1329
Next six cities	1.05	3574
Smaller cities	1.01	5699
Rest of the country	1.05	7392
<i>Gender</i>	***	
Men	1.10	13579
Women	.87	13734
<i>Age</i>	***	
13-17 yrs	.54	2302
18-24 yrs	.77	2872
25-34 yrs	1.00	4041
35-44 yrs	1.19	4881
45-54 yrs	1.30	4374
55-66 yrs	1.19	4568
67-74 yrs	.82	1822
75 + yrs	.40	2452
<i>Household income NOK 1000</i>	***	
< 200	.72	4287
200-399	.76	3506
400-599	.99	3932
600-799	1.18	4024
800-999	1.37	3281
1 000 +	1.52	3179
<i>Number of cars in the household</i>	***	
0	.32	3947
1	.98	11745
2	1.17	9283
3+	1.44	2282
<i>Employment</i>	***	
Weekly working hours > 40 hours	1.43	2529
Full time 30-40 hours per week	1.20	10989
Part time < 30 hours per hour	.87	3444
Not employed	.69	9994

*** p< 0.001

6.3 Characteristics of the long car trips

Most of these trips are connected to leisure activities and holidays and visiting friends and relatives, Figure 6.1.

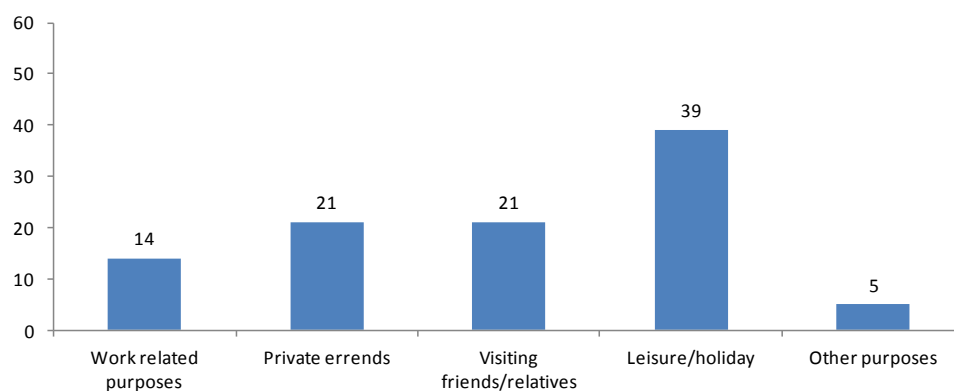


Figure 6.1 Travel purpose of car trips 80 + km. Percent

As many as 17 percent of these trips take place to or from the cottage/holiday house (part of the leisure/holiday category). This is illustrated in Figure 6.2, which shows that 56 percent of these journeys take place in the weekend, about 20 percent on Fridays and the same on Sundays. This indicates a contribution to the traffic peaks in and out of the larger cities in Friday and Sunday evenings. It also indicates the time when charging of the EVs is needed for these types of journeys.

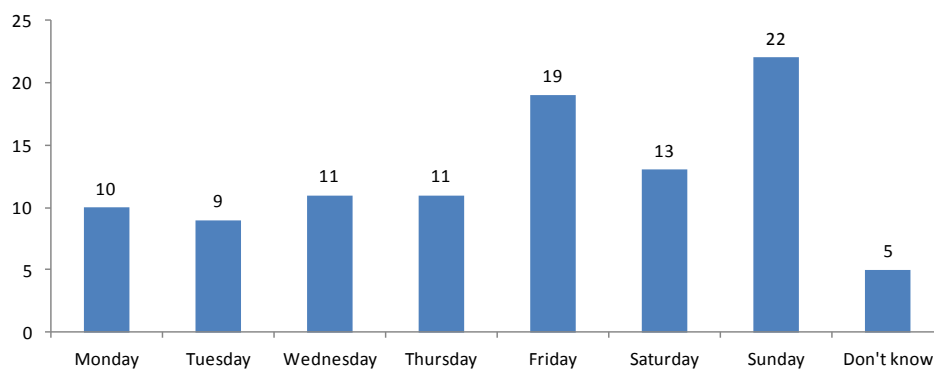


Figure 6.2 Car trips 80 + km by weekday. Percent

Who are the long distance car travelers? To give a short answer: It is couples with (35 percent) or without children (38 percent), people with high household income (41 percent have a household income of NOK 800 000 or more) and more than half of these trips are done by people belonging to households with two or more cars.

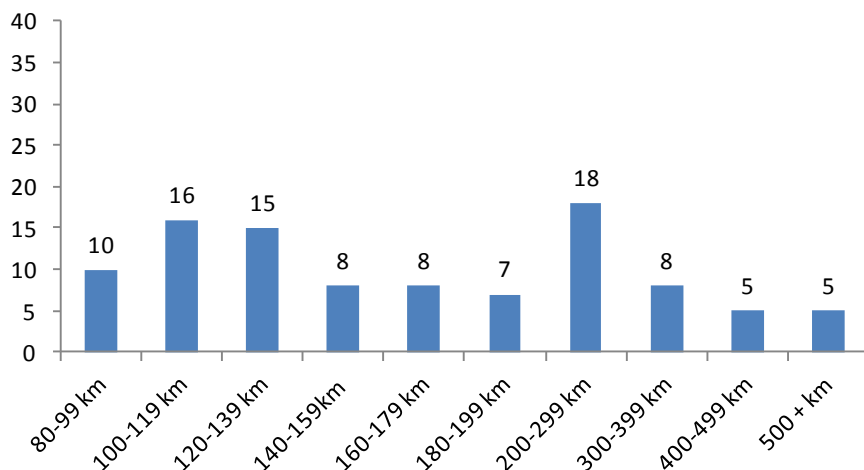


Figure 6.3 Travel length of car trips 80 + km. Percent.

Figure 6.3 shows that about 25 percent of these trips are shorter than 120 km, within the range of most EVs in the summer season. Further 23 percent are between 120 and 160 km, which are in the range of larger EVs. We also see that more 40 percent of these trips are longer than 180 km, and use of EVs on these distances requires recharging on the way for most of the EVs. The Tesla, having a range of up to 500 km are suitable for about 95 percent of all long car trips without having to recharge on the way.

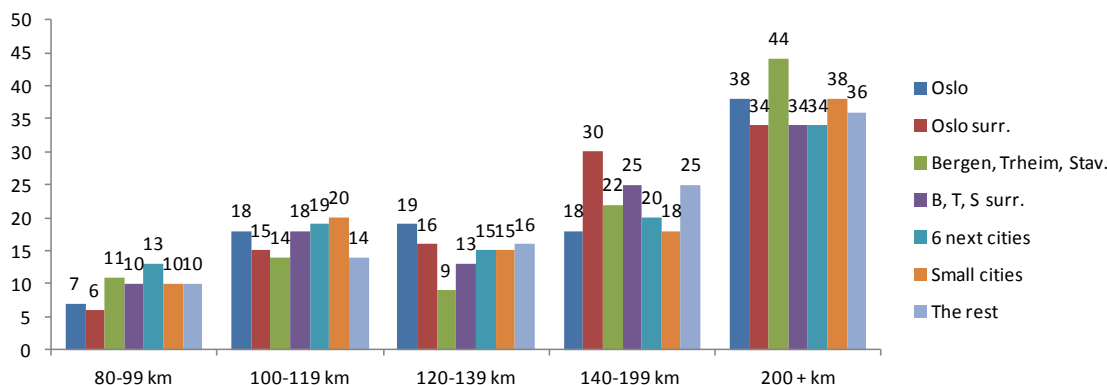


Figure 6.4 Travel length of car trips 80 + km in different geographical areas. Percent

Figure 6.4 shows that the variation in travel lengths between the geographical/residential areas is not very large. There is a tendency that people in Bergen, Trondheim and Stavanger, the second third and fourth largest cities have longer car trips of this category than people living in the other parts of the country.

The average travel distance is also longest in these three cities, Table 6.2. In the other cities and in the rest of the country the average distance varies from 202 to 218 km. Table 6.2 shows that men travel in average longer than women. The average distance to the cottage is 176.6 km, which indicate a request for recharging on the way. The average holiday/leisure trip is 258.8 km, and visiting friends almost the same.

There are some variations by weekdays, with the average longest trips on Monday and Thursday. The table also shows that in households with three or more cars, the average travel distance is longer than in household with fewer cars.

Table 6.2 The average travel distance of car trips 80 +. Km.

	Average travel distance km	N of trips
<i>All</i>	213	14518
<i>Place of living</i>		
Oslo	203	1817
Surrounding municipalities of Oslo	202	1810
Bergen, Trondheim, Stavanger	233	1422
Surrounding municipalities of Bergen Trondheim, Stavanger	218	629
Next six cities	203	1795
Smaller cities	215	2823
Rest of the country	215	4222
<i>Gender</i>		
Men	214	8031
Women	210	6487
<i>Travel purpose</i>		
Holiday/leisure	259	3043
To the cottage/holiday home	177	2491
Visiting friends/relatives	237	3679
Business travel	181	1572
<i>Weekday</i>		
Monday	225	1506
Tuesday	210	1255
Wednesday	204	1549
Thursday	230	1621
Friday	214	3006
Saturday	203	1808
Sunday	211	3197
<i>Number of cars in the household</i>		
1	209	6423
2	210	5827
3+	226	1627

6.4 The geographical distribution of long car trips

In *Oslo and Akershus* (the surrounding county of Oslo) most car trips take place within own region (the Eastern part of the country), but not within own county.

Other counties in the Eastern part. In these counties most of the long car trips take place within the own county or region, including the metropolitan area. Vestfold is an exception with only one third within own region. Only 15-20 percent of the trips go to other parts of the country.

In the Agder counties the majority of the trips take place outside the region. Only 23 percent of the long car trips in Aust-Agder and 29 percent in Vest-Agder are done within own county/region.

In the Western part of the country between 50 and 65 percent of the long trips generated by those who live in these counties take place within own county/region.

In the counties of Middle Norway the long trips take place mostly within own region. A little more than 20 percent are carried out outside.

Due to long distances most trips in *Northern Norway* take place in within own county, 70-80 percent.

Table 6.3 Geographical distribution of the long car trips by county of residence. Percent¹²

	Own county	Own region	Oslo	Akershus	Other	Total
Østfold	2	41	20	23	14	100
Oslo	0	82	0	0	18	100
Akershus	2	81	0		17	100
Hedmark	18	28	23	19	12	100
Oppland	17	26	22	21	14	100
Buskerud	19	41	12	10	18	100
Vestfold	0	31	34	16	19	100
Telemark	19	26	23	11	21	100
Aust-Agder	6	17	14	13	50	100
Vest-Agder	15	14	11	3	57	100
Rogaland	24	23	4	1	48	100
Hordaland	38	33	3	2	34	100
Sogn og Fjordane	28	30	4	3	35	100
Møre og Romsdal	30	28	2	4	36	100
Sør-Trøndelag	42	33	2	5	18	100
Nord-Trøndelag	37	42	2	2	17	100
Nordland	73	13	1	1	12	100
Troms	71	28	1	0	0	100
Finmark	83	14	0	0	3	100

East Norway= Østfold, Hedmark, Oppland, Buskerud, Vestfold, Telemark (except Oslo and Akershus)

Agder= Aust-Agder and Vest-Agder

West Norway= Rogaland, Hordaland, Sogn og Fjordane

Middle Norway= Møre- og Romsdal, Sør-Trøndelag, Nord-Trøndelag

North Norway = Nordland, Troms, Finnmark

6.5 Car use in three different corridors

In 2009-2010 a special study of passenger travel in three main Norwegian transport corridors was carried out (Denstadli and Gjerdåker 2011). These corridors were Oslo-Trondheim (approx 500 km), Oslo-Bergen (approx 520 km) and Bergen-Stavanger (approx 210 km). This section is based on the summary in Denstadli and Gjerdåker (2011).

There are clear similarities between Oslo- Bergen and Oslo-Trondheim regarding travel volumes, travel purposes and transport modes. In both corridors 1,9 million travels were made during the period, of which 35percent were work related and 65 percent private travels. Between Bergen and Stavanger the traffic flow was about 900 000 travels.

¹² The following definition of regions is applied: 1) Eastern part of Norway (except Oslo and Akershus- Østfold, Hedmark, Oppland, Buskerud, Vestfold, Telemark, 2) the Agder counties – Aust-Agder and Vest-Agder, 3) Western part of the country – Rogaland, Hordaland, Sogn og Fjordane 4) Middle Norway – Møre- og Romsdal, Sør-Trøndelag, Nord-Trøndelag 5) North Norway – Nordland, Troms, Finnmark

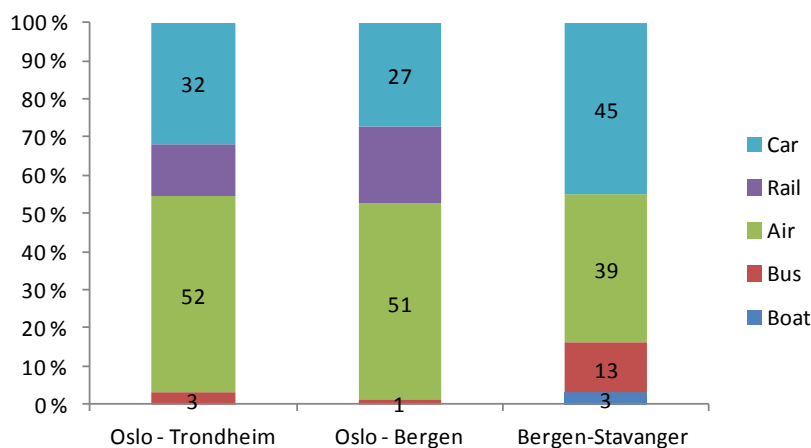


Figure 6.5 Distribution of travels by transport mode in the three corridors. Percent. Source: Denstadli and Gjerdåker 2011p II)

The share of car use varies between 45 percent for the relation Bergen - Stavanger and 27 percent between Oslo and Bergen, Figure 6.5.

In all three corridors there are variations in choice of transport mode regarding purpose of travel and season. This is particularly so for travels by car and air. All in all, aviation is the transport mode most frequently used, dominating on work related travels and in the winter season. Car use is dominant on private travels and in the summer season.

Car travels to/from Trondheim have two alternative routes: Rv3 Østerdalen across Kviknefjell or E6 Gudbrandsdalen across Dovrefjell. There is a clear preference for Østerdalen among car travellers. Contributing to this choice are shorter distance and travel time, fewer populated areas where speed limit is low, and a mountain pass which is not too exposed to stormy weather.

Between Oslo and Bergen there are five alternative routes by car: E139 Haukelifjell, Rv7 Hardangervidda, Fv50 Hol-Aurland, Rv52 Hemsedal and E16 Filefjell. The Haukelifjell crossing has the highest travel volumes.

These three corridors are important long distance routes for passenger car transport. The distances are so long that there is a need for several (fast) recharging stations in these corridors.

7 Discussion of findings

7.1 Different conditions in the three countries

The point of departure for the work documented in this report was to study the potential for purchase and use of Electric cars. We have been interested in examining for what purposes, travel lengths and different social groups the Electric cars are a good solution. The data basis is different in the three countries that have taken part in this work, namely Austria, Denmark and Norway. In addition the institutional and other contextual conditions for purchase and use of EVs are different in the three countries. What is found in one country can therefore not necessarily be transferred to one of the others, which also means that it is difficult to generalize the findings to other (European) countries.

Our main data basis has been the national travel surveys in Denmark and Norway. Unfortunately Austria has not this type of survey, so we have to rely on the results from the two other countries. National travel surveys are carried out in several European countries and in the USA. Some of the basic findings can therefore be compared to the extent that it is of interest.

The incentives for buying and using EVs in the three countries are very different (see 1.3). Norway has the most beneficial incentives of the three, which has resulted in a high level of penetration of EVs in the country and with the world's highest number of EVs relative to the population (Figenbaum and Kolbenstvedt 2013). When discussing the potential, these differences are important to have in mind.

The number of cars per 1000 inhabitants is high in all three countries, highest in Austria and lowest in Denmark. There is also about one third of the households that have more than one car, which means that there is a rather large potential of changing one of the cars with combustion engine in the household to an EV if conditions (mainly the possibility for charging at their home) for an electric car are present.

Even if the level of car ownership is different in Norway and Denmark, the distribution of cars in different social groups in the population is more or less the same. Men have more often access to cars than women. Multicar household is found in high income household, in families with children and more often in small towns and sparsely populated areas than in the larger cities. Also in Austria the gender difference is present.

In Denmark and Norway shopping is the most frequent purpose of car trips, more so in single car households than in multicar households. In Lower Austria work is the most frequent purpose of car trips. In both Denmark and Norway commuting is a more frequent purpose in multicar households than in single car households, which indicates that a second (or third) car often is purchased when there is two employed people in a household.

When analyzing the single car trips it is obvious that a great majority of them are within the limit of an Electric vehicle. In Norway only three percent of the single car

trips are longer than 80 km. In Denmark the percentage is four. The characteristics of those who have more long trips than other are: people living in sparsely populated areas and small villages, have high income, working full time, are men, are on business and leisure trips and have more than one car.

7.2 Most trip chains by car are short

The single trip (which is ended when reaching the destination for the activity, e.g. work) should not be considered as the analytical unit when discussing the substitution of a combustion engine vehicle with an EV. The single trip must be seen in connection with the total travel pattern of the day. The single trip can be part of a longer chain. The trip chain during the day is therefore analysed both to find the total travel length in chains by car during the day and to examine the time duration of the stops between the chains/trips.

A trip chain in these analyses is defined as the following: A car based chain starts and ends at home, and the car is used at one or more trips. Total travel distance is calculated as distance by car, and trips with other modes in between are ignored. If the respondent does not use the car on one or more of the trips in the chain, we assume the car is parked and that no other persons are using it.

The analysis of chains is based on respondents with driving licence, car in the household and those who drove the car at the registration day.

Similar to the length of single trips, also the length of car based chains is relatively short. In Norway 85 percent of them are shorter than 50 km, and in Denmark 75 percent is shorter, indicating that car based trip chains are somewhat longer. It is only 8 percent of the chains in Norway that are longer than 80 km, in Denmark this share is 14 percent. Looking at all the chained trips in general 95 percent of them do not need recharging in Norway, about 90 percent in Denmark.

To summarise this – in Norway there is four percent of the trips, six percent of the chains and 12 percent of the days during a year where the distance is over the range limit. In one year this means that the average number of days that are over the limit (without recharging) is 43. In Denmark the corresponding figures are, 5 percent, 14 percent, 16 percent of the days and 57 days a year. The reason that Denmark has more days over the limit is that the car based travel chains are longer than in Norway.

But even if there are a number of days that either have too long single trips or too long chains there can be stops during the day making it possible to recharge. On the rather few travel days with a travel length longer than 80 km respective 120 km, 29 percent (80 km) and 24 percent (120 km) in Norway have a stop at home between 1-5 hours, which gives a possibility for recharging (partly or nearly full). In Denmark the shares are nearly the same. This counts for people with driving licence and car(s) in the household.

When doing the same analysis, but restrict it to stops longer than five hours, between 20 and 40 percent have such long stops at work at the weekdays in Norway, a little higher in Denmark.

On those days that exceed the limit, we see that the home and the workplace are important for recharging; the home for stops shorter than five hours and work for the longer stops. There is however several other places people stops (between one and five hours) during the day, and these stops can be at different types of places,

with or without the possibility of recharging. As presented in chapter 3, a large part of the car trips is related to shopping and service. Recharging (fast) stations located at shopping centres gives these drivers a possibility to manage the total trip chain, even if it exceeds the limits by charge while shopping.

7.3 Little interest for buying electric cars in Denmark

Compared to Norway, the incentives in Denmark are more modest. This is perhaps also a reason why the interest of buying an EV is rather low. Special questions about different aspects of electric cars were added to the Danish national travel survey. As many as about 80 percent of the Danish respondents would not consider buying an electric car. Only 6 percent said yes, while 13 percent said maybe. The knowledge about electric cars is low, as many as 33 percent say that they have no knowledge. From the literature we know that there is a connection between knowledge and the tendency to buy. The results from the Danish study show two potential EV buyers:

The first group is characterized as following:

- Middle aged
- High income
- Well educated
- Pretty good knowledge about electric cars
- Access to more than one car
- Have good parking and recharge facilities at home
- Not necessarily few long trips.
- Concerned about the environment

The other type of potential buyer is quite different:

- Young
- Relatively low income
- Have no access to a car, or maybe just one car.
- Live in a big city
- Have relatively bad parking/recharge facilities at home
- Relatively little knowledge about electric cars
- Few long trips
- Concerned about the environment

This indicates that the motives for buying probably are different in these two groups, and that incentives for buying might also be different.

7.4 Many leisure homes in Norway

The analyse of the long trips (100 km+) from the Norwegian travel survey from 2009 shows that the majority of these trips are connected to holidays and leisure activities, and most of them are done by car. In average people have about 12 long trips per year.

People living in the surrounding municipalities of Oslo are those who have the highest number of long car trips in the country. Men have more long car trips than women. People in their middle ages, 45-54 years, those with high household income, those with three or more cars, and work more than 40 hours per week have most frequent long car trips.

About 40 percent of the Norwegian population own or have access to a leisure home/cottage/summer house (Denstadli et al. 2006). In total there are nearly 450 000 holiday houses in Norway. People living in the large cities and the surrounding areas have the highest ownership, but few of them have a cottage within the home county. They have to travel further to visit their holiday house than people living smaller cities and sparsely populated areas. The estimated average distance to the holiday houses is 150 km, but one third has less than 50 km to the cottage, and further 20 percent have a distance between 50 and 100 km. This is within the range of most EV in the summer season. But not all cottages have access to electricity. Results from “Fritidsboligundersøkelsen 2008” (Survey of holiday houses 2008) indicate that about 60 percent of the holiday houses have electricity installed (special analyses, see also Farstad and Dybedal 2011).

In the metropolitan area of Oslo about 20 percent of the cottage owners have a distance shorter than 100 km to their cottages. In the next three biggest cities and the surrounding municipalities about 50-60 percent have a cottage within their reach. In the other parts of the country this is even higher. For most EVs this is within the range of the batteries in the summer season, but in the winter season this (upper) distance is a problem for most electric vehicles without recharging on the way. This result shows the dilemma - those who take EV in use in the larger cities, where the climate and environmental benefits are greatest, have the longest distances to the holiday houses, which makes it difficult to manage with an EV as a single car.

A substitution of a traditional car with an EV considering transport to the holiday house is primarily a problem for a majority of those living in the metropolitan area of Oslo, and first of all in the winter time. Recharging on the way can solve the problem, but one question is the willingness to spend extra time on the way to and from the cottage if this is a weekend trip, which in average takes place a little more than once a month, 14 times a year. In connection with vacation seasons many will be on the way at the same time and create a capacity problem on charging stations.

7.5 End comments

The analysis above is valid for the typical EVs available in the market in 2014. Next generation vehicles coming on the market 2017-2020 will probably be equipped with batteries allowing longer range, reducing the number of days the range is insufficient. Tesla Model S is already capable of delivering a range compatible with almost all travel needs analysed in this report.

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Appendix 1

The Norwegian national travel survey 2009

The Norwegian travel survey 2009 (NTS 2009) is the sixth national survey of travel behaviour conducted in Norway. The NTS 2009 covers personal travel of all types, including short trips taken on a daily basis and longer journeys undertaken less frequently, as well as all modes of transport, including cycling and walking.

The respondents of the NTS 2009 represent the population of Norway 13 years of age and above. The NTS yields socio-demographic information about the respondent and his/her household, including level of education, income, occupation, number of children and their age, etc., as well as travel activity on a particular day (registration day, often the day before the interview), long trips (100 km and longer) during the previous month, work trips and other work-related questions, access to a car(s), bicycle and quality of public transport. In NTS 2009 approx. 29,000 persons from 13 years on were interviewed. Around 10,000 of them constitute a representative sample of the entire country; the remainder is supplementary regional samples.

The respondents were interviewed by telephone, and a computer aided system (CATI) was used to register the answers. Origin and destinations of all trips were geo-coded (grunnkrets). The interviews were carried out from February 2009 to September 2010.

In NTS 2009 a trip is defined as any movement outside own residence, school, working place or leisure home, independent of length, duration, purpose, or transport mode. Daily trips are defined and limited by the purpose of the destination. At arrival at the destination, the trip is ended. For example a trip to the shop is a shopping trip, and a trip to the working place is a commuting (working) trip. If the person goes to the shop on the way to the work, there are two trips – first a shopping trip and then a commuting trip. Trips ending at home are defined from the previous purpose; a trip from work to home is defined as a commuting trip, while a trip home from a visit to a friend is defined as a visiting trip.

The Danish National Travel Survey (continuous)

The Danish national travel survey (TU) has been conducted every year since 1992 with a short break 2004-2005. The survey has been undergoing some changes through the years, but the core remains the same. In recent years it covers Danes between 10 and 84 years. The number of people included each year has varied from around 25.000 (to collect sample data for a traffic model), to around 10.000 in 2013. The survey is mostly done by interview (telephone, aided by computers), but some are carried out through a web-service.

In the survey the travel behavior on a certain day (often the day before the interview) is being analyzed. To secure that people on long trips or holidays are not underrepresented in the data, people can be contacted and interviewed several days after the day the interview is about. The results have been analyzed, and the number of long trips should be close to the actual level. All days through the years are being covered, which gives about 30 interviews a day. A trip is defined by having a distinct purpose and taking place in public areas (like public roads).

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