TØI report 1281/2013

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Institute of Transport Economics
Norwegian Centre for Transport Research

Electromobility in Norway - experiences and opportunities with Electric vehicles

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Summary:

The Norwegian Electrical Vehicle (EV)-policy, with its many incentives and the establishment of Transnova, a body giving financial support to charging facilities, have reduced the barriers for E-mobility. Norwegians were ready to buy EVs when the big automakers launched their models into the Norwegian market. The share of EVs in the new car market in Norway is the largest in the world. The early adopters of EVs are typically men in multi-car households located in the largest City-regions. They are most often used for driving to work. Akershus is the province with the highest EV-share, here EV drivers have access to the bus-lanes and do not have to pay the tolls to get into Oslo city. It is likely that EV-drivers will continue to use EVs in the future and it seems that range is less of an issue for the existing drivers than expected. Most daily trips are within the range capability of modern EVs. The EV-trips in general replace trips with ICE-vehicles but also in some cases public transport. Fleets are lagging behind private consumers in EV-application. Modifying the extensive Norwegian EV-incentives as E-mobility enters the market expansion phase will be a major challenge.

Sammendrag:

Det norske elbilpolitikken med mange insentiver og etableringen av Transnova som gir støtte til utbygging av ladestrukturer har gjort kjøp av elbiler mulig og har håndtert barrierer mot elbilbruk. Når de større bilmerkene kom på markedet med sine biler var norske brukere klar til å kjøpe. Norge har i dag flest elbiler pr innbygger og høyest andel elbiler av nybilsalget i verden. Elbilen kjøpes i den første fasen oftest av menn i husstander med flere biler og boende i de større byregionene. Bilene brukes mest til arbeidsreiser. Akershus, der man kan kjøre i kollektivfeltet og passere bomringen gratis, er det fylket som har flest elbiler. De som har kjøpt elbil vil fortsette med det og erfarer at rekkevidden er et mindre problem enn antatt. De fleste daglige reiser kan håndteres med de nyere elbilene. Elbilen erstatter i hovedsak andre bilreiser, men også noen kollektivreiser. Utfordringer og muligheter framover ligger i utvikling av elbilflåter og i endring av insentiver når markedet vokser.

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Preface

Electrification of vehicles is important for achieving goals of reducing greenhouse gas emissions and improving local air quality. Norway is currently in the forefront of electromobility. Summarizing and publishing Norwegian experiences with electric mobility, will therefore be useful for those working with electrification in other countries. Important questions are for example the framework for the Electric vehicle manufacturers, government adaption and management of various barriers to development, user needs and motivs as well as the benefits and costs for the involved actors and to society. Institute of Transport Economics (TØI) has published several studies on electric/electrified cars (Electric cars, Hybrid cars and Plug-in hybrids) and also have some unpublished material from an assignment for Swedish authorities and the ERA-NET project COMPETT. There are also some internal notes and data files from surveys from various private businesses that we have secured access to. These documents formed the inital basis for the work on this report.

The Nordic research program BISEK (The Social and Economic Significance of the Motor Car), funds research that sheds light on the consequences for individuals and households, of various aspects of car policy. BISEK 2 is especially focused on environmental measures. The electrification of the vehicle fleet obviously impacts the everyday life of individuals and households, and BISEKs Board has therefore commissioned TØI to prepare a report on the Norwegian experiences with electric mobility.

BISEK is one of 14 parties in the strategical vehicle research project SEVS (Safe, Efficient Vehicle Solutions). The project is initiated and operated by SAFER, (Vehicle and traffic safety research center at Chalmers university) in Gothenburg. SEVS is financially supported from VINNOVA (Swedish Governmental Agency for Innovation Systems) as an FFI program (FFI handles vehicle strategy resarch and innovation), see the description of SEVS in Annex I. The present TØI report is an important contribution from BISEK to the SEVS project, and is thus also part of this project. In Norway, the report has received support from Akershus county's transportation department . Akershus county, as will appear from the report, is the county in Norway with most electric vehicles. It is therefore of particular interest to look at the situation in this county. Henrik Swahn and Thomas Tvedt has been the contacts respectively at BISEK and the Akershus County Council.

The report was prepared by TØI researchers Erik Figenbaum with responsibility for chapters 2-6, 8, 10 and 11 and Marika Kolbenstvedt with responsibility for chapters 1 , 7 and 9. The latter has been the project manager. In the work we have benefitted from material prepared by Lasse Fridstrøm, Aslak Fyhri, Rolf Hagman, Randi Hjorthol and Liva Vågane - all researchers at TØI. Secretary Trude Rømming has been responsible for the final design of the report. Research Director Michael W. J. Sørensen has been TØIs quality assurer. Transnova represented by Tom Eirik Nørbech, has provided external quality assurance of the report.

This is an updated English translation of TØI-report 1276/2013. The English translation has been made possible by financial contributions from Transnova, The Norwegian Public Roads Administration and internal TØI-funding.

We thank all contributors for their efforts.

Oslo, November 2013
Institute of Transport Economics - Norwegian Centre for Transport Research

Gunnar Lindberg	*Michael Wøhlk Jæger Sørensen*
Managing Director	Research Director

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Summary:

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Electrification of vehicles is an important measure to reduce environmental impacts and climate gas emissions from transport. Electric propulsion is energy efficient, does not cause local emissions and reduces noise. The main challenges with electric propulsion is related to range, price and the production of batteries. A long lasting broad interaction between private enterprises, public authorities and non government organizations, have resulted in Norway being home to the largest per capita Electric vehicle market in the world. The Electric vehicle share of the total vehicle market was around 3% in the first half of 2013 and the share of the fleet reached 0,5%. From the 1990s Electric vehicles have been high on the political agenda resulting in the introduction of incentives necessary to meet market challenges, and encourage the early adopters to test the new technology. Economic incentives such as exemption from vehicles taxes (registration tax, VAT) have secured the potential to sell Electric vehicles competitively. Reductions in the annual circulation tax on vehicle ownership and exemptions from toll road charges, reduce the owner costs compared to conventional vehicles. The public investment support for charging infrastructure reduces the range issue in daily transport activities. The access to bus lanes has only been available for the Electric vehicle owners. The combined effect of these and other incentives, has made Electric vehicles popular with increasingly larger shares of car buyers in Norway. The Electric vehicle market in Norway is expected to continue to grow as more models are coming on the market, and given the government decision to extend the economic incentives through 2017. Further into the future the market will depend on future incentives, market- and technology developments, and the competitiveness of Electric vehicles compared to other technologies.

Electric vehicle evolution through five phases

The Electric vehicle (EV) development has been through five distinct phases in Norway, concept development, testing, early market, market introduction and finally from 2013 entering the market expansion phase.

In the concept development phase (1970-1990), prototypes of EVs and propulsion systems were developed by private enterprises such as Bakelittfabrikken (forerunner of Think), Strømmens Verksted and ABB with financial support from the research council of Norway.

In the test phase (1990-1999), the first vehicles were tested in public test programs, and the first serious efforts to commercialize Norwegian made EVs were launched (Think). The first users were enterprises and organizations. The wish to establish Norwegian EV production was a driving force, and local air quality, energy efficiency and increased use of Norwegian electricity were presented as the main advantages. Lobbying activities were launched and the Norwegian EV association, Norstart, was established. This resulted in the introduction of the first EV incentives, exemption from the registration tax and the annual vehicles license fee, and the exemption from toll road charges. The vehicle registration tax at that time was levied on the value of the car, and this became prohibitively high on the first expensive Electric Vehicles. Later in this phase free parking on parking lots owned by the municipalities, and reduction in the imposed benefit tax on company cars, were introduced as measures to make EVs more attractive. Kewet Electric Vehicles were imported from Denmark. This phase ended with Think and the small Danish producer Kewet going bankrupt.

An early market phase was introduced with Ford Motor Company buying Think in 1999, soon launching the first model. Ford initiated development of a new model better suited for the US market, targeting reduced cost and improved quality. Kollega Bil established production of the Kewet in Norway after buying the assets from the Danish bankrupt estate. In the Grenland region the big industrial conglomerate Norsk Hydro scaled down activities, resulting in business development aids given to the region, some of which was found its way to Miljøbil Grenlands EV leasing business. A Norwegian electric vehicle industry cluster was thus developing and it became important to support the development of a home market. New incentives were launched, the exemption from VAT from 2001 (25% in Norway) and test of bus lane access in the larger Oslo Region from 2003 (permanent and nationwide from 2005, with minibuses being banned from 2009) and reduced rates on main road coastal ferries (2009). But it seemed that the technology was not sufficiently developed, and Ford Motor Company pulled out of Think in 2003, also as a result of changing ZEV-regulations in California. This meant that few vehicles were available to Norwegians, and a second hand import of French EVs manufactured between 1998-2002 filled the demand. The Norwegian Kewet producer faced an expired type approval, and new type approval requirements having outpaced the concept. They reverted to redesigning the vehicle to the L7e type, a vehicle category with a much simplified type approval procedure. The main EV-market was in the greater Oslo/Akershus region where users could save time driving in the bus lanes, and in areas with high road toll charges. Think was bought first by an Indian investor living in the UK, which during a couple years of ownership did not achieve much and the company was again bankrupt in 2004. This time Think was bought by Norwegian investors with a serious intent to launch the new model developed in the Ford ownership period.

The market introduction phase from 2009 started with the launch of new Think and Pure Mobility (known as Buddy or Kewet) models. In 2010/11 the big car manufacturers Mitsubishi, Peugeot, Citroën and Nissan launched their vehicles. The EV-market expanded rapidly to about 3% of new vehicle sales at the end of 2012. A hefty price competition broke out with rapidly falling prices causing the Norwegian manufacturers to go bankrupt. A substantial part of the 2 500 Norwegian EV owners in 2009, and probably many in their social networks, were ready to buy a new EV when the big automakers launched their products from 2010. These factors could have contributed to the rapid market growth from 2010. The Electric vehicle association developed into an important organization in this period. They supported their members efforts to get the most out of the vehicles, by compiling and making available information on charging facilities, they recruited new EV drivers through test drives, and other dissemination activities, and they facilitated knowledge transfer on an internet user forum.

The government organization Transnova was established in 2009 to support testing and expansion of new technologies to reduce climate gas emissions from the

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transportation sector. This new organization has made it possible to finance the establishment of charging stations on a larger scale and to start various test- and demonstration activities. Transnova also supports Grønn bil, an organization promoting EV usage in municipalities and fleets. The energy industry sector have become economically involved in business development related to EV charging.

The first Plug-in hybrid vehicles (PHEV) were launched at the end of 2012, but a lack of incentives has limited sales to low numbers. These vehicles have slightly lower registration tax than traditional hybrid vehicles. Studies of the usage of PHEVs indicated that they run on electricity from the mains 44-68% of the time, driving somewhat more yearly than EVs, but the drivers do not get any of the EV incentives. In 2013 they have been allowed access to public charging stations.

Figure S1 shows the development of EV-sales from 2000 to 2012 and some important events in the Norwegian EV history. During 2012 the number of EVs in the car park reached 10 000 (0,4% of the total fleet of passenger vehicles).

In 2013 *the market expansion phase* is entered with an increasing number of car dealers offering Electric Vehicles. The number of EVs passed 13 000 in first half year of 2013. The Norwegian EV market is a very competitive market with most vehicles being sold to private buyers. Different business models are tested, amongst these the free of charge loaning of ICE-vehicles for 20 days the first 3 years of EV ownership offered by Nissan. This enables some single car households to opt for EVs. Renault tries out battery leasing without success. Norwegians seem to prefer owning the entire vehicle. In 2013 the fleet market is waking up with municipalities among the more active purchasers. Oslo is leading the way, planning to buy up to 1000 EVs the next years.

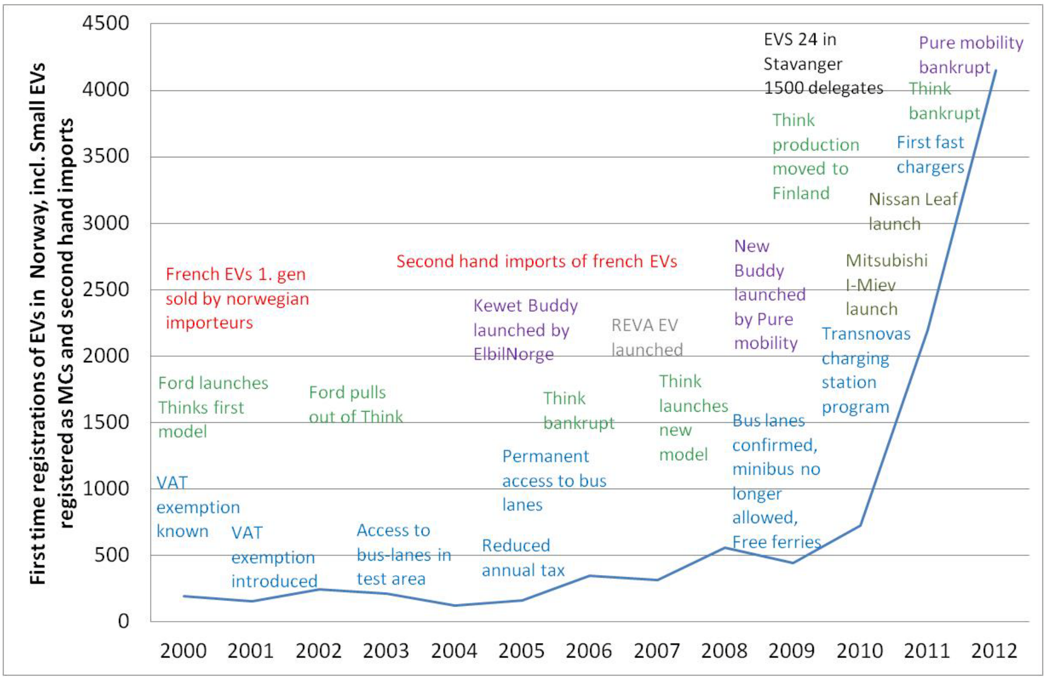

Figure S1: Estimate for EV-sales in Norway 2000-2012 and timeline for the introduction of incentives. Source: TØI, based on vehicle stock statistics from Grønn bil and OFVAS. Sales figures in the early years are uncertain. (EV=Electric Vehicle).

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Electric biking is in its infancy

Electric biking is another important measure to achieve climate goals because of its potential to contribute to increased biking. Norwegians are barely familiar with electric bikes (Pedelecs), and are far behind other European countries. Pedelecs are ideal in areas with large altitude differences, and makes longer distance biking accessible for more people. There are currently no incentives for pedelecs in Norway. The price increase compared to traditional bikes seems to be around 600- 1 800 €. Test programs are under way to increase the knowledge, supported by amongst others Transnova and the province of Akershus.

EV policy to reach national targets through incentives

Climate policy is the major driving force in the Norwegian politicians commitment to EVs. Also a renewed interest in local air quality the latest years is apparent. During the period from 2000-2010, industrial development was also a political driving force, as it seemed possible to establish a national EV-industry. Electrification involves replacing conventional vehicles with EVs and Plug-in Hybrid vehicles (PHEVs). Electricity is considered CO_2-emission free in Norway as more than 98% of Norwegian electricity is produced in hydro-electric power plants. In addition it should be noted that the Norwegian electricity production is part of EU Emission Trading Scheme for CO_2-emissions. Every conventional vehicle replaced with an EV results thus in about 100% reduction in CO_2,-emissions. PHEV emission reduction is estimated to be 44-68%, the same as the share of electric driving, depending on type. In a life-cycle perspective, taking into account emissions for extracting, preparing and distributing energy, using average European electricity mix, including emissions for producing the vehicles, the CO_2,-emissions of EVs would still be lower than for conventional vehicles of the same size.

Incentives for EVs can be targeted at making the purchase cost comparable to conventional vehicles, removing barriers to usage, giving the buyer an advantage that compensates for the EVs disadvantages, thereby reducing the risk of buying and using EVs early in the development phase. Table S1 contains the writers assessment of the effectiveness of the most important incentives.

The Norwegian EV policy has made EVs possible to buy and attractive to use. The incentives have been added one at the time until the market finally responded with increased sales. The prolonged EV interest, and lobby organizations that have battled for better incentives, have resulted in Norway having the largest EV incentives in the world in 2013. As a result Norway has the largest EV fleet and yearly sales per capita.

EVs are small and used to have lower comfort and poor safety level compared to conventional vehicles. Early owners apparently traded comfort and safety for access to the bus lanes, and to drive free of charge on toll roads. A few may have been motivated by technological interest. It is obvious that the bus-lane access has been a profound factor influencing EV sales in Asker municipality outside of Oslo, as commuters here face the largest rush hour delays in Norway. Some places the exemption from toll road charges has been important, especially places with yearly toll road charges in excess of 2 500 €. In 2012 and 2013, sales are spreading to areas where these incentives cannot be the only or the most important explanation.

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Tabell S.1: Authors assessment of the effectiveness of measures and incentives to promote EVs in Norway.

Incentive	Introduced	Importance	Evaluation
VAT exemption	2001	++	EV's are more expensive to produce than traditional vehicles causing VAT to be higher. A 12 500 € price increase of the vehicle results in a 3125 € increase in VAT making the vehicle 15 625 € more expensive to the consumer. This would actually increase government income unless the VAT is exempted. The Exemption in Norway has evened out the price difference between EV's and conventional cars.
Access to bus lanes	2003/2005	++	Very efficient in regions with large rush-hour delays in the traffic. The disadvantage is that only a limited number of vehicles can use the bus lane before buses are delayed. There is a risk of increased vehicle ownership if people drive an EV in the bus lane rather than taking the bus. Minibuses were banned from the bus lanes in 2009, leaving EV's as the only vehicle type consumers can buy to get access to bus lanes.
Exemption from registration tax	1990/1996	+	The exemption from the registration tax was introduced temporarily in 1990, and permanently from 1996. It was based on the value of the car and the exemption was very important to initiate test programs in the 1990s. Today this tax is totally changed and most EV's with a weight below about 1540 kg would anyway get a zero tax, given the way the tax system works. Examples of tax on gasoline vehicles: VW Up: 2 600 -3 600 €. VW Golf typical taxes: 5 600-9 400 €. The tax on these competing vehicles makes the EV's more competitive.
Free parking	1999	+	Effective where parking space is limited. A limited number of places are available and many have a time limit. Little influence on the total number of EV's unless parking spaces are converted to EV parking on a larger scale.
Free toll roads	1997	++	This measure has a large impact when the toll roads are expensive. This is the case many places in Norway. In the Oslo-area the costs are 600-1 000 €/year for commuters. Some places in Norway there are tolls exceeding 2 500 €/year, resulting in EV sales in unexpected areas such as small Islands with underwater tunnels to the mainland.
Reduced annual vehicle license fee	1996/2004	+	Three rates apply for private cars. EV's and hydrogen vehicles have the lowest rate of 52 € (2013-figures). Conventional vehicle rates: 360-420 €.
Reduced rates on ferries	2009	0	Not important up to now, few use it and the value of the incentive is limited.
Reduced imposed taxable benefit on company cars	2000	0	This incentive had little impact up to 2012 but might be more important from 2013 for the sales of Tesla Model S. This should be an attractive company car, given its long range and the free of charge supercharger network put in place by Tesla in Norway.
Financial support for charging stations	2009	+	Reduce the economic risk for investors establishing charging stations, and the range issue for EV owners is alleviated as they can charge the vehicles during a longer trip. Contributes to expansion of the EV market, and aids in get more EV miles out of every EV. The EV alternative becomes more visible to the population.
Fast charge stations	2011	+	Fast charging increases the EV miles driven and the total EV market. It becomes easier for fleets to use EV's and is a premise for using EV's as Taxis.
Reserved EL number plates	1999	+	Increases visibility and makes other incentives easier to control, i.e. free parking, exemption from toll road charges.

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Incentives have triggered early adopters

Innovation is not just about developing or manufacturing new technologies, items or new ways of doing things. When it comes to taking innovations in use, the innovation process must be understood as a communication process where success presupposes that:

- The "new" has specific characteristics; such as being compatible with user needs, has relative advantages compared to other similar offers, can be observed and tested before decisions on use are taken.
- The knowledge about the innovation is distributed in suitable channels, from producer to media and various networks the users are parts of.
- Those who decide to use the new, have qualities that enable them to take risks. This is the case both for individual users, and for decision makers on different levels that are influencing the framework surrounding an innovation.

Studies of diffusion of innovations shows that the first 2-3% that adopt or take an innovation into use are risk taking, young, educated, well off and in contact with scientific communities. The risk tolerance enables them to test new technologies, and their high income means they can take a loss. The next wave of early users, that can make up around 13% of total users, are also well off, educated with higher status and younger than those that takes the technology into use later. They are often opinion leaders and important for the further market introduction process. They are more cautious than the first users, which aids in the communication with those that follows.

The early EV adopters have characteristics that fits well with the picture outlined. There is a higher share of married men aged 30-50 years with higher education, full time job and high income among EV users, than in the average population. They live in or near the largest cities, and 91-93% belong to households with more than one vehicle. However, one cannot take for granted that the future EV owners will have the same characteristics as the first owners. EV-ownership is socially more like multicar ownership in general. The national travel survey from 2009 shows that 42% of the population belongs to households with two or more vehicles. Among multicar owners, the share of men, couples living together, employed and households with high income is far larger than among those that have none or only one vehicle.

Most new technologies in the car industry are expensive and most often in the initial phase introduced in large and expensive luxurious vehicles. EVs have not (until Tesla Model S appeared) been available in the luxury segment. The EVs properties have thus been more advantageous to society than to consumers. Incentives have been used to make EVs more attractive to the consumers. One could say that access to the bus lanes has replaced status as a reason to buy the new technology in Norway. It is a necessity that some try out new things especially when it comes to environmental technologies. Buyers today contribute to making better performing EVs more affordable and available in wider choices in the future. The Norwegian incentives have made buying an EV within reach of most vehicle buyers. 2013-surveys shows that EV-owners now are more like the average car owner. A survey from September 2013 shows that more young people with lower income consider EV as an alternative when buying a new car the next couple years, compared to previous surveys.

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Users are motivated by economy and environment

Results from 19 Norwegian surveys on the perception of the EVs advantages, and disadvantages, and the reasons why consumers would consider buying an EV, have been analyzed. Figure S2 shows representative answers from one of the surveys. The EV buyers are mainly motivated by the comparative economical and practical advantages that EVs offer, compared to conventional vehicles, as a result of the incentives offered. All the incentives are seen as important advantages for an EV. Age, sex, income and family situation influence the motivation profile.

The EV is foremost used for daily trips, especially work trips. After buying the EV it is used for a large share of the households trips. This results in a benefit to the environment but can increase car use in general. The biggest disadvantage of EVs as it is seen in the surveys, is that the range is too short. Data on trip chain lengths from national travel surveys indicates, however, that most daily travels can be covered with the range EVs have today.

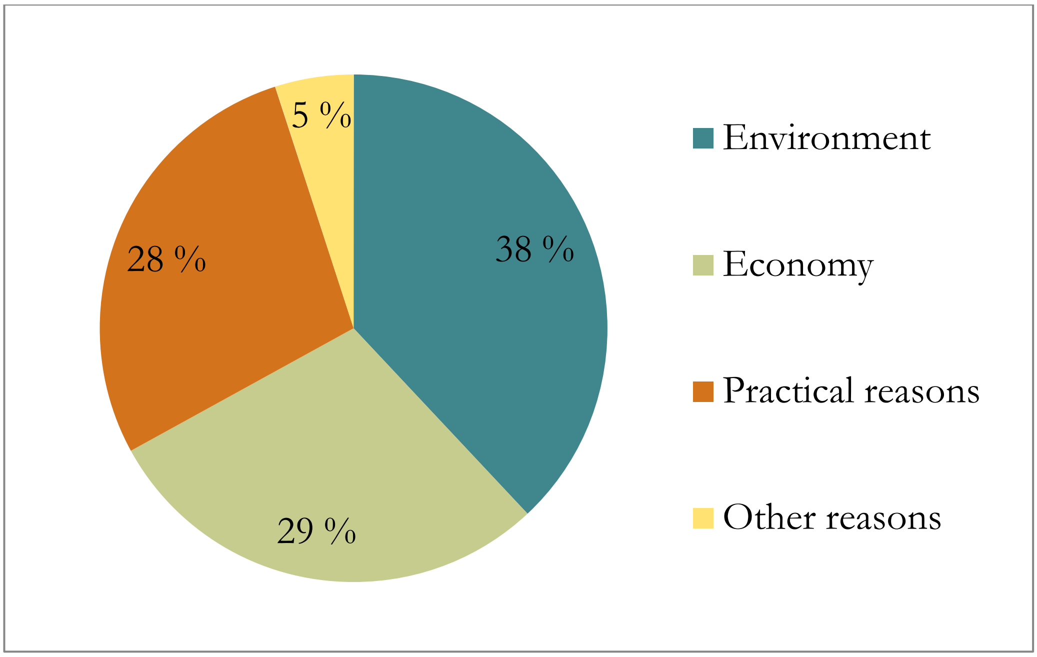

Figure S.2: Share of EV-owners reasons for selecting an EV. Percentage. (EV=Electric Vehicle). Source: Haugneland 2012.

The surveys shows that a large share of EV and Hybrid Electric Vehicle (HEV) owners are committed to their choice. 35-60% will buy EVs also in the future but more people consider buying a HEV than an EV. This could be influenced by the limited level of range and comfort on early EVs. Given that the price is equal about 19% would consider buying an EV. When comparing survey results from the latest couple of years, it becomes apparent that the share of potential EV customers is increasing. From 2012 to 2013 the share that considers buying an EV as the primary car has increased from 13% to 21%. The environmental benefits are not on the top of the list of reasons to buy an EV. Price, safety and efficient time saving transport is more important to the population. The EVs share of new vehicle sales is so far much

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lower than the positive attitude expressed in surveys. The real market potential and the real environmental effects are therefore lower than stated in surveys, roughly 10-15% with the current EV technology. With longer range vehicles that could become available in the future, the market share assessment would be more optimistic

Potential for EVs in Norway

Many of the conditions for a successful diffusion of EV's in Norway have evidently been present. Given that the EV fleet in the summer of 2013 passed 13 000 EVs and that this increases by 3 000 per half year, Norway has more EV's per capita than any other nation. Authorities and organizations have countered objections, developed solutions for problems, and communicated them to potential users. Early adopters with financial ability to take risks, and social capital to influence others, have bought the first EVs. This has led to an expansion of the customer base.

Our review of the population's assessments of the EV's advantages and disadvantages and actual data on the population's travel behavior form the national travel survey of 2009, leads us to believe that there still is a large potential for EV's in the private market in Norway. Especially in the cities and suburbs around the cities and in multicar households. Range is sufficient for most daily travels, including travels to and from work. The potential is larger among multicar households, and for those who have access to parking facilities at work. 42% of the population in Norway have access to two or more vehicles, so the theoretical potential for replacing conventional vehicles with EV's is large.

Price reductions have been substantial enough to give EVs a competitive price regardless if the user can utilize local incentives or not. This should result in sales also in areas without local incentives, and indeed evidence to this can be found in the Norwegian market last year. The second hand market, where many secondary vehicles for multicar households are bought, is less developed, but should pick up gradually as more new EVs are sold. Second hand value is however still uncertain.

The expansion of the charging infrastructure the last years has reduced range- and charging challenges reported in EV owner surveys from earlier years. The development is likely to go on, both improving batteries and an expansion of the charging network. Further market opportunities can be created by spreading more information on EVs, exemplified by the fact that they nowadays fulfill safety requirements, but also information on what range the user can expect in different driving situations, what different types of charging means and the impact it can have on battery life. The facts point at increased potential for sales of EVs in Norway.

It is early in the diffusion process and there is a risk of setback unless the EV sales speed up in other more populous countries than Norway or if competing technologies achieve major advances.

An obvious focal point for Norway and other countries is to encourage fleets to use EVs. Especially those operating in larger cities. Vehicles in fleets are used for specific tasks that cannot be solved by public transport. They drive medium long distances per day, making fleets an interesting EV market. In Norway today the fleet share of EVs is merely 25% of EVs sold and in use.

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EVs are important to reach national environment targets

The 2012 Climate policy settlement in the Norwegian parliament contains a target for emissions from new passenger vehicles. The average emission should not exceed 85 g/km (related to emissions measured in type approval testing). The target can be reached if either EVs or PHEVs or both types of vehicles achieves significant market shares, in parallel with substantial emission reductions from conventional vehicles. EV shares up to 20% are deemed necessary if PHEVs fail in the market, and a share of 30% PHEVs is needed if EVs fails in the market. The main measure to reach the 85 g/km target will be to increase the CO_2-part of the registration tax, making high emitters more expensive. At the same time this makes EVs and PHEVs more competitive against higher emitting conventional vehicles. The consumers will over time get an increased selection of low emission vehicles to chose from. The proposed tax increase is phased in over time at roughly the same pace as the expected availability of low emitting vehicles increases.

EV sales are expected to remain high in Norway. The economic incentives will remain in place at least through 2017. At the same time EVs will become cheaper than other vehicles (with incentives) and the selection will be wider. The market for PHEVs have been slow and around 500 were in the vehicle fleet in summer 2013. There are signs of increased competition which could lead to future price reductions, leading to increased sales.

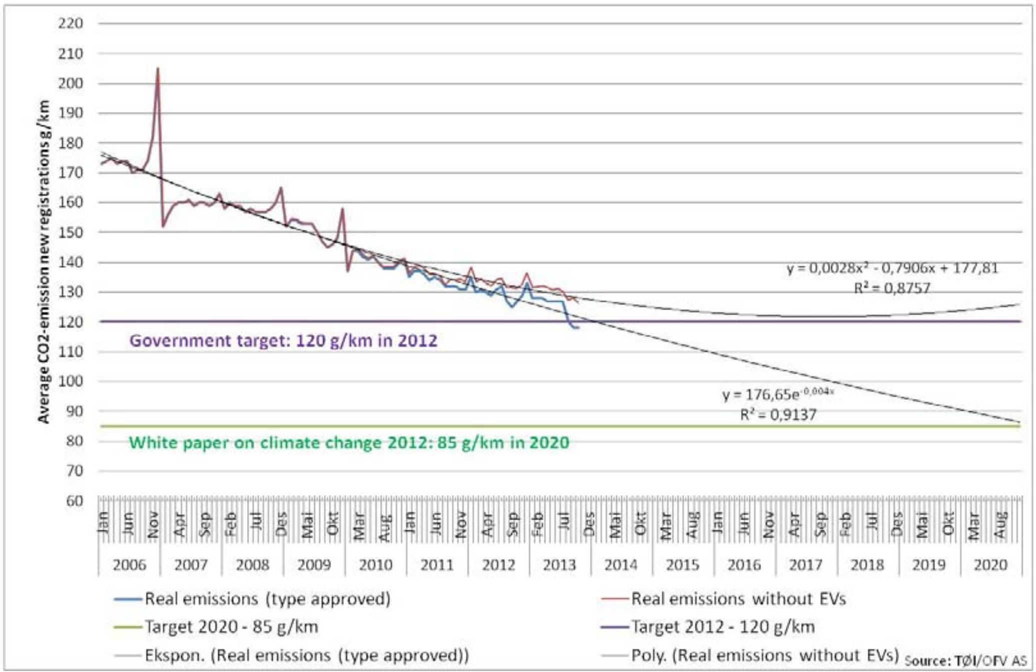

Figure S.3: Status of emissions (actual and estimated) from new passenger vehicles with and without EVs from 2006-2020 relative to national targets. Source: Figenbaum et al 2013.

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Phasing out incentives will be challenging. The incentives are so large and wide that to remove all at the same time will cause big disturbances in the market. The most challenging incentive to remove will be the exemption from VAT, which for a car costing 25 000 € will add another 6 250 € to the price tag. The most attractive user incentive, access to bus lanes, will probably be phased out some places within the next couple years to make room for the buses.

When EVs are selling well in all parts of the country, a gradual removal of the local user incentives can be initiated without disturbing the market to much. This will be a balancing act in cities. Here EVs are wanted since they can replace conventional vehicles and thus reduce pollution and noise. Fast charge stations will have a bigger market in cities. But if EVs replace public transport, biking or walking rather than conventional vehicles, then targets to reduce congestion can be troublesome to meet. Congestion as a result of urbanization and lack of incentives to increase vehicle utilization, are challenges not being solved by a transition to EVs.

The Norwegian example proves that EVs are attractive when incentives are powerful enough. If this situation contributes to EVs becoming really competitive in the market, or if this market will need permanent incentives at some level, remains to be seen. Another question is if the powerful incentives can be modified to stimulate behavior supporting other environmental goals, such as increased public transit shares in cities.

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1 Introduction

1.1 Electro-mobility - a response to climatic and environmental challenges

Transport is a necessary activity in all societies. Transport binds countries and regions together, giving people access to various activities and aspects of social welfare, as well as making goods and services from the business community and public institutions available to users. At the same time, transportation can produce considerable challenges to the environment and the climate. The transport sector (domestic transportation of people and goods) accounts for almost 30% of the total national Norwegian greenhouse gas emissions of 53.4 million tonnes of CO_2 equivalents. (http://www.ssb.no/natur and environmental data/statistics/ greenhouse gas). The proportion for the transport sector varies slightly according to the assumptions of the calculations. While the National Transport Plan (NTP 2014-2023) defines the transport sector share as 25.5% of total emissions in 2011 (Ministry of Transport 2013), the figures provided by Statistics Norway for 2012, which also include mobile machinery, indicate a percentage of 33% (ibid). Most of this – 10.1 million tonnes of CO_2 equivalents – come from road traffic (Ministry of Transportation 2013).

To deal with this, a number of different types of measures or packages of measures will be required. It is not only necessary to reduce the need for transportation, but also to influence the distribution of transportation, so that people and goods are transported in the environmentally best way possible, ensuring that the means of transportation uses the best environmental technology possible, e.g. the electrification of the vehicle fleet. If petrol and diesel cars are replaced by Electric vehicles, there can be substantial savings made in energy consumption and emission of the greenhouse gases. There is zero emissions of hazardous exhaust gases from Electric vehicles, and from Plug-in Hybrid vehicles when these are run on electrical energy stored in the batteries.

Electricity production is covered by the European Union Emission Trading Scheme (ETS) for CO_2. This means that when an Electric car replaces a car with an internal combustion engine, the emission is moved over to a CO_2-quota-regulated sector. The increased consumption of electric power would then be compensated for by other measures in quota-regulated sectors. The total available CO_2-quotas in the market, has a ceiling and the number of quotas on the market is thus fixed. Given that the quota system works as intended, in the long term it will lead to a gradual decarbonisation of average energy production in the European Union.

Electrification is an important factor when attempting to reach the goal of reducing greenhouse gas emissions and local pollution. For example, Figenbaum et al. (2013) show that not only Norwegian, but also European climatic goals for average emissions from new cars, can be reached with increased electro-mobility. Development is quick and an assessment of experiences and consequences for individuals, businesses, and communities is important. Norway is currently at the

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forefront in terms of electro-mobility and consequently possesses experience that can be shared. This is the background to this report summarising the Norwegian experience with electrification.

In order to achieve the other environmental and transport policy goals of restricting the growth of traffic in cities and reducing land use and congestion problems, measures other than electrification are required. Such measures are not dealt with in this report.

1.2 Scope of report

The main theme of the report centres on the Norwegian experiences with, and the development of, the Electric car market in Norway. To illustrate the significance of various policy instruments with respect to the development of the market, we have made a number of comparisons with other European countries. For the same reason, we have also taken a special look at the situation in Akershus, which is the county in Norway that has historically had the highest number of Electric vehicle users.

The potential for electro-mobility can be substantial in a number of different market groups, both private and public. BISEK in Sweden, which is one of the clients financing this study, is working with the social and economic significance of vehicles, and is particularly concerned with what different strategies for environmental transport could mean for individuals and households. Consequently, we are primarily looking at privately owned vehicles in this report. It is in this segment we find most Electric vehicles (76%) in Norway today (www.gronnbil.no). In some parts of the report, we have included data on the use of Electric vehicles in commercial transport and the public sector, and assessments from businesses.

Furthermore, we are primarily looking at pure Electric vehicles; this constitutes the largest Electric vehicle market in Norway and it provides the most available material. Where there is knowledge of assessments and facts about usage, we have also included data about Plug in Hybrid cars. We have also included some Norwegian data on electric bicycles and electric scooters, which constitute a growing market in several countries.

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Table 1: Different types of Electric vehicles. Source: COMPETT (2013).

Designation	Description of the drive system
EV	**Electric vehicles**
EV	*Electric vehicle.* A regular Electric vehicle in which the propulsion power is provided by the electric motor. The motor has a fixed device that produces a rotating magnetic field, as well as a magnetic rotor that is moved by this field. The rotor is connected to the drive shaft via a gear ratio, and this movement drives the wheels of the vehicle. This type of vehicle stores all its energy in batteries that are charged with power from the power grid.
EREV	*Extended Range Electric vehicle.* Electric vehicle equipped with a range extender. In addition to the batteries being recharged with electricity from the power grid. This type of vehicle has an internal combustion engine that is connected to a generator producing electricity that recharges the batteries and provides power to the electric motor while the vehicle is running.
FCEV	*Fuel Cell Electric vehicle*. Functions as an Electric vehicle where the power in the vehicle is produced by a fuel cell that converts hydrogen stored in the vehicle's hydrogen tanks, into electricity that powers the electric motor. This type of vehicle can also be a Hybrid variant with a battery.
HEV	**Hybrid Electrical Vehicles – Hybrid vehicles**
Parallel HEV:	*Parallel Hybrid:* Has two systems for operation, a common combustion engine (petrol or diesel) and an electric motor. Both engines are mechanically connected to the driven wheels. All propulsion energy comes from petrol or diesel, (or other liquid or gaseous fuel). The electrical system helps the combustion engine to operate in a more energy efficient manner, and can recover braking energy stored in batteries which in turn can be used for acceleration.
Serial HEV:	*Serial Hybrid.* Here only the electric motor is connected to the drive wheels. The second engine (typically an internal combustion engine (ICE Internal Combustion Engine) provides power to a generator which in turn, produces energy for the electric motor and the batteries.
Mild HEV:	This is a parallel Hybrid Electric vehicle with a rather small electrical motor/generator, and for which pure electric operation is not possible.
Full HEV:	Also a parallel Hybrid Electric vehicle but with an electrical device that enables pure electric operation of the vehicles for very short distances, using power stored in the battery.
PHEV, **Plug in HEV:**	*Plug in Hybrid vehicle.* These vehicles can be recharged from an external energy source, for the most part a charging station connected to the electricity grid, and is therefore equipped with a larger battery than regular Hybrid vehicles and an onboard charger. They can run purely on electricity; typically 20-80 km per charge.
2 W EL	**Two Wheeler with Electric motor - Electric two-wheelers**
EPAC PEDELEC	*Electric Pedal Assisted Cycle/ PEDal-ELECtric Vehicle (EPAC). An electric cycle* is a cycle with a small motor. Pedalling activates the motor. Motor power is limited to 250 Watts and the motor will not drive the bike faster than 25 km per hour. All EPACs are characterised by having a pedal sensor and a brake sensor.
E scooter	*E-scooters* constitute scooters (mopeds) in which the regular petrol engine and fuel tank has been replaced with an electric motor and batteries.

1.3 Electric propulsion - types of vehicles and designations

The goal of electrification is to replace internal combustion engine vehicles with Electric vehicles and Plug-in Hybrid vehicles in the vehicle fleet. In addition, increased use of electric bicycles and electric scooters will constitute measures for electrification, and will contribute to more people using bikes instead of driving cars. Table 1 shows the various types of vehicles with English terms; these are also often used as abbreviations in Norway. COMPETT (2013) provides a detailed and updated account of the technology.

EV - Electric vehicle. An Electric vehicle driven by an electric motor powered by a battery pack, which in turn, is recharged with electricity from the power grid. The strength of the Electric vehicle is that the motor has high efficiency , it is 2-3 times

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more energy-efficient than a regular internal combustion engine; see Table 6 in Section 5.1. It does not generate local exhaust emissions and is considerably less noisy than a comparable car with an internal combustion engine at low speeds. An electric motor has less heat generation and energy consumption stops when the car is standing still (but lights and other equipment consumes power). Parts of the kinetic energy can be recovered by running the electric motor as a generator when braking, thereby recharging the batteries.

The main challenge for Electric vehicle technology lies in storing energy in the batteries. Electric energy is stored in a battery as chemical energy, which in turn, can be converted into electrical energy. The batteries can only be charged with a limited amount of energy and it takes time to recharge the vehicle with new energy. Typically under normal conditions, Electric vehicles that were marketed from 2011 until the middle of 2013, had a range of 160 km with around 200 kg battery packs. The corresponding range under adverse winter conditions can be 80 – 90 kilometres. In autumn of 2013, the Tesla S EV was launched on the market with a range of up to 480 kilometres. The upgraded Nissan Leaf, that became available from mid 2013, has an longer range of approximately 200 kilometres. Normally, battery charging from a 220V outlet takes up to 6 to 8 hours for an Electric vehicle with a range of 160 kilometres. Batteries can be fast charged up to 80% capacity in 15 to 60 minutes, depending on the capacity of the fast charger and the ambient temperature. The fast charging time increases significantly at sub-zero temperatures. Batteries that store more are constantly being developed with the target to increase energy density and thereby enable longer ranges. In Norway, recharging stations are being built in order to alleviate the challenges of range; see Chapter 5.

PHEV – Plug-in Hybrid Electric vehicle. Plug-in Hybrid vehicles are also being launched that can be driven purely on electricity for between 20 – 80 kilometres. For longer distances, an internal combustion engine is engaged, which either operates the wheels directly, or delivers electricity to an electric motor or recharges the batteries. Range is then extended to several hundred kilometres, and energy can be replenished as needed in minutes. Thus, the vehicles are suitable for all areas of use. The proportion of annual mileage that can be achieved using electrical energy will depend on how the vehicle is used, but it can be at a level of 40 to 70% for typical users, depending on configuration. There is little experience of how this works in practice and in the winter. The pure electric range for rechargeable Hybrid vehicles is also reduced in real traffic, especially when it is cold.

EPAC – Electric bicycles and Electric scooters. EPAC (Electric Pedal Assisted Cycle), also goes by the name Pedelec. It was against the law to sell electric bicycles in Norway up until 2002. In 2003, an exemption from vehicle regulations was introduced, which made the sale of EPACs legal in Norway. EPACs expand the potential for cycles in hilly terrain, where there is a lot of wind, and where distances are long.

1.4 Prerequisites for environmental effects

Electric vehicle technology makes vehicles 2 -3 times as energy-efficient as cars with internal combustion engines; see Table 6. This is an important reason for electrification, but not necessarily sufficient to achieve good results. Conditions that are crucial for the effects of electro-mobility on the environment, the climate and the population are;

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1. Where the energy in the batteries is derived from; i.e., the energy mix that is used.
2. The development of battery technology that affects range and price.
3. The kind of materials that are used in the batteries, and the levels of energy and emissions caused by their production.
4. The infrastructure and the support schemes that society organises in order to support the introduction, and what this costs.
5. What kind of market there may be for different types of Electric vehicles, that is, the types of travel Electric vehicles, Plug-in Hybrids, electric bicycles and scooters are suitable for.
6. Which groups in the population that want to and can use an Electric vehicle/Plug-in Hybrid vehicle. and the consequences for the users.
7. Which public and private businesses will be benefited by using Electric vehicles.
8. The way in which electrification can be utilised for industrial and commercial urban transportation is an important issue, especially the "last mile" or the last link in the transport chain.
9. The extent to which e-mobility will replace travel or transportation with other means of transport, or lead to new travel/increased vehicle use/increased vehicle ownership.

In this report we will elaborate on the Norwegian experience with electro-mobility, and from this perspective shed light on important elements for several of the factors mentioned above. We will not linger into technical details or the global environmental perspectives related to themes 1, 2 and 3. Here, we refer to a recently released collection of articles from Chalmers (Sandèn red. 2013), highlighting different aspects of electro-mobility from the perspective of a larger system. In terms of users, we are primarily looking at individuals (item 5) and to a lesser extent at businesses (items 6 and 7). This is based on agreement with the client. Norway distinguishes itself from other countries in that Electric vehicles are primarily purchased by individuals, not businesses and thus, it is reasonable to focus on individuals.

1.5 Frames of reference

Assessing market opportunities for new products is complicated because many factors come into play, both on the industry side and the user side. In order to gather the potential for Electric vehicle usage we require, among other things;

- A framework for understanding the factors that affect the diffusion of new technologies.
- General knowledge about both vehicle purchase and travel behaviours to see which influential factors are relevant.
- Knowledge of what people actually do, for example, which trips are undertaken, the duration of these and how behaviour is changed. This is important for assessing actual environmental effects and adverse behavioural adaptations.

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- Knowledge of the experiences and expectations of the users, in order to improve the products.
- Knowledge about given framework conditions, and how changes in these are assessed by society, individuals and businesses.

The aim of the project has not been to contribute the development of the theoretical framework for travel behaviour or theories for understanding the driving forces behind the various processes for proliferation of new technologies. However, we still require a few frames of reference.

1.5.1 Population travel patterns

The most important national survey on the transportation habits and travel patterns of people in Norway, (RVU), is based on extensive empirical and theoretical studies. The RVU analysis is based on a well-developed theoretical framework for what affects the transport behaviours of different people. Many of the socio-demographic, economic and residential and transportation-related variables used in studies of how people use Electric vehicles, are also included in the RVU, which thus provides a frame of reference. Hjorthol's (2012) overview of the changes in the pattern of travel habits of the population over time, provides a good insight into trends and motivational forces.

Currently, the RVU does not provide data about which vehicle the respondents are using, and consequently does not provide any opportunity to study the travel habits, or characteristics of Electric vehicle users compared to users of other types of vehicle. This will be changed as of the RVU 2013, in which questions about the type of vehicle will be included. Furthermore, there will be a study of travel habits in Akershus that will investigate the use of Electric vehicles. In the COMPETT EU/ERA-NET project headed by TOI, a study of Norwegian, Danish and Austrian Electric vehicle owners will be carried out in autumn 2013; see Section 3.5.

However, the RVU will provide data about the distance of different types of travel, and about the total distance of daily travel for different groups in the population, according to socio-demographics, economy and place of residence. In addition to studying data from surveys regarding the use of Electric vehicles, see Chapter 7, we are therefore using some data from the latest Norwegian National Travel Survey, (RVU 2009), in order to compare Electric vehicle users with the general population.

1.5.2 Diffusion of new technology

Theories about the introduction of new technology have been developed in a variety of disciplines such as psychology, sociology, history, and economics. Rogers (1962, 1995) developed a theory for diffusion processes that focuses on how an innovation is communicated through various channels over time amongst members of a social system, and then put to use. We will use this theory as basis for understanding the status and the development of the Electric vehicle market in Norway. According to Rogers, an idea is an innovation, a way of doing things or an object, (a technology), that is perceived as new by those who will adopt the innovation. An innovation can often create uncertainty and therefore people search for information in order to overcome this. This is why the communication process is so important.

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Based on Rogers' diffusion theory, it is not merely the innovation in itself that is significant to whether or not it will come into use. The significance of the innovation will evolve gradually through a social construction process with different phases over time. Key elements in addition to the properties of the actual innovation, are the social system which provides the framework, the characteristics of the users and the channels of communication used.

Diffusion of innovations, technological and others, take place in a social system. A social system tends to have a structure that organises the units in relation to each other. Structure provides stability and provides information that reduces uncertainty with respect to the behaviour of other units. A system will have norms for what is valid behaviour within the system. This will have great significance for the diffusion processes and how new ideas and products are welcomed. Other framework conditions that affect the chance for an innovation to have an impact, are the previous practice of this field, and the degree to which the innovation responds to a need or a problem.

In the classic "Diffusion of Innovations" (Rogers, 1962), we find a model that places the different impact factors and characteristics that contribute to the innovation, and tools for classification of users according to their place in the innovation process. Figure 1 is based on Rogers' (1995) somewhat simplified variant of the model.

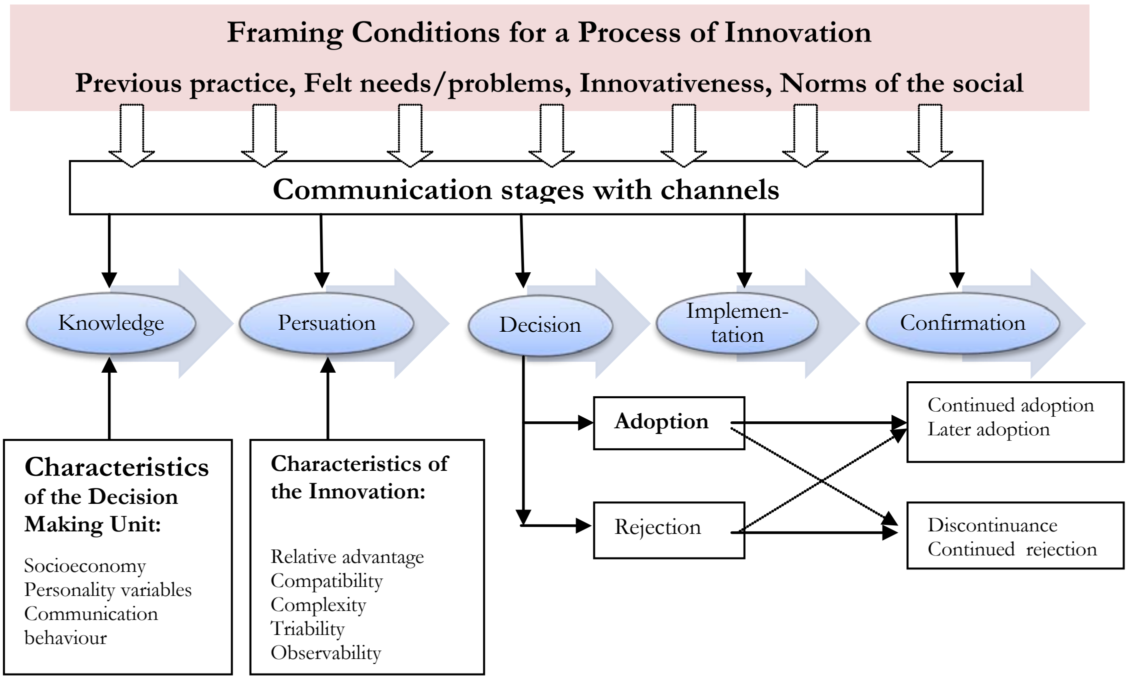

Figure 1: A model of the different types of factors that affect the diffusion of innovations. Source: Based on Rogers 1995, (p. 170)

Rogers (1962, 1995) shows that communication is the key issue in all five phases into which he divides the diffusion process. Users, individuals or other decision-makers, require different types of information in the various phases of the diffusion process;

I *Knowledge:* In the initial phase, knowledge of the new technology (or the new organisation), and how it works, is required.

II *Persuasion*: When users have acquired knowledge of the innovation, they must develop a basis for a decision regarding possible use. They need to be exposed to arguments for using the innovation to create a positive or negative attitude to the innovation.

III *Decision:* Making a decision implies choosing between using and adopting the innovation or rejecting it. In this phase, having the opportunity to try an Electric vehicle from friends, at work or at a ride and drive event, can be an important part of the communication process.

IV *Implementation:* This is the phase during which the innovation is put to use. Here there will still be a certain amount of uncertainty associated with practical use, and the consequences use will have. It is often easier to handle this information when it is organisations and not individuals who are the decision makers.

V *Confirmation:* During this phase, you will need reinforcing arguments to continue to use an innovation, and last but not least, to further develop it. Innovation does not mean simply copying a new idea or a new object. As a rule, an innovation must be changed or modified during the course of the implementation phase. Whether or not you wish to continue using the innovation, or reject is, is related to the type of new knowledge provided by the first time use of the innovation.

Key elements in the early phases are how the new technology is perceived with respect to;

1 *Relative advantages:* What advantages does the innovation have or is perceived to have, relative to other technologies? According to Rogers, relative benefits can be measured in economic terms, but social status, practical benefit and satisfaction are just as important.

2 *Compatibility:* To what extent is the innovation compatible or in accordance with the needs of the user and with basic values and norms in the social system? Innovations that cross the norms and values in a system take longer to be completed, that is, values may need to be modified first.

3 *Complexity:* How complex is the product? To what extent is the innovation perceived as easy to understand and put to use? Can it accommodate more opportunities?

4 *Opportunity for trial:* Applies to the possibility of testing the innovation in practice. Innovations that can be tried out on a small scale are perceived as less uncertain than those that require full implementation from the start, and are therefore often more quickly put to use.

5 *Observability/visibility:* Can the results of the product (process) be observed and visualised for others? The better the visualisation, the faster the innovation will be put to use. The need for visualisation stresses the importance of network communication.

The characteristics of the policy makers, individuals and groups, that Rogers presents, are: socio-economic characteristics, personal characteristics and communication behaviours. Different players will react differently to new products. It is therefore essential that there is someone who is willing to try new things out, the so called "Innovators/early adopters", early users/opinion leaders or change agents. Rogers (1962, 1995) distinguishes between five types of users, see Figure 2.

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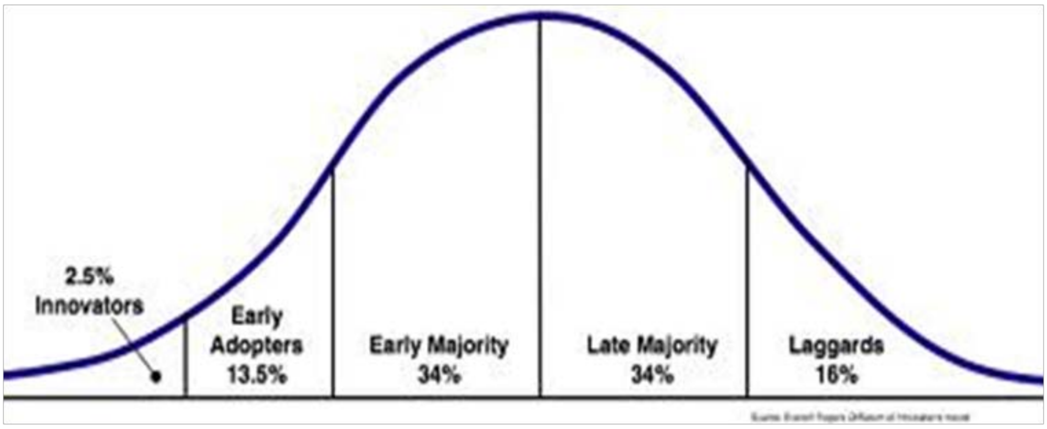

Figure 2: User types in an innovation process. Source: Rogers (1962).

The five groups of users of innovations that appear in different phases of the process, and that have different significance when it comes to spreading the new technology, are;

- *Early users (Innovators*) are the first to adopt or utilise an innovation. They are the young risk-takers, with a high education, good finances and are in contact with scientific environments, and other early users. Their risk tolerance allows them to try new technologies, which may eventually fail. Their finances are good enough to allow them to bear the loss.
- *Early adopters* come directly after early users. They also have better finances, education and status, and are younger than those who adopt at a later date. Individuals in this group are often opinion leaders and important for the further introduction process. They are somewhat more cautious than the innovators, which gives them credibility when communicating with others.
- *The early majority* adopts an innovation significantly later than the two former groups. Their social status is above average for the population, and they are often in touch with the early adopters, but they themselves are not opinion leaders.
- *The late majority* comprises a group that adopts innovations later than the average population. They meet innovations with scepticism. Their social status is lower and their finances are worse than the average. They are not opinion leaders. They have contacts with others in the same group, but also members in the early majority group.
- *Laggards* are the last ones to adopt an innovation. They are often older, negative to change agents and have low social status and a poor economy. Their contact is directed towards the family and close friends.

As mentioned, we do not intend to advance theories about the diffusion of new technology. The many key items of importance to the dissemination of innovations that Rogers cites are, nevertheless, an important background to our description of the experience of Electro-mobility in Norway.

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2 Norwegian Electric vehicle history

2.1 Development of the Electric vehicle in five phases

The Electric vehicle development in Norway has been through five phases as outlined in Table 2, concept development, testing, early market, market introduction and is now in the fifth phase, market expansion.

Table 2: Phases in the development of Electric vehicles in Norway; activities, market operators, measures and incentives

Phase	Year	Activities	Primary market operators	Measures and incentives introduced
Concept development	1970-1990	Development of Electric vehicle prototypes and propulsion systems	Bakelittfabrikken Strømmens Verksted ABB	Research funding
Test	1990-1999	Testing in test programs and car fleets, and the prelude to the commercialisation	Energy companies Think Citroën Norge Peugeot/Bertel O. Steen Kollega bil Miljøbil Grenland	Exemption from registration tax (1991) Free parking (1993, -1998) Reduced annual licence fee (1996) Road Toll exemption (1997) Reduced imposed taxable benefit on company cars (1998)
Early market	1999-2009	First attempt at commercialisation, supply of vehicles is a challenge, the technology has some teething problems	Think (part of Ford until 2003) Kollega Bil (Elbil Norge, Pure Mobility) Miljøbil Grenland	VAT (25%) exemption (2001) Experiment with bus lane access (2003), permanent 2005. Mini-buses removed from bus lanes (2009) Ferry ticket exemption (2009)
Market introduction	2009-2012	Established vehicle importer starts selling Electric vehicles in larger volumes. Supply of vehicles is no longer a limitation. Prices are decreasing.	Mitsubishi, Peugeot, Citroen, Nissan, Tesla, Renault, Mia	Plug-in Hybrids defined as hybrid vehicles and are thus given a 10% weight reduction before calculation of the weight tax (part of registration tax), and only the combustion engine power is subject for the engine power tax (2011).
		Plug in hybrid vehicles from 2012	Toyota, Opel, Volvo, Fisker	Plug-in hybrid vehicles are given permission to recharge and park at charging stations (2012).
Market expansion	2013-	More importers want to sell vehicles from 2013-2014, increased competition with more dealers will mean a continued decrease in price, but not as fast as seen in the previous phase for Electric vehicles.	As above + BMW, VW, Audi, Smart, Daimler, Ford	Plug-in hybrid vehicles have been given a greater weight reduction of 15% when calculating the registration tax (2013). In this phase, the bus lane access, will be a challenge to public transport, and this will eventually be removed, first locally, then nationally. As the market increases, it will be difficult to maintain other incentives and a phasing out plan must be formulated.

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In the last six years interest in Electric vehicles has grown in the Norwegian media, see Figure 3. It is interesting to note that media coverage increased significantly during the last three years before the proper launch of Electric vehicles on the market. In this period media attention was primarily associated with the Norwegian Electric vehicle manufacturers and operators. This may have created a media focus on the technology, and this helped to prepare the ground for the 2009 market launch as this increased the awareness of the technology in the population. However, the technology was not completely unknown. In 1993, more than half the respondents in a Gallup Compass survey (1993) stated that they would consider buying an Electric vehicle. A survey of car use done by TØI in the same year, found that 30% of those living in urban areas would consider an Electric vehicle as the main family vehicle, and 77% would consider it as an additional vehicle (Ramjerdi et al. 1996).

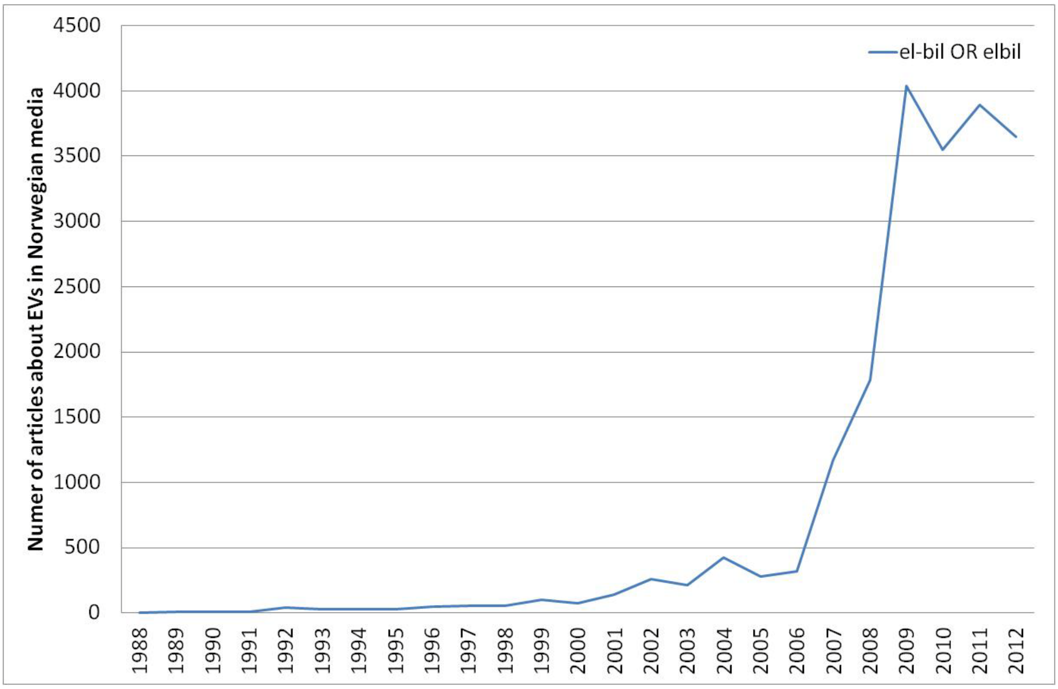

Figure 3: Number of articles in Norwegian media about Electric vehicles 1988-2012, Source: Retriever 2013. Keywords used: elbil or el-bil (different variants of the term "Electric vehicle" in Norwegian language)

2.2 Concept development 1970-1990

In this phase, which lasted from the beginning of the 1970s until 1990, prototypes of Electric vehicles was developed. Strømmens Verksted focused on electric vans and built several prototypes, see Figure 4.

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Source: www.autofoto.no

The Electric vehicle of the Norwegian ELBIL (Electric vehicle) project : photographed in front of Strømmens Verksted with test plates CC 28, photographed in 1972. Source: Norwegian Museum of Science and Technology

Figure 4: The Norwegian Electric vehicle produced at Strömmens Verksted.

A man named Lars Ringdal was inspired by the oil crisis and developed a small Electric car with plastic bodywork in the 1970s, see Figure 5. This was the forerunner to PIVCO and Think, but by then his son Jan-Otto Ringdal had taken up the challenge.

Source: http://www.flickr.com/photos /saabrobz/4120742370/sizes/z/in/set-72157629099446090/

Figure 5: Experimental vehicle, Bakelittfabrikken/Ringdal.

ABB Battery Drives in Vestby outside Oslo, developed a propulsion system for Electric vehicles which was used in the first VW Golf Citystromer Electric cars that were made in 1989, see Figure 6. There was a plan to industrialise the propulsion system, however it was never realised.

http://www.electroauto.cz/golf2_citystromer.html

http://www.isea.rwth-aachen.de/electricaldrives/vehicles/en

Figure 6: Golf Citystromer.

2.3 Test phase 1990-1999

In the testing phase from 1990-1999, the focus was on testing the technology and the most important aspect was to remove the 'disincentives' that made the purchase of an Electric vehicle impossible, difficult or very expensive. The environmental organisation Bellona, spearheaded the registration of the first Electric vehicle in the Norwegian Motor Vehicle Register, see Figure 7. This helped clarify the regulations,

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ensured there was expertise in the Norwegian Public Roads Administration, and thus made it easier for those who would later come to register Electric vehicles.

Figure 7: Bellona's Fredrik Hauge with pop group A-HA and solar energy enthusiast Harald Røstvik at an Electric vehicle conference in Bern in 1989. Source: The Bellona foundation http:/ / www.flickr.com/ photos/ bellona-foundation/ 5831990755/ sizes/ l/ in/ set-72157626959726220/

Figur 8: Kewet El-jet. Source: Wikipedia

The high value-based tax on registration of vehicles made it practically impossible to buy an Electric car in Norway. Electric vehicles had a high price and therefore a high associated value added tax (VAT). VAT was calculated on the sum of the total car price and the value based registration tax. This increased the price to the customer even further. Bellona managed to get an exemption from the value based registration tax on its Electric vehicle in 1990, and after this all Electric vehicles were exempt.

After the cars were exempted from the registration tax, it was possible for Kollega bil to import and sell the first Kewet Electric vehicles, see Figure 8. Pivco could start the development phase for its Electric vehicle. In 1994, eight prototypes were presented and used during the Winter Olympics in Lillehammer. In 1996, approximately 100 cars were built based of a new version, of which half were sold in Norway and the rest exported to the US for use in a 'Station Car' project in California (a car sharing scheme combined with public transport). In late 1998, the first production version was made, which was now called the Think City, see Figure 9. But before Think managed to put the car into production, the company went bankrupt.

PIV1 1994. Photo: PIVCO AS (1994)

PIV2 1996. Photo: Egil Kvaleberg

Think City. Photo: Think

Figure 9: Generations 1-3 of Think cars.

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Citroën was also active in the early 1990s, and considered importing the small C15 electric van. One of these was tested at the National Institute of Technology.

In the early 1990s, Electric cars were low on the political agenda, so study trips for politicians were organized. This included trips to France and a visit to La Rochelle, one of the primary testing and service centres for Electric vehicles, and for education of Electric vehicle technicians during the mid-1990s.

2.4 Early market phase 1999-2009

The early market phase lasted from 1999 until 2009. During this phase, major operators entered the field in Norway. Think was bought by Ford, the French energy company EdF was part-owner of Miljøbil Grenland and the new owners of Elbil Norge were members of some of the wealthiest families/investors in Norway. Plans for EV production in Norway was implemented. It was during this phase that a series of new incentives were introduced. The most important incentives were the VAT exemption and the access to bus lanes.

Figure 10: A numbered model car was given to all attendees at the opening of the Think factory.

12 November 1999 was a great day at Aurskog. The King of Norway opened the Think Electric vehicle factory. The King was given the first car. The CEO of Ford also attended the opening.

In a paper by Think from 2004, it is shown how the demand for Electric cars in Norway during this phase was affected by changes in the regulatory framework, see Figure 11. It can be seen that demand plunged when the VAT exemption was made public in October 2000, i.e., almost a year before it was introduced in July 2001. Correspondingly, demand skyrocketed when the trials of Electric vehicles in bus lanes started in 2003. But by then Think had been sold by Ford to an Indian investor living in the UK, that proved unable to get the production up and running. This meant that Think was not able to deliver cars to market during the first years of bus lane access. The demand was to a large extent covered by imported used French Electric vehicles, and Think Electric vehicles produced during 1998-2002, being sent back to the Norwegian market from the U.S. and Europe. Elbil Norge sold Kewet/Buddy and imports of Reva Electric vehicles from India commenced. The last two types were registered as L7e, i.e. 4-wheeled Heavy Motorcycles.

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On the Norwegian BEV market, which was the largest and most stable market for TH!NK, VAT (24%) was removed during the production of the TH!NK *city*. This had a significant impact on vehicle sales, as can be read from the graph below.

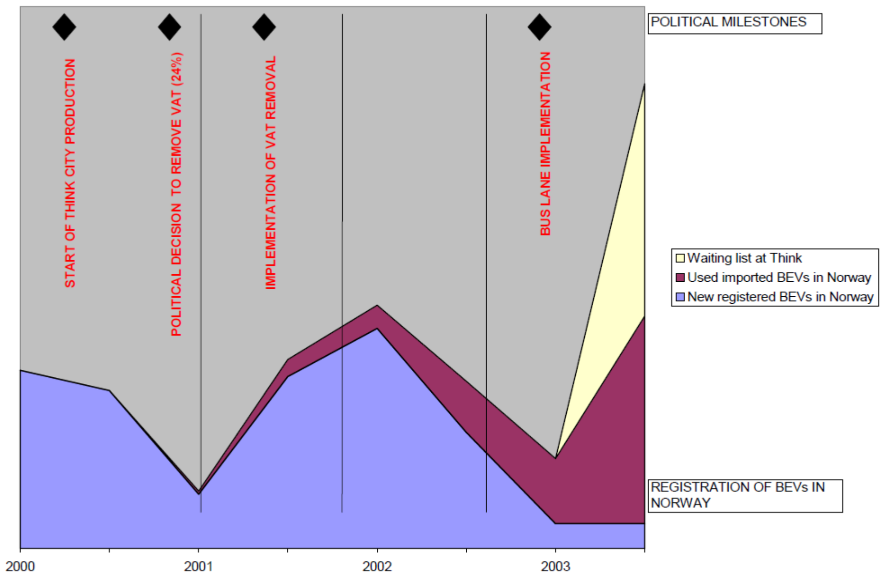

Figure 6: Impact of political incentives on sales in Norway

A one-year test program for access to bus lanes were introduced after the production had stopped, The result was a significant incerase in demand for second hand BEVs

Early feedback on the test program from bus and taxi organizations and companies shows that the introduction of BEVs to the bus lanes does not obstruct other and existing bus lane traffic.

Figure 11: Demand as a function of incentive changes. Source: Think Nordic 2004.

Powerful and attractive measures were established during the early market phase. This caused some car buyers to purchase Electric vehicles despite the fact that they were not as advanced, safe or comfortable as other cars. They apparently traded comfort for the access to the bus lanes, free parking and no road tolls. The significance of this can be seen in the sales of Electric cars in the Asker municipality, which has been the highest in Norway relative to the population. Asker is home to many commuters who take the E18 to Oslo, which is the Norwegian road with the longest delays during rush hours, and the longest continuous bus lane. A major contributing factor was probably also that when the access for Electric vehicles in bus lanes became permanent from 2005, this was followed by a ban of mini-buses in the bus lanes from 2009. Another important factor has also been the fact that Electric vehicles have their own number plates starting with EL. This makes them readily identifiable at the automatic toll booths. It also makes the management and control of the free parking incentive easier. Finally it increases the visibility of EVs in the traffic.

Throughout this period, Electric cars were high on the political agenda, and new measures for Electric vehicles were established. During the early years, the dream was the creation of a sustainable Norwegian Electric vehicle industry with Think. Later, the reduction of greenhouse gas emissions became an important topic of increasing interest amongst politicians and car buyers alike. Norwegians view electricity as a 'clean' energy source.

The Indian owner of Think did not achieve much and Think went bankrupt again in 2006. This time the company was acquired by Norwegian investors with a plan to put the car that Ford had almost fully developed in 2002, into production. Also Elbil

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Norge had expansion plans, and developed a new model, which was launched in 2009. The name of the company was changed to Pure Mobility, and they tried to establish large scale production in Portugal. The Indian vehicle manufacturer Tata, bought into Miljøbil Grenland, and planned for the manufacture of Electric vehicles in the Grenland region based on 'gliders'[1].

The phase ended with the financial crisis of 2008, which created challenges for Think, which at that time was in a critical phase in relation to launch of the new generation of the Think City model. The model was launched at the Geneva Motor Show in 2008 and was planned to be put into production at the end of that year, see Figure 12. There were significant delays. Think was in a situation which regularly required new capital to fund the next phase of industrialisation. The financial crisis put a sudden stop to access to assets, and Think had to search for new funding before being able to start production of the car.

Figur 12: Thinks launch at the vehicle exhibition in Geneva in 2008.
Source: http://www.r-zs.de/en/projects/international-motor-show-geneva-2008

2.5 Market introduction phase, 2009-2012

During the market introduction phase from 2009, the established automotive manufacturers made an aggressive entrance into the field. The Electric vehicle market in Norway was turned upside down. The dream of Norwegian Electric vehicle production faded away. Think and Pure Mobility went bankrupt in 2011. It was over for Miljøbil Grenland in 2012 after Tata sold the company to a battery manufacturer that closed down operations in Norway. It seems that it was not possible to compete against vehicle manufacturers able to determine the price of Electric cars without regard to short-term revenues. However, Pure Mobility has recently re-started development activities on the Buddy again, now operating under the name Buddy Electric AS. They will also support existing owners with service, repair and spare parts.

Transnova was established during this phase. Transnova is a government instrument tasked with advancing the use of climate efficient transport technologies and concepts, by supporting test, demonstration and dissemination projects. Transnova had a good start after being given responsibility for a support programme for the establishment of charging stations, which could be initiated quickly. This meant that infrastructure development accelerated from 2010. In addition, some counties and municipalities set up their own infrastructure support programmes. Strictly speaking, only Oslo and Akershus had regular programmes for this, while for others it has

[1] Glider is an automotive industry concept in which cars are taken off the assembly line without a driving system for resale to a rebuilder that installs its own drive system in the car.

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been some sort of 'stunt'. Eventually, support was also provided for the establishment of fast charging stations. Infrastructure development was the only new incentive in this phase of Electric car development. An interesting observation is that Electric vehicle sales have increased dramatically since 2011 without the introduction of other new incentives. From this it may be inferred that it was probably not the lack of incentives that limited the Electric vehicle sales earlier, but probably the lack of a variety of attractive vehicles.

The permanent access to bus lanes from 2005 and the ban of minibuses from 2009, created enough demand in the market, so that Mitsubishi was able to quickly sell more than 1,000 of the I-miev Electric vehicle, that went on sale in late 2010. Think was out of production for much of 2009 and was therefore not able to utilise market demand before New Year 2010, and by then it was known that Mitsubishi would start selling its cars, and apparently many were waiting for this. For many, Mitsubishi was a safer choice with an established dealer network, and a solid 5-year or 100 000 km warranty on batteries. Another important aspect is that through many years of activity and vehicle production, Think and Elbil Norge had created and maintained a small Electric vehicle market in Norway. This was now ripe and ready to buy the new Electric cars coming from the major vehicle manufacturers. It can also be imagined that potential customer groups became familiar with Electric vehicle technology, through friends and family belonging to the Electric car pioneers, but not willing to take a chance on buying an Electric car before the established manufacturers had such a vehicle on offer.

The first publically available fast chargers based on the Chademo standard, were set up in 2011. All Mitsubishi i-MiEV, Peugeot Ion, Citroen C-Zero and Nissan Leaf vehicles can use this type of quick charger. They provide up to 50 kW of charging power, (80% recharge in about 20-30 minutes), but it was quickly discovered that during the winter, when it is cold, it does not charge at any more than 20-25 kW power. This is because the batteries cannot withstand such fast charging when they are cold. It was Transnova-supported fast chargers that were initially set up, but eventually several counties became involved in the effort to get quick chargers up and running, providing some financial assistance. Nissan requires all dealers selling the Leaf to install fast chargers. Table 3 provides an overview of the fast charger operators, fast chargers that were installed by June 2013 and the type of payment selected. Note that in practice, some operators may have a monopoly in areas where there are currently few chargers in operation. The market has been dominated by operators positioning themselves, and testing different business models. In the beginning, many stations have been free of charge, now most stations cost money. The interoperability has been improving in the fall of 2013. When all that has received financial support is in place, there will be a lesser degree of monopoly. See the fast recharger map at: http://elbil.no/elbilfakta/teknologi/444-hurtigladekartet.

2.6 Market expansion phase from 2012

The market expansion phase has been so short that there has been little research done to analyse the driving forces. Electric vehicles have entered the market with a market share of around 3% in 2012 and the first half of 2013. It is likely that the strong demand in the market introduction phase will continue and increase, as long as the incentives are constant, and also as several new dealers and vehicle manufacturers will be launching vehicles. More and more people will know someone

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who owns an Electric vehicle and therefore knowledge about the technology will spread in the population.

Table 3: Overview of fast chargers and operators, Oct 2013. Prices are in NOK, 1 € = 8 NOK. Source: elbil.no, 16.10.2013

Operator	Locations today	Charge stations today	Charge outlets today	Planned charge stations	Online status	Accessibility	Subscription	Monthly rate	Punch card	Occational charging	Price per charge	Comments
ABB	Oslo, Asker, Skien, Bergen	4	4	0	Yes	Open	No	-	No	Yes	Free	Will be transferred to other operator, with a payed service
Eidsiva	Hedmark, Oppland	4	4	4	Yes	Visa/Master card + others RFID	No		No	Yes	44 NOK/15 min	In winter per 20 min, allows access for subscribers to other operators, SMS on new stations
EV Power	Trøndelag	9	9	2	Yes	RFID	Yes	299 NOK free usage	No	Yes	100 NOK/charge (when calling)	Allows occational charging upon call, later SMS/Bank card
Fortum	Østfold, Akershus	5	6	9	Yes	Cell phone SMS or RFID	No		No	Yes	2.5 NOK/min	3 NOK/min with SMS
Grønn kontakt	Agder, Buskerud	6	10	5	Yes	RFID	Yes	150 NOK+25 NOK/charge	50 NOK/charge	No	Free	Cell Phone SMS coming
Hordaland fylke	Hordaland	8	8	4	Yes	Open	No		No	Yes	Free	Various Energy companies/Utilities, Future payment with smartphone APP
Ishavsveien	Akershus, Østfold, Oppland	5	10	7	No	RFID	Yes	350 NOK free usage	100 NOK/Charge	Yes	150 NOK/charge (when calling)	Cell Phone SMS coming
Lyse Neo	Rogaland	6	6	0	Yes	Cell phone SMS or RFID	Yes	199 NOK (for 15 charges)	No	Yes	99 NOK/Charge	
Statoil	Oslo, Akershus, Østfold	5	5	0	Yes	At the counter	No		No	Yes	44 NOK/15 min + 74 NOK/30 min	
Nissan dealers	Across the country	20	20	1	2							Varying conditions for payment and access
Others existing	Akershus, Buskerud	3	3		Yes	Open	No			Yes	Free	
Others coming	Across the country			9								
Tesla	Southern Norway	6	44	0	No	Open	No			Yes	Free	Free only for Tesla Model S
Total		81	129	41								

In this phase, the first incentives could be up for a fall. In particular, access to bus lanes will be difficult to maintain in a rapidly growing market. This also applies to financial incentives when volumes increase. However, the Government has the ability to compensate for this, by increasing the fees to car owners who pay tax in line with the increasing Electric vehicle percentage. When there is a large proportion, it will start to become noticeable to those who pay tax, and there may be resistance to maintaining the tax incentives. At the same time, this also reduces the need for incentives as vehicle prices go down with increasing volumes. Mitsubishi sold 1,000 i-MiEV in Norway while the price was 30,000 €. Now the price has been reduced to 21,000 € (October 2013). The difference represents more than the value of the VAT exemption.

However, Norwegian politicians agree that the financial incentives for Electric vehicles should be continued until the end of 2017 according to the Climate Policy settlement in the Parliament 2012 (Klimaforliket 2012).

In this phase, the first plug in hybrid vehicles were also launched. The technology is a combination of Electric car and hybrid vehicle, and the fact that Electric vehicle technology is becoming so well known and established in Norway, is likely to be an advantage in the marketing of these vehicles. Traditional hybrid vehicles are selling well and it is therefore possible to envision increased sales of the Plug-in Hybrid type of vehicle. The Plug-in Hybrid vehicles are currently selling poorly, which may be due to a lack of incentives, (Hagman and Amundsen 2013). The vehicles are about as expensive to produce as Electric cars (Figenbaum 2010) and have few incentives in Norway. They are doing fairly well in the registration tax system (tax based on CO_2- and NOx-emissions, weight, and combustion engine power), as they have such low CO_2-emissions, resulting in a negative CO_2-tax which compensates for the tax on the other elements. The Plug-in Hybrid vehicles cars have also been allowed access to

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charging at charge stations that have been created, but they have not been given free parking. In mid-2013 the weight allowance when calculating the registration tax for the Plug-in Hybrid cars was increased from 10% to 15%. This measure reduced costs of the Plug-in Hybrid vehicles to consumers.

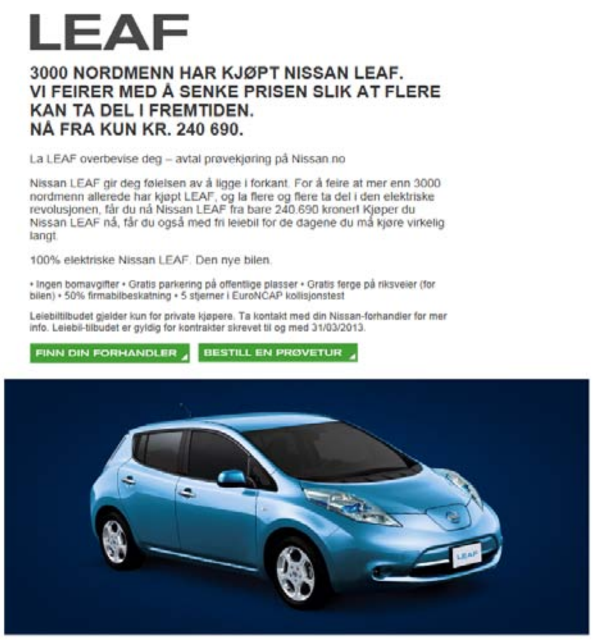

Figure 13: Sales advertising for Nissan Leaf 1st quarter 2013, Stating that 3000 Norwegians have bought the car and that the price is being reduced.

Nissan reached sales of more than 3 000 Leaf vehicles in Norway in Q1 2013. The new version of the Leaf is sold with 20 days of rental of a gasoline vehicle of similar size, during the first three years of vehicle ownership, included in the price as an introductory offer in 2013.

Nissan was offering financing for the outgoing model with a guaranteed buyback price after three years/ 45,000 km of 15,400 €. The new car price was 30,100 €.

The new Leaf cost from 27,100 € (without delivery costs) in Norway, and deliveries started in the summer of 2013.

During spring 2013, the outgoing model was sold with large discounts. Members of NAF (Norway Automobile Association) were able to get the car for 30,000 €, including winter tyres, registration and delivery costs and three years servicing included.

2.7 Important elements have converged

We will come back to the assessment of the market development and evaluation of various incentives in Chapter 10. Here we only mention some of the characteristics of the Norwegian development, which have clearly had an impact on growth in purchases of Electric vehicles. Diffusion is a process by which new technology or other innovations are communicated through various channels to the members of a social system. An innovation is an idea, a way of doing things or an object that is new to an individual or a group of operators. The sharing of information is an important element in the process.

In his model, Rogers (1995) points out the five key dimensions significant to the impact of an innovation, see Figure 5 in section 1.5.2.

- *Relative advantages (Advantage):* Electric cars in Norway have many clear benefits because of the incentives, both of the convenient and economical kind for users. Electric vehicles match most of the everyday travel needs, but not all. The relative advantages from the perspective of climate and the environment (energy efficiency, non-local pollution, low noise, etc.) are also in place.

- *Compatibility (Compatibility):* Compatibility with the norms of the social system is met with electrification of transportation, which is perceived as an important response to, and part of the solution to, the main problems locally, nationally and globally - namely greenhouse gas emissions and local air pollution. The need to increase the use of Electric vehicles is firmly rooted in both the transport and environmental sectors and the Parliament, through a climate policy settlement between all Norwegian parties (with one exception). The Electric car is also perceived, based on the relative advantages, to be compatible with the needs of multiple user groups.

- *Complexity (Complexity):* Electric vehicle technology is not so difficult to understand but a new style of driving can be a challenge for anyone. At the same time as being a challenge, it is also the 'trigger' for early users (*innovators/early adopters*).
  Complexity in the sense that the Electric car can cover many different purposes, means that there may be several different operators involved in the Electric vehicle development and support. The history of the Electric vehicle in Norway is largely based on actors at different levels and with different roles running the same thing from every side. Both the authorities and businesses and new and old organisations are involved.
- *Possibility to try out the new technology (Trialability):* Government subsidies have grasped this dimension. The financial arrangements have made it less risky to try out the new technology and the continuous testing and use of Electric vehicles in the last 10-15 years has also helped.
- *Opportunities to observe innovation (Observability):* That experiments are conducted and the fact that cars with number plates marked EL are seen commonly in the traffic, are advertisements in themselves and help drive development forward. The early adopters are important opinion makers at the early stages, illustrated by the fact that they have managed to attract increasing interest from the media.

The fact that many prerequisites for a good innovation process or convergence, is present, makes it possible to achieve a 'Tipping point', i.e., the point at which a number of different individual choices is able to cause the balance or the collective situation in a system to change significantly. The concept of the 'Tipping point' developed by Schelling (1971, 1978) was initially formulated for the study of residential separation processes in the U.S., but is also often used to denote substantial changes in other systems. When it comes to the diffusion of Electric vehicles, it might be said that the decisions of politicians and authorities, along with the involvement of organisations and the media have provided the conditions that enabled both production decisions and decisions regarding individual purchase and use choices. A lot of micro-level choices have provided an environmentally sound macro-result, although the operators did not necessarily have the same motives for their ventures, choices and actions.

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3 Goals and policy instruments

Norway has clearly defined goals for reducing national greenhouse gas emissions. In connection with the transport sector, different means and measures to increase the proportion of Electric vehicles are being evaluated and proposed in official Norwegian reports, investigations and white papers, and adopted in policy decisions and agreements in the Norwegian Parliament. Financial incentives are determined annually in connection with the adoption of the national budget, but through the Climate Policy Settlement of e 2012, a longer time horizon is provided, extending to the end of the election period in October 2017. By and large, local incentives are regulated by national regulations or municipal statutes.

3.1 Targets and analyses

3.1.1 Climate Policy Measures Analysis by SFT 2006-2007

The Norwegian State Pollution Control Authority's (SFT[2]) analysis of Climate Policy measures from 2006/2007, studied a measure aimed at replacing petrol and diesel cars with Electric vehicles. The total reduction in emissions from the measure was calculated to 7,519 tonnes of CO_2 equivalents in 2010 and 235,577 tonnes of CO_2 equivalents in 2020 (SFT 2007).

It was estimated that in 2020 around 2% of private cars could be replaced by Electric vehicles, by gradual phasing in with 2% of new car sales from 2010 and 5% of new car sales from 2015 and up to 2020. This would result in more than 70,000 electrical vehicles on Norwegian roads in 2020. In the calculations it was assumed that a reduction in emissions from heavy duty vehicles, would be achieved by replacing conventional buses with zero emission buses. This would provide a reduction of 3% of the emissions from heavy duty vehicles. Zero emission buses were defined as trolley buses, or buses using hydrogen as fuel in fuel cells or as fuel in internal combustion engines.

3.1.2 White paper on Climate Policy and Climate Policy Settlement in 2007

The first white paper on Climate Policy and the first Climate Policy Settlement in the Norwegian Parliament came in 2007. These resulted in establishment of a goal that greenhouse gas emissions in the Norwegian transport sector should be reduced by 2.5-4 million tonnes in relation to the reference pathway (what the development would have been without a new policy). This target was derived from the total reduction in emissions that should be achieved domestically; 12-14 million tonnes, and the percentage the transport sector has of the total emissions in Norway. Before the White Paper was written, the Norwegian Climate and Pollution Agency (KLIF,

[2] The State Pollution Control Agency in 2010 changed name to the Climate and Pollution Agency, and from 1. juli 2013 to the Norwegian Environment Agency.

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now the Norwegian Environment Agency) produced analyses of measures of how much emissions in different sectors in Norway can be reduced by, and at what cost.

3.1.3 Norwegian target of 120 g/km in 2012

In October 2007, the government adopted a target that on average new passenger vehicles would not emit more CO_2 than 120 g/km in 2012 (see Annex VI). They have attempted to steer towards this target by adjusting the CO_2 element in the registration tax, resulting in higher taxes on high emitters. The target was adopted at the time when the EU target was that the average emissions in 2012 would be 130 g/km from the vehicle itself (a further 10 g/km less due to better tyres, on board tyre pressure monitoring systems, biofuels etc). The Norwegian target was more stringent than that of the EU as it was only related to emissions from the vehicle. The EU adopted a gradual phasing in of the 130 g/km target, so full phase-in would not be achieved until 2015. The Norwegian target was not changed and was not achieved either. On average, in 2012, emissions for new passenger vehicles amounted to 130 g/km.

3.1.4 Action plan for electrification of road transport 2009

The resource group for electrification of road transport was appointed after an initiative from the energy companies, and consisted of a selection of private and public stakeholders. The energy companies pressed for Norway to establish a target for electrification of road transport. On behalf of the Ministry of Transport, the energy companies organised a resource group. In 2009, it presented a plan of action for the electrification of road transport, which assumed that it would be possible to reach a 10% share for Electric vehicles and Plug-in Hybrids in the passenger car fleet in 2020. This would be attained through a continuation and strengthening of the use of existing measures and some new ones. Among other things, an extra grant of NOK 3,750 € per vehicle was proposed. This was however not adopted by the government.

3.1.5 Klimakur report 2008-2010

The Klimakur (Climate Cure) project was established by the government through a joint mission from the concerned ministries for the underlying agencies: The Norwegian Public Roads Administration, the Norwegian Climate and Pollution Agency (the Norwegian Pollution Control Authority at that time), the Norwegian Maritime Authority, the Norwegian National Rail Administration, the Norwegian Petroleum Directorate, Avinor (the Norwegian Civil Aviation Administration) and Statistics Norway. Klimakur assessed the potential for national emission reductions in all the sectors. The work within the transport sector was led by the Norwegian Public Roads Administration. The final report and sub-reports were published in February 2010 (Klimakur 2010). Klimakur (Figenbaum 2010) described the following measures to reduce average emissions from new passenger cars.

- Efficiency improvements of vehicles with internal combustion engines
- Better tyres
- Electrification
- Hydrogen.

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The electrification measure imply that Electric vehicles and Plug-in Hybrids will replace internal combustion engine vehicles. In this context, electricity is calculated as zero emissions (electricity production is a part of the EU European Trading Scheme (ETS) and anyway belongs to another sector). Thus, each Electric vehicle that replaces a vehicle with an internal combustion engine, reduces CO_2 emissions by 100%. Rechargeable hybrids were assumed to provide a reduction in emissions of 44-68% depending on type of vehicle. It was estimated that Electric vehicles could make up approx. 7% of the new vehicle market and Plug-in Hybrids approx. 8% of the vehicle market in Norway by 2020 (a higher expected percentage than in the EU). The reduction in emissions in 2020 calculated to reach approx. 200,000 tonnes of CO_2 equivalents. It was assumed that there would in parallel be a significant improvement in the efficiency of petrol and diesel vehicles, something that would reduce the potential for emission reductions with Electric vehicles.

3.1.6 White paper on climate and Climate Policy settlement 2012

The work with the Klimakur project was part of the basis for drawing up the White Paper on Climate Policy published in 2012. The White Paper (Miljøvern-departementet 2012) established a goal that the average CO_2 emissions from new passenger cars would be reduced to 85 g/km by 2020. The Climate Policy Settlement in the Norwegian Parliament from June 2012 maintained this goal (Klimaforliket 2012). The White Paper that was adopted by the Settlement, states the following with regard to the 85 gram target:

> *«Has as its goal that in 2020, the average emissions from new private vehicles will not exceed an average of 85 g of CO_2/ km.».*

In order to achieve this goal, the Climate Report describes a number of measures and incentives that should be implemented:

- *«Continue to use vehicle taxes to contribute to the shift to a greener and more climate-friendly vehicle fleet.*
- *Evaluate gradually phasing in requirements for environmental properties and CO_2 emissions for taxis that can use bus lanes.*
- *Contribute to the development of infrastructure for electrification and alternative fuels, among other things, through Transnova.*
- *Be a promoter of international efforts for the standardisation of solutions, and the harmonisation of regulations, for zero and low-emission vehicles.*
- *Continue to be internationally at the forefront in facilitating the use of electric and hydrogen vehicles.*
- *Provide plug-in hybrids with access to parking with charging facilities (charge stations for EVs).*
- *Establish better systems for monitoring and controlling the development of traffic in the bus lanes so that, as far as possible, Electric vehicles and hydrogen cars can have access without this delaying public transport.*
- *Develop a plan for extended environmental information when selling new vehicles, including information about fuel costs and fiscal disadvantages for vehicles with high emissions, as well as strengthened controls of environment and energy labelling when selling new vehicles.»*

The Climate Policy Settlement contains the aforementioned points with the following additions:

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- *«Zero-emission vehicles, plug-in hybrids and other environmentally-friendly vehicles shall fare better (in the tax/incentive system) than corresponding vehicles using fossil fuel. Electric vehicles and hydrogen incentives will be frozen until the next parliamentary term (i.e. at the end of 2017), if the number of vehicles does not exceed 50,000 before that time.*
- *Other incentives to promote zero-emission vehicles such as exemptions from road tolls and ferry fees, access to bus lanes and free parking must be seen in the context of traffic development in the major cities. The views of local authorities must weigh heavily in decisions regarding these incentives.*
- *Plug-in hybrids shall fare better than corresponding vehicles using fossil fuel»*

In addition, there are some points in the Climate Report that may indirectly affect the 85 gram target:

- *«Aim at having public transport, cycling and walking accommodate the growth in passenger traffic in the metropolitan areas.*
- *Establish Transnova as a permanent organisation and gradually increase funding.*
- *Develop routines for better public procurement by updating and developing the set of criteria used by DIFI (Agency for Public Management and eGovernment), for environmentally conscious procurement of vehicles and taxi-services in the public sector. »*

Figenbaum et al (2013) has calculated to what extent the 85 g target can be attained in different scenarios, with different degrees of commitment to Electric vehicles and Plug-In hybrids, and which tax regimes may be necessary. Their conclusion is that the 85 gram target can be attained in scenarios where one assumes that either Electric vehicles or Plug-In hybrids or both technologies make an impact on the market and gain significant market shares. In the scenario where none of these technologies make an impact, it will be very difficult and costly to reach the target, as this would imply a unification of the of the market where the average vehicle will have to be small and diesel-powered. Further restructuring of the vehicle registration tax to encourage consumers to buy vehicles with low CO_2 emissions, will be necessary in all the scenarios. The consequences for the state and consumers will be relatively small because technological development, and EU requirements for reducing average emissions for vehicles, will contribute to making vehicles with low emissions available on the market, so that consumers can avoid increases in charges by selecting vehicles with the lowest emissions.

3.2 State measures and incentives

A list of the financial measures and incentives can be found in Fridstrøm (2012).

3.2.1 Own identifying vehicle licence plate - EL

Electric vehicles have their own identifying letters, EL, on the vehicles license plate. This simplifies any control of whether the vehicle fulfils the conditions for user incentives such a free parking, free passage through toll booths etc. Correspondingly, hydrogen vehicles have HY as identifying letters. There is no equivalent for Plug-in Hybrids. Being able to see passing vehicles with either EL or HY can have an informative effect on the general public.

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3.2.2 Vehicle registration tax exemption

The registration tax is imposed on all vehicles registered for the first time in Norway with exception for Electric vehicles and hydrogen cars. It is also imposed on second hand imported vehicles, but there is a usage allowance that increases with age.

The registration tax is calculated based on unladen vehicle weight, combustion engine power, CO_2- and NO_X emissions, which are data obtained from the type-approval documentation; see Table 4. A separate tax is calculated for each of the parts which are then added to form a total registration tax. The CO_2 tax element can be positive or negative. A negative tax can be deducted from the weight, power and NO_X tax. The total amount cannot however not be negative, no subsidies are handed out.

Table 4: The vehicle registration tax in 2012 and 2013. Composition and value of different components Source: Ministry of Finance 2012.

Vehicle registration tax	2012	2013
Unladen weight tax NOK/kg		
first 1,150 kg	36.89	37.59
next 250 kg	80.41	81.94
next 100 kg	160.84	163.90
the rest	187.06	190.61
Engine power tax NOK/kW		
first 65 kW	0	0
next 25 kW	315	275
next 40 kW	895	790
the rest	2,220	1,960
NOx emission tax, NOK/mg/km	22	35
CO2 emission tax NOK/g/km		
first 110 g/km	0	0
next 15 g/km (20 g/km in 2012)	750	764
next 40 g/km	756	770
next 70 g/km	1,763	1,796
the rest	2,829	2,883
deduction below 110 g/km down to 50 g/km for vehicles with emissions below 110 g/km	750	814
deduction below 50 g/km for vehicles with emissions below 50 g/km	850	966

Electric vehicles have as a pilot scheme been exempted from the registration tax charge since 1990. The scheme became permanent in 1996. In practice, most Electric vehicles would not have a registration tax even if they were covered by it. They would get a discount of NOK 88,350 in the CO_2 part of the tax, and not be imposed a vehicle NOx-emissions tax, also not an internal combustion engine (ICE) power tax since they do not have an internal combustion engine. They will only have a positive total registration tax when their weight exceeds approx. 1,540 kg. Thus, no tax would be imposed on the Nissan Leaf, while the Tesla Sedan S is so heavy that it would have a positive tax.

Some of the Plug-in Hybrids fare well when it comes to the registration tax. They have low CO_2 emissions that achieve a large deduction in the vehicle emissions fee of the registration tax, this compensates for much of the weight and engine power fees. Like all other hybrids, up to the first 6 months of 2013, they had a weight allowance

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of 10% prior to the calculation of the weight fee. From the second 6-month period of 2013, the allowance has increased to 15%. The power of the electric motor is not included in calculating the registration tax as it is only combustion engine power that is taxed in the system. Some Plug-in Hybrids positioned in the luxury market with big powerful combustion engines, have been penalised by the progressive engine power tax, resulting in a high overall vehicle registration tax. The last few years the engine power tax has been reduced and in the national budget proposal for 2014, further reductions are proposed.

3.2.3 The lowest annual licence fee

The annual licence fee is imposed on all private vehicles registered in the Vehicle Register each year on 1st January. There are three rates on private vehicles. Owners of Electric vehicles and hydrogen cars pay the lowest rate of 52 € (figure for 2013), while a rate of 360-450€ is imposed on other vehicles. The low rate for Electric vehicles was introduced in 2004. In the period between 1996 and 2004 Electric vehicles had a total exemption from the fee. The lowest rate covers that which previously was a third party injury fee, a state fee that was intended to cover the costs incurred during vehicle accidents. Up to 2004, this charge was a mandatory part of vehicle insurance, but became a part of the annual fee in 2004.

3.2.4 Lower imposed benefit taxation for company cars

Private citizens using a company car, must pay a fee for the benefit of being able to use the vehicle for private driving. For Electric vehicles, the imposed benefit taxation is halved in relation to other vehicles, as only half the vehicle's value is counted when calculating the benefit. The reasoning for this is that the private benefit is less than for regular vehicles, since the Electric vehicles cannot be used for long road trips. A reduced rate for Electric vehicles was introduced as of 2000. Initially, the decision was formulated as follows:

'The Ministry of Finance has decided that there will be lower imposed benefit taxation if the company vehicle is an EV. Company vehicles are taxable according to kilometre rates depending on prices classes defined in more detail. After an amendment to regulations by the Ministry of Finance, Electric vehicles are taxable according to a kilometre rate that is two classes below the actual list price of the vehicle'.

Source: Aftenposten Morgen 11/012000 Page 31.

The decision was made public the month before the Think EV-factory in Aurskog near Oslo opened in 1999.

Today (2013) the system is such that the regular rate (added to income before tax is calculated) is 30% of the vehicle list price below NOK 33,300 € plus 20% of the vehicle's list price above 33,300 €. If the vehicle is older than three years, 75% of the list price is counted, while only half of this fee is imposed on Electric vehicles.

Thus, an EV with a list price of 30,000 € will provide a 15% basis for taxation instead of 30%. Given an earned income of 56,000 € (giving a marginal tax rate of approx. 45%), this measure results in a theoretically possible saving of approx. 2,000 € a year for the employee affected. This is not believed to have affected many employees. According to the resource group for electrification of road transport (2009), 3% of all employees in Norway have a company vehicle where all costs are covered by an

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employer. Based on a total of approx. 2,6 million workers, this makes for approximately 78,000 company vehicles. The gains that can be achieved will vary a lot.

3.2.5 Increased mileage allowance rate for Electric vehicles

13% of all workers receive an allowance for using their own vehicles at work; in all about 330,000 people. EV drivers receive an allowance of 0.52 €/km while drivers of regular vehicles gets 0.5 €/km.

3.2.6 VAT exemption

The Value Added Tax (VAT) is at 25%, and is added to all goods and service sold in Norway. For vehicles, the tax is added to the sales value without the registration tax. Electric vehicles have been exempted from VAT since 2001. The exemption was disclosed to the public in the national budget that was published in October 2000. The manufacturers and importer of Electric vehicles did not sell many Electric vehicles to private citizens after the decision became known and until it was introduced. This incentive plays no role for companies as they have tax accounting, i.e. they can deduct any VAT they have paid.

3.3 Municipal and local incentives

3.3.1 Access to bus lanes

In 2003, Electric vehicles gained access to drive in bus lanes on selected test road sections (most of the bus lanes in the greater Oslo region). The system became permanent as of 2005. From 2009 minibuses were banned from the bus lanes. It is assumed that the system significantly affected the sale of Electric vehicles in Asker Municipality due to major time delays on the E18 in to Oslo during rush hour traffic. Most of this stretch has a continuous bus lane. Questions can be asked about whether allowing access to a scarce commodity like bus lanes, over time will be a suitable instrument for promoting reduced CO_2 emission. In a situation where there are shortages and increasing pressure on road capacity, incentives prioritising greater occupancy in vehicles, time-critical driving where payments are made to drive in bus lanes, or different forms of commercial transport, might be good alternatives. Increasing numbers of Electric vehicles in the bus lanes will reduce the benefits for public transport. To the extent that Electric vehicles contribute to increase vehicular traffic, the system will give rise to indirect negative effects of queuing, since vehicles in queues will be in the queues for longer periods of time, resulting in increased conflicts and a worse flow of traffic.

3.3.2 Road Toll exemption

As of 1997, Electric vehicles were exempted from tolls in road projects in which the state is a partner. In some places this may give the owner of an EV significant financial benefits. Tolls are applied to finance road capacity expansion and to improve public transport, the latter so that there is a reduction in the need for expansion of the road network. It is not clear why owners of Electric vehicles should not be subjected to this type of regulation over time. If rush hour fees or time-

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differentiated toll rates are introduced, these will be based on the consideration to reduce peak loads on the road network, as an alternative to expanding the transport system. Electric vehicles contribute to the total transport load in cities, and their exemption undermines the purpose with such regulation. This suggests that this instrument can and should gradually be phased out.

3.3.3 Exemption from ticket fee on national road ferries

Since 2009, Electric vehicles have been exempted from paying ticket fees on highway ferries; i.e. ferries that count as part of the national road system. Passengers in the vehicle will still have to buy a ticket. A justification for introducing this incentive was equal treatment with tolls, as ferry costs constitute the "tolls" for the coastal regions of Norway.

3.3.4 Free public parking with and without free charging

Electric vehicles have been able to park free of charge on municipal public parking areas since 1999; however, some places have allowed this since 1993. Among others, the utility company Oslo Energi, was out early offering free parking and charging at charging stations that were set up on its own sites from 1993. In 1997, a unanimous city council in Oslo decided that they wanted free EV parking. Oslo Municipality then requested that the Ministry of Transport change the regulations so that this would be possible. It appears that the final decision came on 19 January 1999.

Excerpt from the parking regulation:

§ 1. *Measure*

This regulation applies to the halting and parking a motor vehicle or trailer of a motor vehicle, on a road open to public traffic, cf. traffic regulations

§ 8a. *Free parking for electric and hydrogen-powered motor vehicles*

Electric and hydrogen-powered motor vehicles may be parked without paying any fee on a site where toll parking has been introduced in accordance with § 2.

For sites with a time limit, a parking disc must be used to document that parking is in accordance with the time limit. Added for regulation of 19 Jan. 1999, no. 139, amended for regulation of 24 May 2011, no. 542 (came into force on 15 June 2011).

The scope defines that there is parking along a road that is regulated. This means that municipal sites in a parking garage are not included in the scope of the regulation, as a parking garage is not defined as a road. Where there is parking with a time restriction, this time restriction also applies to Electric vehicles. There should be a parking disc in the vehicle showing when parking commenced. The smallest vehicles are allowed to park across the direction of travel under the conditions shown in the box below. In practice, this applies to the smallest 4-wheeled MCs that are shorter than 2.5 metres.

In many places, apart from free parking, the electricity that Electric vehicles use for charging, while parked at charging stations, is also free.

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'Small Electric vehicles can park side-ways, but not in a parking spot for a motor cycle and moped (MC spot).
The Ministry of Transport has made a change to §8a of the parking regulation that specifies that exemption from fees for an EV shall apply to all Electric vehicles, i.e. also vehicles that are registered as motor cycles. Exemption shall also apply to hydrogen-powered vehicles. Exemption will only apply to regulated public places.
There has also been a change in §9 of the parking regulation. This is now regulated so that a vehicle must be placed lengthwise in the field. However, an exception has been made for electric and hydrogen-powered motor vehicles that can park side-ways, with several vehicles in the same field, if all the wheels are within the field and any overhang outside the field does not exceed 40 cm on each side.
In practice, this means that the wheels on the motor vehicle must touch the lane within the field, and that the overhang does not exceed 40 cm outside the field.
Side-ways parking must not reduce safety or interfere with mobility for other road users'.

Source: Oslo Municipality/City Environmental Agency

In 2013, Plug-in Hybrids were given access to the charging stations. However, the regulations are more subtle than for Electric vehicles. Below you will find a fact box with quotes from Oslo Municipality's web pages regarding charging stations, describing the current praxis in Oslo when it comes to parking and charging Plug-in Hybrids.

Oslo Municipality regarding parking and charging Plug in hybrids.

Normally, Plug in hybrids may only park at locations with signs for «Rechargeable motor vehicle»; however, until all location have been given new signs, the can also park at locations for an «Electric motor vehicle» Plug-in Hybrids my charge at all locations if our traffic officers can see that your are driving a Plug-in Hybrid vehicle. Plug-in Hybrids do not have the statutory right not to pay a parking fee that Electric vehicles and Hydrogen vehicles have. Plug-in Hybrids must pay a parking fee at all paid municipal parking spots. Always look at the sign at charging stations. If it says «Plug-in Hybrid for a fee» on the sign, you must pay at the nearest parking meter. If there is no sign, you can park and charge your vehicle at no charge.

At all time-limited charging stations, Electric vehicles and Plug-in Hybrids must have a parking disc and adhere to the maximum time for the location. Set the time you arrive at the parking space on the parking disc"

Source: Oslo Municipality/City Environmental Agency June 2013

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3.4 Institutional policy instruments and measures

3.4.1 Establishment of Transnova

Transnova was established in 2009 to help get technologies and concepts that can reduce greenhouse gas emissions from the transport sector, going from the research stage to becoming a commercial activity or enterprise. In particular, there is a focus on the demonstration phase.

Transnova shall support project that contribute to:

1. replacing fossil fuel with fuel and energy carriers that generate low or no CO_2 emissions,
2. a transition to forms of transport that have a reduced effect on the climate,
3. reducing the extent of transportation,
4. energy efficiency, i.e. less consumption per km or per nautical mile.

Transnova has been most active when it comes to the first item, while the last item was adopted into the mandate as of 2013. Transnova can support projects within all forms of transport, but does not provide support for developing infrastructure beyond what is required for distribution (including filling/charging stations) of alternative fuel and energy carriers.

The Research Council of Norway support research while Innovation Norway supports the commercialisation phase. Before Transnova was established, it was possible to apply for support for demonstration activities from the Research Council of Norway that managed research funds from the Ministry of Transport. The three organisations coordinate activities between them to avoid overlaps.

Formally, Transnova is organised as a part of the Norwegian Public Roads Administration, and its leader reports to the director of that Administration. Transnova has however its own budget and its own letter of assignment, and the head of Transnova is delegated with authority to allocate the budget. It organisation allows Transnova to operate independently, while at the same time it is able to utilise all administrative systems in the Norwegian Public Roads Administration. Transnova had 10 employees in 2013.

At start-up, Transnova's budget amounted to NOK 50 million per year, while in 2013 this had increased to NOK 87.2 million. Of this amount, NOK 20 million are earmarked for environmental technology projects. In 2009, an additional appropriation of NOK 50 million was granted for the charging infrastructure for Electric vehicles, in conjunction with a crisis package to keep activities in the economy afloat during the financial crisis

The work of Transnova has been an important complement to other support schemes and incentives. Transnova has had a large impact on the development of charging infrastructure for normal charging and fast charging in Norway through different support programmes (Transnova 2012). Even individual technical development projects, and some demonstration projects with innovative use of Electric vehicles, have received support, e.g. the testing of Electric vehicles and taxis in, among other places, Trondheim.

Transnova also supports Grønn Bil (Green Car), whose primary task is to promote the increased use of Electric vehicles in Norwegian public fleets and in businesses. Transnova also has supported the establishment and maintenance of a database for

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charging stations for Electric vehicles and work with drawing up a strategy for the development of fast charging in Norway.

3.4.2 Charging programmes - Transnova, municipalities and counties

The charging programmes have one thing in common - private citizens cannot apply. Otherwise the amount of support and facilities vary.

Transnova's support programme for charge points was established with a limit of NOK 50 million in 2009, as part of a larger crisis package to counteract the financial crisis. The funds were to go to normal charge points, and there were no guidelines related to where these charge points could be established in the country. The first come first served principle applied, and all documented costs up to NOK 30,000 per charge point were covered. The programme resulted in a total of 1,800 charge points. By far the most charge points cost less than the maximum amount. In 2011 and 2012, Transnova has given support to around fifty fast charge stations, and additional support will be provided in 2013. The fast charge stations are supported with up to NOK 200,000, while the total incurred costs typically are from NOK 500,000 – 1,000,000 excluding VAT. The support limit will be increased slightly in the next call; see http://www.transnova.no/sok-stotte/10245-revision-v1.

A new development is the establishment of semi-fast charge stations (20 kW). ´When it comes to the costs for this, some are more reasonable than for fast-charging (http://www.elbil.no/ladestasjoner/ 1065-norges-storste-semihurtigladestasjon-for-elbil).

Oslo Municipality has its own charge station programme, where, in addition to providing support for establishing charge stations, 404 charge points have been established and are being operated under municipal management up to 2013. For example, the municipality leases a floor in the Saga P House at Slottsparken, and has adapted this for free parking and charging with space for 30 Electric vehicles. At Aker Brygge an EV parking and charging facility with space for 50 Electric vehicles is established. The support programme targets housing cooperatives, condominiums and commercial players that can receive up to NOK 10,000 per charge point, limited to 60% of documented costs eligible for support. The charge point must have its own reserved EV parking space. The charge point can be publically available for everyone, or reserved for vehicles belonging to the organisation receiving support. The recipient is obligated to operate the charge station for at least 5 years. There have been some challenges in getting joint housing properties and cooperatives to introduce charging. A new guide for this has just been completed; see http://www.transnova.no/project/ladbare-biler-i-borettslag-og-sameier.

Akershus County Council has also had a support programme that provided a support of up to NOK 10,000 per charge point. A total of NOK 2.0 million was allocated in 2012, i.e. support for up to 200 charge points. Up to NOK 1.0 million was allocated in 2011 for support to establish charge points in sports facilities (a maximum of NOK 10,000 or 60% of the documented expenses per point). Øst-Agder and Vest-Agder County Councils have provided support of NOK 600,000 for establishing four fast charge stations in these southern regions in 2013. (The county councils' web pages and newspaper articles constitute sources for this section.)

Chapter 10 deals with challenges for the commercial operation of charge stations.

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3.4.3 Public procurement

The public procurement of vehicles is decentralised to municipalities, counties and government enterprises with a great degree of independence. There are no requirement that these must use Electric vehicles or Plug-in hybrids in their own operations. However, they are confronted with the same framework conditions as other vehicle buyers with regard to taxes, fees and other incentives. Many municipalities and counties prefer leasing vehicles. This presents a challenge since they have to pay VAT on leasing Electric vehicles, while they do not have to do this if they purchase Electric vehicles. Normally, municipal technical utilities, such as water and sewage works, are distinguished as municipal companies that make their own decisions about which vehicles should be used. The counties purchase few vehicles for their activities. However, they have great influence on the purchase of public transport and will be an important player in relation to future purchases of electric buses.

Government enterprises and other government agencies can use Electric vehicles on a relatively large scale. In particular, this applies to the Norwegian Postal Service that has an environmental strategy involving the replacement of 1,300 diesel vehicles with electric "trolleys", 3-wheeled electric MCs and other electrically propelled transport vehicles. With support from Transnova, Trondheim has served as a test area for the strategy of the Norwegian Postal Service. Gradually, however, Electric vehicles will be introduced into more places (http://www.transnova.no/project/co$_2$-fri-postdistribusjon-i-trondheim-sentrum). By the end of January 2013, the Norwegian Postal Service had 643 Electric vehicles at its disposal of which 24 were Electric cars, 261 electric mopeds, 213 electric jeeps and 145 electric trolleys (http://www.gronnbil.no/nyheter/posten-faar-groenn-bil-prisen-for-norges-stoerste-satsning-paa-elbil-article314-239.html). The investment has not gone entirely smoothly. In Northern Norway, parts of the fleet have stood still while waiting for a battery upgrade. In the Northwest Region they have not been able to complete the route with Electric vehicles, and have had to reload onto diesel cars to complete deliveries on the last half of the route. The delivery men complain that the vehicles are cold.

Figure 14: Photo: Tidens krav, The Norwegian Postal Service's electric trolley, electric moped and Electric car. Source: www.siste.no/motormagasinet/article6028271.ece.

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In addition, the Norwegian Public Roads Administration has lots of vehicles at its disposal, but a great number of these are used by those working with road development. Many of these are robust 4-wheeled drive diesel vehicles. The agency has purchased a few Electric vehicles.

Table 5 shows figures for purchases of EV fleets in some Norwegian municipalities. In addition, there are many municipalities that have purchased one or few Electric vehicles for evaluation and testing.

Table 5: Examples of current EV procurement in Norwegian municipalities. Source: Miscellaneous press coverage.

Municipality	Current procurement of EV fleets
Oslo	Tender on framework agreement for purchase of up to 1,000 Electric cars and electric vans in the period from 2013 to 2016. Have allocated NOK 50 million to the scheme where the city districts can be granted a loan without interest rate for purchasing Electric vehicles.
Oppegård (Akershus)	29 Nissan Leaf will be delivered in April 2013
Trondheim	60 Electric vehicles in 2013 (previously has 38 Electric vehicles)
Bergen	Will increase to 200 before 2015; previously has 33
Municipalities in Nord-Møre	26 Mitsubishi i-MiElectric vehicles

It is estimated that about 2,000 passenger cars and minivans per year will be purchased or leased for publically controlled vehicle fleets (Klimakur 2010).

3.5 Research and demonstration projects

In Norway, research projects on electro mobility are financed by the Research Council of Norway, while Transnova finances demonstration projects. Transnova also has allocated resources for supporting the participation of Norwegian communities in EU and ERANET projects. Before Transnova was established in 2009, see Section 3.4, the Research Council of Norway also supported near- market demonstration projects. In addition, the Norwegian Public Roads Administration has some funds for studies.

Norwegian research environments are involved in different EV-related research projects. Some projects currently in progress are;

- *COMPETT:* The project analyses the potential for cost-effective areas of application of Electric vehicles in city traffic. TØI is the leader of the consortium for this ERA-NET project, which is supported by Transnova and the Research Council of Norway (Assum et al 2012). Reports from the project are posted on their web page: www.compett.org.
- *CRAFTTRANS:* The project analyses the potential for the use of electric vans in the craftsman enterprises. TØI leads the project, which is in its initial phase and is financed by the Research Council of Norway.
- *E-Car:* The aim of the project is to analyse the consequences to the environment and the energy sector in Norway, by replacing a significant part of fossil energy used in road transport with electric energy by 2020. It will also draw up a strategy for the electrification of road transport. The project is a KMB (competence-building project with user interaction) in the

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RENERGI-programme and is financed by the Research Council of Norway. Sintef Energi AS is leading the project; see www.sintef.no/Projectweb/ECar/Organisering/.

- *REKKEVIDDE (RANGE):* The project studies challenges with the range of Electric vehicles in Nordic climates. This is a Nordic project supported by the Nordic Council of Ministers. VTT in Finland is the leader of the consortium. A report from Hagman et al will come out in the autumn of 2013 (see Hagman 2013 and 2013 b).
- *InnoBike:* The project started at TØI in 2013 and will study how electric bicycles can contribute to more people choosing to cycle on daily trips in the Oslo region. The project is supported by a Regional Research Fund and the Research Council of Norway. (Fyhri et al 2012).
- *Electric taxi:* Electric vehicles are being tested in regular taxi operation in Trondheim and to Værnes Airport. The project constitutes collaboration between Trondheim Municipality, Trønder Taxi, Stjørdal Taxi, SINTEF and NTNU and is financed by Transnova; see www.Transnova.no.
- *Electric postal distribution* The project in Trondheim is supported by Transnova. See discussion in Section 3.4.3.
- *Electric Mobility Norway:* Electric Mobility Norway constitutes a cluster of businesses that collaborate and develop business opportunities in the EV market. Together they target to develop, test and commercialise products that make driving an EV a much better experience. This gives the Electric vehicle a central place in the future of transport. The project springs from the technology environment in Kongsberg. One of the sub-projects is to develop a test arena for testing Electric vehicles in the Kongsberg – Oslo region.

Transnova has an overview of the demonstration projects it has supported on its homepage (www.transnova.no). A summary of Transnovas investment in Electromobility projects during the first three years of business can be found in Transnova (2012).

3.6 Status in relation to goals

Figure 15 shows the EU goals, the Norwegian goals and actual development in CO_2 emissions for new vehicles. As can be seen, the government did not reach the 120 g/km goal from 2012, and there is need for quicker reductions in emissions in order to reach the 85 g/km goal in 2020. During the last year there is a tendency for emissions from combustion engine vehicles to flatten out, and there is an increasing dependency on Electric vehicles to further reduce emissions (Figenbaum et al 2013).

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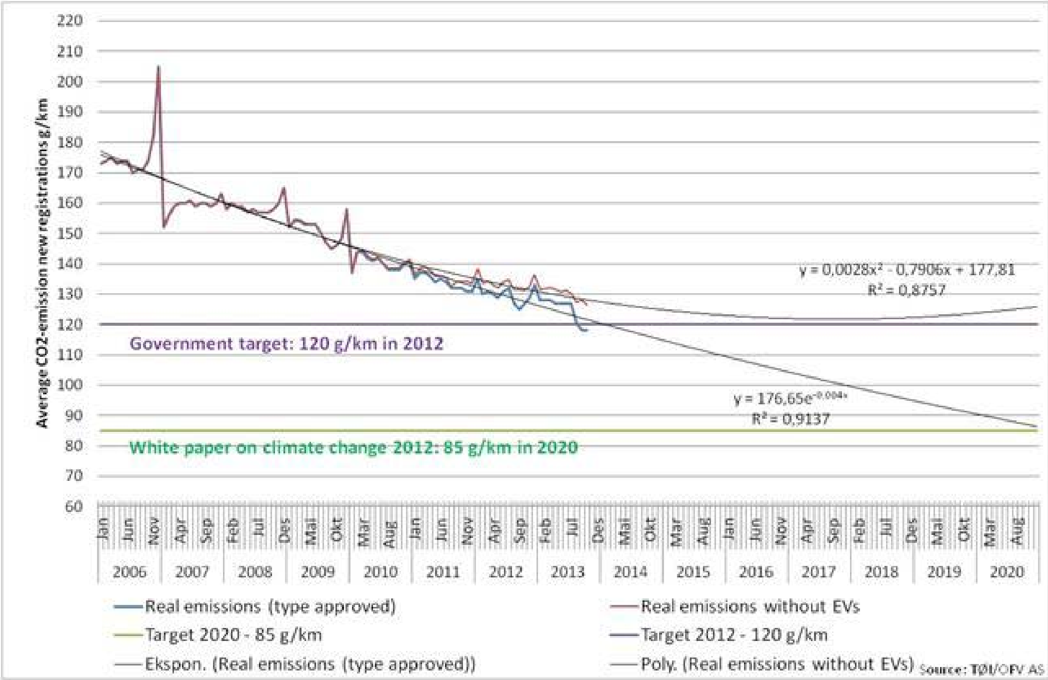

Figure 15: Status of CO_2 emissions (actual and estimated) for new vehicles with and without Electric vehicles from 2006-2020, in relation to different goals. Source: Updated from Figenbaum et al (2013).

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4 Private sector and non government organizations

4.1 The Electric vehicle industry in Norway

4.1.1 Think as a locomotive

Think has been the EV locomotive in Norway. Think started as the PIVCO project in 1991. It was a Eureka project partially financed by the Research Council of Norway and EU funds, with contributions from Oslo Lysverker and Stavanger Energy, among others, as well as the companies of its founder, Jan-Otto Ringdal. In the next phase, capital was provided by Norwegian investors. The Think City Electric vehicle became industrialised from 1996-1998 with market launch panned for the end of 1998. The company went bankrupt in the same year and was eventually purchased by the Ford Motor Company (USA) and investment increased significantly. The Think City vehicle was launched onto the market in 1999 and a new vehicle was developed for launching in 2002.

There were not that many Norwegian subcontractors, but Norsk Hydro supplied the upper frame in aluminium and Kongsberg Automotive the gear selector. Norwegian suppliers also manufactured brackets and other minor parts. Think had a patent for the molded plastic body plates, and these were manufactured locally at the factory in Aurskog.

There were plans to establish an annual production of 5,000 – 10,000 vehicles. In the middle of 2002, Ford found that it did not wish to continue its involvement in Think, and the company was put up for sale. It was purchased by an Indian businessman who proved unable to industrialise the products. Think went into bankruptcy again in 2006, and was purchased by a consortium of heavy Norwegian investors. The vehicle was to be launched in 2008, but production was greatly delayed due to financial problems. Production was moved to Finland at the end of 2009 and a number of vehicles were produced. In late 2010 there were new problems and Think went into bankruptcy once again in 2011. This time the company was bought by a Russian investor, and was moved to Germany. After this, things have been quiet when it comes to Think.

In all, probably more than 500 million € have gone into the different phases of Think and around 2,500 vehicles have been produced. (www.E24.no, 22.06.2011 and http://e24.no/bil/think-begjaert-konkurs-i-norge/20072175). Several Norwegian companies stem from Think; ZEM that is primarily engaged in developing battery solutions for maritime applications, and Move About that is engaged in EV sharing and leasing.

4.1.2 Other smaller development companies

Kollega Bil - Elbil Norge - Pure Mobility - Buddy Electric, the company that has produced Kewet and the Buddy development project, has had many names and gone into bankruptcy several times. They have had solid Norwegian owners since the

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2000s, and have recently started up again. Buddy is registered as a 4-wheel motor cycle and is a vehicle intended for local transports in urban areas.

Miljøbil Grenland started up in the wake of Norsk Hydro scaling down its business in Grenland southwest of Oslo. State restructuring funds were made available, and Miljøbil Grenland was one of many companies that were established. (These restructuring funds are general and do not provide a special incentive related to the development of the Electric vehicle). The business idea was to lease Electric vehicles to vehicle fleets. Initially, French Electric vehicles were leased out, and the French energy company, EdF, became one of the owners. Things went well for a time, but they gradually began to have problems with supply of vehicles as the French car manufacturers discontinued the production of EVs. Miljøbil Grenland subsequently developed a concept for producing Electric vehicles based on gliders (vehicles delivered without a drive system) from the automotive industry; first the plan was to use the Smart fourtwo, later the Indian vehicle, Tata Indica. This did not really get started before the company was bought up by Tata (2008), and their ambition was also extended to produce EV batteries. Tata invested in the production facility. However, the strategy was restructured once again; this time so that Miljøbil Grenland would only work with battery production for Tata. Things were stopped in 2012. Tata sold Miljøbil Grenland to the battery producer Electrovaia, which laid off all its Norwegian employees. After this, little has been heard of the company.

4.1.3 Norwegian vehicle parts manufacturing companies

Traditional Norwegian vehicle parts production industries have also gained entry into EV projects, including Kongsberg Automotive and Eltek, both of which were suppliers to Think in the initial phase. Eltek has a contract to deliver chargers to Volvo's V60 plug-in hybrid, while Kongsberg Automotive delivers, among other things, gear selectors and other components for several Electric vehicles being marketed by the large car manufacturers.

Electric Mobility Norway is a broad, composite cluster of businesses, who wish to look at business opportunities in the interface between Electric vehicles and public transport. The cluster is supported by Transnova.

4.2 The vehicle importers

In the early years, different companies experimented with imports of Electric vehicles from different small independent newly-started EV manufacturers. These activities have faded out as the regular car importers have started EV imports and sales.

The Vehicle Importers that have Electric vehicles in their product range, have experienced that these vehicles have been among the best-selling models for the car brand in Norway. This is true of Mitsubishi and Nissan. These are relatively small car brands in Norway. Several vehicle importers are in the process of importing Electric vehicles, among others Norway's largest importer, Harald A. Møller who is marketing products for the Volkswagen Group. This increases the professional competence of Electric vehicles in Norway since vehicle importers, vehicle mechanics and vehicle salesmen with an increasing number of car dealerships in Norway, will receive training and knowledge about the new technology.

Since 2011, the established vehicle manufacturers have completely taken over the EV market in Norway. It started when Mitsubishi started selling I-MiEV through all its

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dealerships from the end of the year 2010/2011 followed by Peugeot and Citroën a few months later. At the end of 2011, Nissan started sales of Leaf through its dealerships, which during the course of second 6 months of 2012 was expanded to all Nissan dealerships in Norway.

Tesla has in 2013 established itself as a new importer in Norway, which is considered to be the largest market for Tesla outside the USA. Tesla sells the vehicles through its own dealers.

As of autumn 2013, Volkswagen, Ford and BMW will be importers of Electric vehicles. BMW will initially be rolling out its i3 EV at a limited number of dealerships. VW will roll out their Electric vehicles to most of their dealerships.

4.3 Non Government Organisations (NGOs)

Several organisations are involved in the Electric vehicle field, doing marketing activities, and being responsible for studies and different types of user support.

The Norwegian Electric Vehicle Association has established itself as a significant player with 3-4 permanent employees. This has happened thanks to the fact that most vehicle dealerships give their EV-customers the first year membership in the Norwegian Electric Vehicle Association for free. In the middle of 2012, the association had around 7,500 members. The Norwegian Electric Vehicle Association was started in the 1990s after an initiative from Oslo Energy and Oslo Municipality.

The association has set up a database of charging stations and runs an information service for not only members and the press but also politicians. New members receive information about different aspects pertaining to Electric vehicles, get offers for reasonable insurance, keys to charging stations, and the association purchases green certificates for electricity, on behalf of its members, for all the Electric vehicles in Norway. They have arranged thematic days and public days with the presentation and test driving of Electric vehicles. The association has a web site that distributes news about Electric vehicles, and they have close contact with the Electric vehicle industry. They have also set up an Electric vehicle user forum on the Internet at www.elbilforum.no, where there are lively debates about Electric vehicles, and information about how the vehicles function when used in normal situations.

Grønn Bil (Green car)was started with funds from Transnova in 2009. Energi Norge, Transnova, the Norwegian Association of Local and Regional Authorities, and ZERO are behind Grønn Bil. The overall objective for Grønn Bil is to contribute to increase the phase-in rate if Electric and Plug-in Hybrid vehicles, so that by 2020 there will be at least 200,000 such vehicles on Norwegian roads. Grønn Bil compiles comprehensive statistics about Electric vehicles, charging stations and dealerships on its web pages (www.gronnbil.no)

Several Environmental organisations, ZERO in particular, have worked actively with promoting Electric vehicles and to investigate what their users mean. ZERO has also stood as organiser of a ZERO rally where owners of Electric vehicles, Plug-in hybrids and Fuel-cell vehicles have competed in different tasks. These arrangements have created a lot of publicity about these types of vehicles, and have served as a focal point for the players involved. Bellona was a central player in the 1990s, when it was about fighting for incentives for Electric vehicles, such as the exemption from the vehicle registration tax and free parking.

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4.4 Information services

Several information services, benefiting users requiring information about different aspects of purchasing and using Electric vehicles, have been started in Norway as collaborative efforts between authorities and private actors and organisations.

4.4.1 The New Vehicle Guide

The Norwegian Public Roads Administration has established the New Vehicle Guide service. This searchable database contains all the passenger cars and model variations that are available on the Norwegian market. The New Vehicle Guide is updated daily, and is thus a dynamic database that always contains information about the vehicles and model variants that can be ordered at Norwegian car dealers. With the guide the user can set up performance criteria for the new vehicle, such as environment and safety and wanted user amenities, select the size of the vehicle, number of seats etc. The guide then presents the user with a list of vehicles that meets the requirements with the ones with lowest CO_2-emissions at the top of the list.

The service is based on data collected by OFV (the Norwegian Road Federation) in collaboration with all the country's vehicle importers. The importers enter the data themselves, while OFV approves the posted data before it becomes visible in the database on which New Vehicle Guide is based. The prices in the database are without delivery costs. The New Vehicle Guide web address is: http://nybilvelger.vegvesen.no/

4.4.2 Grønn Bil's statistics

Grønn Bil's web page contain current statistics about the vehicle fleet divided up into counties and municipalities, dealerships, types of owners and vehicle brands.

4.4.3 NOBIL and Ladestasjoner.no

NOBIL was established in June 2010 and is tasked with providing information about charging stations for Electric vehicles in Norway. All data about the Norwegian charging stations is collected to one site in order to provide increased knowledge of the infrastructure. The purpose of this being to make things easier for EV motorists so that there will be more EV motorists in the future.

NOBIL is initiated, developed and administered by the Norwegian Electric Vehicle Association. Quality assurance of data is prioritised so that NOBIL provides correct and reliable information to EV motorists requiring electricity. A strategic choice was to ensure public ownership of the database, so that its content is available to everyone. For this reason, NOBIL is owned by Transnova. At a minimum, this organisation model will continue until the summer of 2014.

NOBIL has detailed data about the charging stations, and provides real time data. Everything is freely available via an 'API' for anyone wanting to develop services. There are more than 4,000 charge points in the NOBIL database.

The database can be transferred to the navigation systems in the vehicles so that motorists have access to information about charging stations, and can receive directions to the closest station. The database also contains information about what kind of power outlet is available at the station, access information, if it is locked, images etc. Free use of NOBIL's software is offered to the authorities in all Nordic

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countries. Finland has accepted and a contract was signed in May 2013.

4.4.4 Electric vehicles for vehicle charging – Move About

Move About was founded in Norway in 2007, and was the first vehicle sharing scheme in the world offering Electric vehicles. Currently, the fleet consists of 100 Electric vehicles operating in Norway, Sweden, Denmark and Germany. The organisation has 2,500 member is Norway. Move About is directed towards two market groups, regular business companies and individual private users.

The regular business customers, use a certain number of vehicles from Move About's booking system. The vehicles are stationed at the business premises. The aim is to offer an efficient use of the vehicles, thereby reducing the business daily transport costs, including for parking or taxi rides. They also want to give employees flexibility with regard to choosing a means of transport for journeys during the workday, since they can rent vehicles as required during the day from Move About. DNV (Det Norske Veritas) is one of the customers using vehicles. Individual users book a vehicle via the Internet, and can pick it up at specified parking lots where the vehicle is opened using cell phone SMS messaging. The key is in the vehicle, which is returned to the same location.

4.5 Activities

An EV/zero-emissions rally has been arranged in Norway for several years. It started with the Viking Electric rally in 1993. For the past five years, the rally race for Electric vehicles, hydrogen vehicles and Plug-in Hybrids, has been arranged by the environmental organisation ZERO, under the name ZERO rally. In 2012, the race was between Trondheim and Östersund in Sweden; see Figure 16. The rally was cancelled in 2013.

Figure 16: ZERO rally 2012. Östersund Source: ZERO.

In 2009, the Electric vehicle Symposium (EVS) 24 was held in Stavanger with about 1,500 international participants; see Figure 17. EVS moves between continents and is arranged in Europe every 3rd year.

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Figure 17: Electric vehicles Symposium 24, Stavanger 2009.Photo: Roland Reichel [www.Electric vehicles24.org](www.Electricvehicles24.org).

4.6 Public - Private Partnerships

The interaction between the many public and private players, Private Public Partnerships (PPP) in a broader sense, is an important distinguishing feature of the development of Electric vehicles in Norway. We are seeing that public authorities are starting and supporting the build-up of organisations working towards the same goal as the state, and we are seeing that private organisations and players are performing information tasks that could have been public. In this way, the norms of the social system (the importance of being eco-friendly, buying alternative vehicles and similar), are acquiring a broader foundation. This constitutes an example of integrated communication; see Figure 1, and is something that will strengthen the diffusion process.

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5 Energy consumption, batteries and charging stations

5.1 Energy consumption and emissions

Electric vehicles are two to three times more energy efficient than traditional vehicles with internal combustion engines. An EV with an energy consumption of 0.18 kWh/km will be more than double as energy-efficient as a vehicle with an internal combustion engine that have a CO_2-emissions level of 110 g/km (Klimakur 2010). In theory the difference is greater, but when it comes to Electric vehicles, such things as heating requirements during the winter must be taken into account.

Table 6 shows an overview of energy consumption and emissions from vehicles with different types of propulsion technology. We can see that if petrol and diesel cars are replaced by Electric vehicles using electricity from hydroelectric power (or wind power), there can be substantial savings in energy consumption and emission of the greenhouse gas, CO_2. There is zero emissions of hazardous exhaust gases coming from Electric vehicles, and from Plug in hybrid vehicles when these run on grid electrical energy stored in the batteries.

Table 6: Energy consumption and emissions for vehicles in 2010 with different propulsion systems, provided electricity is from a carbon-free source. Source: HBEFA 2010 and own assumptions.

	Petrol vehicle	Diesel vehicle	Hybrid	EV
Energy consumption [MJ/km]	2.3	1.7	1.4	0,7
CO_2 [g/km]	160	122	100	0
NOx [g/km]	0.265	0.430	0.006	0
HC [g/km]	0.083	0.017	0.058	0
CO [g/km]	1.092	0.053	0.258	0
PM [g/km]	0.003	0.022	0.000	0

Since the Electric vehicle is 2-3 times more energy-efficient than an internal combustion engine vehicle, the total emission of greenhouse gas from the energy source to wheels (Well to wheel) from an EV will be lower than today's vehicles, even if the electricity is produced with an average European electricity mix. In Norway, gains for the climate could be more than 95% because of Norways renewable hydroelectric power system (Ressursgruppe 2009).

Energy production results in environmental impacts in the form of land use, infrastructure development and emissions. Thus, it is interesting to see where and how energy production takes place. An EV will certainly reduce emissions from transport. However, if the electricity is produced from coal-fired or gas-fired power, there will be emissions of greenhouse gases in the production phase.

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The production of electric power has been taken into the EU Emission Trading Scheme. This means that by replacing a vehicle that emits greenhouse gases with an EV, emissions will be moved to a CO_2-quota-regulated sector. The increased consumption of electric power would then be compensated by other measures in quota regulated sectors. It could be cleaner electric power such as development of more renewable energy, a transition from coal to gas, the separation and storage of CO_2 from power plants, or more efficient industrial processes. Given that the Emission Trading Scheme works as intended, it will in the long term lead to a gradual decarbonisation of the average energy production in the European Union.

Figure 18 shows CO_2 emissions in a life cycle perspective for an EV. If the electricity is derived from a carbon-free source such as Norwegian hydroelectric power, the EV will come out well in the life cycle assessment. However, if the energy comes from a coal-fired power plant, the EV will come out worse than a vehicle with an internal combustion engine.

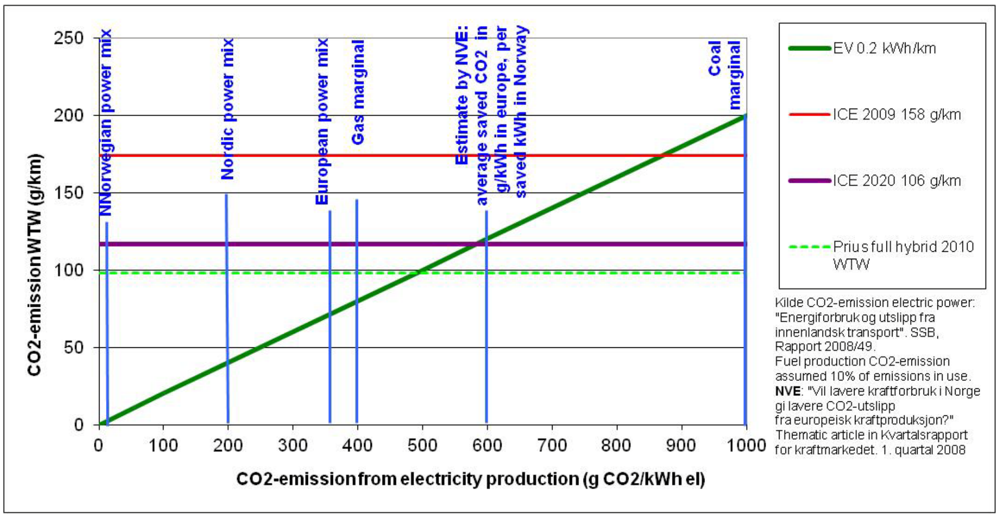

Figure 18: CO_2 emissions from electricity production. Source: Figenbaum 2010.

5.2 Development of batteries

In a battery, chemical energy is converted to electric energy. In particular, there are four properties that are important to optimise in batteries used in Electric vehicles.

1. The energy storage capacity, measured in kWh
2. The capacity to supply power, measured in kW
3. Service life measured in years
4. Costs measured in €/kWh available battery energy storage capacity

Basically, power is not a problem; the greatest potential for improvements lie in the energy storage capacity, but probably even more important is the improvement in the service life of batteries so that it corresponds to the service life of the vehicle. Also cost reduction is needed for EVs to be successful in the long run. A good battery should have a high level of energy density in relation to its weight, a low price and last for the service life of the vehicle. Table 7 shows the different types of batteries used in Electric vehicles, with respect to their energy density and power density (ability to deliver power). Lithium-ion batteries (Li-ion) come out as the best option.

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These batteries are the most common in Electric vehicles and most vehicle manufacturers only invest in this technology for the present generation of vehicles.

Table 7: Energy density and power density for batteries. Source: Resource group 2009

	Li-ion	Li-M-Polymer	NiMH	NA- $NiCl_2$	Lead
Energy density (Wh/kg)	75-120	100-120	50-70	100-120	20-30
Power density (W/kg)	1,000 -3,000	200-250	1,000-1,500	180	200-500

Earlier, several manufacturers have used lead batteries and Ni-Cd batteries and some, among others Think, have used Na-$NiCl_2$. During the period 1998-2003, up to 10,000 Electric vehicles were produced with Ni-Cd batteries (Think, Peugeot, Citroën, Renault). Many of these cars were still in operation in Norway in 2012. The production of new vehicles with this technology is however no longer allowed. This is because Cd is a pollutant that can cause great deal of damage in nature, if it is not handled in a good way when the service life of the battery is at an end.

Unlike lead batteries, Li-Ion batteries represent a new type of technology. There is not as much lessons-learned data about service life and performance over time available. However, according to vehicle manufacturers, a service life of approx. 10 years can be expected for Li-ion batteries, used in those Electric vehicles sold from 2010. However, there is a risk that battery service life may be shorter. Service life is considered as being reached when the battery has less than 80% of its original capacity intact. Vehicles with lower capacity can still be used, but mileage will be reduced correspondingly. Presumably it will not be profitable to replace complete Li-ion batteries in Electric vehicles. Nissan informs that they have a modular battery system where individual modules can easily be replaced, something that will extend the service life of the battery. In the light of this, the service life of Electric vehicles could be somewhat shorter than for a corresponding petrol vehicle. Eventually, we will gain experience of this in practical operation.

For Plug-in Hybrids it may be possible to oversize the batteries to obtain a service life corresponding to the service life of the vehicle. The Plug in Volt hybrid vehicle from GM/Chevrolet has been launched with a 16 kWh battery, indicating that a little more than half the capacity is used to give the vehicle its range of 60 km in the all-electric mode.

California requires a warranty that covers a service life of 10 years/230,000 km for batteries in hybrids, in order from them to receive a subsidy of up to USD 1,500 from the state, and access to high occupancy vehicle lanes (CARB 2013). In the meantime, it must be remembered that there is very little data available to calculate the service life of Li-on batteries. Test data from laboratory testing is available to a certain extent, but there is very little data from real use available in the public domain. It is possible for Nissan to obtain information about the state of the batteries, and how far the vehicle has been driven, in all its Leaf Electric vehicles in normal operation from among 83,000 customers all over the world. It can be assumed that other car manufacturers also collect similar data from their own products

In the Norwegian market, the battery warranty has steadily improved with new vehicle types entering the market. The VW E-up currently has the best warranty of 8 years/160,000 km with at least 70% remaining battery capacity.

In 2010, with support from Transnova, Think Global had 100 of its vehicles equipped with a monitoring and data acquisition system, that would assemble data

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about the usage of the vehicles and the status of the battery for 3 years. The aim of the project, that should have concluded at the end of 2012 was to establish a theoretical service life model, which, calibrated with data from typical driving patterns, would provide a better estimate of the service life of batteries. After Think went into bankruptcy, this work was continued by the ZEM company. They are now directing their efforts to the increasing activity within the electrification of ships, where there is a strong Norwegian supply industry and several project under way, among these a fully electric ferry.

5.3 Charging station technology for normal and fast charging

Norway started early building charging stations not only for normal charging but also fast charging. Transnova has had several programmes for supporting the development of fast charge stations and a large programme for developing normal charging stations.

Transnovas support schemes for charging infrastructure, have been linked to the establishment of charging stations for normal charging and a pilot phase for the establishment of fast chargers. Altogether approx. 1,800 normal chargers were established all over the country through an earmarked allocation of NOK 50 million from 2009. Fast chargers have been prioritised since 2011, and approx. 70 fast chargers are established in 60 locations in Southern Norway. Transnova is now refocusing its support schemes in order to adapt the fast charger infrastructure to new charging standards, and to increase the capacity since the number of Electric vehicles is increasing rapidly.

Transnova has funded a project that produced a proposal for a strategy of fast charging, but has tentatively not done the equivalent for normal charging. In June 2013, Transnova put out a tender for assistance to create a general charging strategy for Norway, and a strategy for Transnova's continuing work with support for charging stations.

For normal charging, the strategy in the initial phase has been to build out normal sockets with a “Schuco” contact (Figure 9), which Electric vehicles on the market have been able to use. This “simple” type can be installed in a box on the wall or on a charging post along the road, while the more robust, watertight model can be mounted directly on the wall or post. See Figenbaum and Amundsen (2013) for details. The EU has recently adopted the so-called “mode 3 type 2 plug (on the right in Figure 19) as the EU standard. The Norwegian charging stations must consequently be rebuilt so that both variants are available at each charging station, so that existing and new vehicles can use all charging stations. No plan has been made for this yet. In a tender posted in January 2013, Oslo Municipality has specified that new charging stations must be of both types.

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Figure 19: Types of contacts for normal charging; from the left, two versions of Schuko and mode 3 type 2 plug. Source images: www.ladestasjoner.no.

Norway was also early out with fast charge stations. Transnova wanted to quickly gain experience with fast charging, and has on several occasions given support to fast charge stations based on the Chademo charging standard (Figure 20 on the left). These are standards used by Electric vehicles from Nissan, Mitsubishi, Peugeot and Citroën, which up to 2013 were the only Electric vehicles on the Norwegian market that could be given a fast charge. In the meantime, the EU has decided to go for a European standard with a Type 2 contact/Type 2 Compo, that is not compatible with Chademo. This means that the existing Norwegian stations must gradually be converted so that both types can be offered. Normally, this will imply replacing the charger itself, with one that has several cables with different types of contacts. Foundation work, excavations, signs etc must not be repeated.

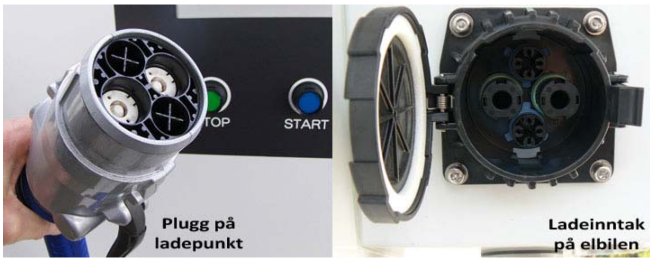

Figure 20: Fast charging contacts, Left Chademo and right European Combo. Source images: www.ladestasjoner.no.

The fast charge strategy (Econ. Pöyry 2012) involves a roll-out rate that corresponds to about 1 fast charger per 250 Electric vehicles, and that initial locations will be in the Oslo area, which house the largest population concentrations in Norway, and along the West Coast up to Trøndelag. In addition, there is a proposal to establish of a few stations to enable driving between the major cities and over the mountains between Østlandet and Vestlandet. The proposed criteria are shown in Figure 21 and their geographical location in Figure 22 and Table 8.

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Criteria positioning	
Oslo region/big city 1 charger per district/20,000 inhabitants Centre location (return traffic) Residential areas (traffic after 17:00) Positioning as for densely populated area Monitoring of need	**Densely populated area** Petrom/energy stations Parkingspots / centre functions (commerce/public service, sports etc) Shopping centres, Restaurants Traffic passing through
Corridor nodes 1 per max 50-60 km (depending on terrain profile) Consider halving the distance if increasing traffic or vehicles justitifies this Traffic passing through	**Periphery** Traffic passing through or startspot for return traffic Should fullfill following requirments - gas station, restaurant or similar - commerce, public service, sports

Figure 21: Criteria for location of fast chargers. Source: Econ Pöyry 2012.

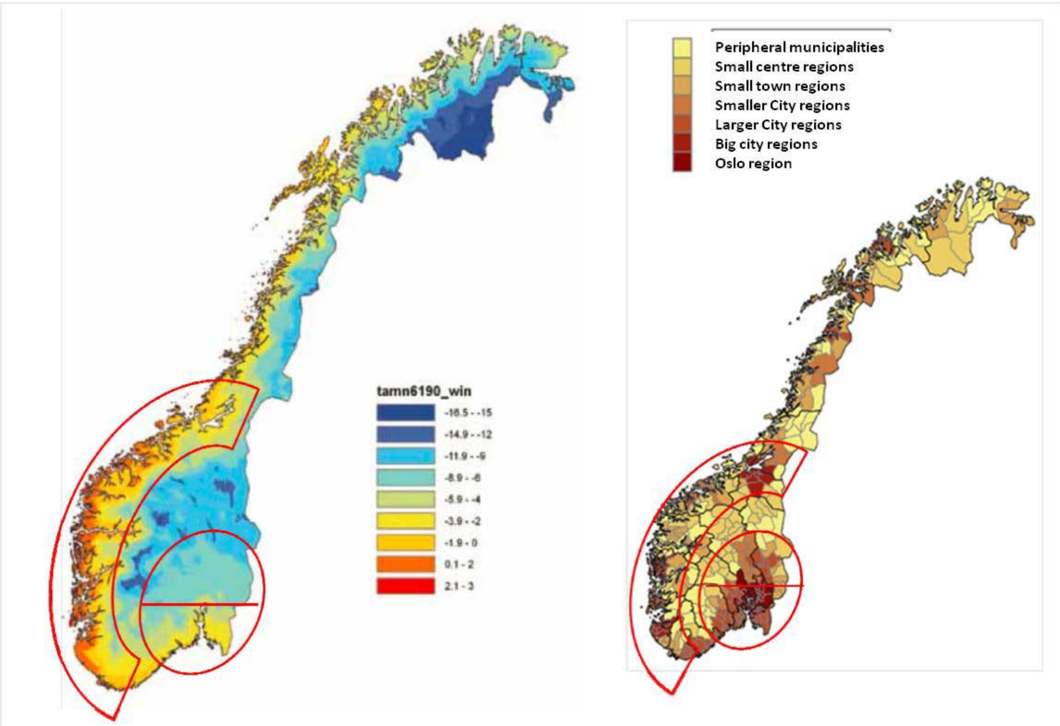

Figure 22: Proposed main regions for fast charging development (within red lines) and map of population concentrations and mean winter temperature (Celsius). Source: Econ Pöyry 2012.

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Table 8: Proposed strategy for location of fast chargers. Number of stations in different areas and along different national roads. Source: Econ Pöyry 2012.

		Optimised minimum	Total	Earlier	2012	2013	2014	2015	Comments
		1. Primary market							
Pri 1		Oslo-regionen	105	19	25	16	20	25	
Pri 1		Kystringen E18/E39 til Bergen	40	16	9	6	9		
Pri 2		E39/E6/E14 Bergen til Nord-Trøndelag	21	7	6	8			
Pri 2		Nord-Norge (pilot)	11		5			6	
		2. Secondary market							
Pri 2		E6 Trondheim-Lillehammer (fjell)	7		2	5			
Pri 2	E134/Rv36	Drammen - Bø - Porsgrunn	6	2	4				Indre Telemarkskorridor
Pri 3	Rv 41/Rv 42	Bø - Evje - Egersund	7			7			Indre Sørlandskorridor
Pri 3	Rv 13	Stavanger - Røldal - Voss	8				8		Indre Vestlandskorridor
Pri 4		S&F, M&R - sidekorridorer	19			7	2	10	Nordvestlandskorridorer
Pri 4	E134	E134 Seljord - Røldal (fjell)	2					2	
Pri 4		Support station inner west coast corridor	7				1	6	
Pri 4		Support station inner south coast corridor	3				3		
Pri 3/4		Support station Kristiansand	2			1		1	
Pri 3		E16 Voss - Høneføss (fjell)	8	1			7		
Pri 3		Support station E16/E39	1				1		
		Mature phase	2	2					
			249	47	51	50	51	50	

According to Transnova, who was the client for the Pöyry Report, the estimate for 1 fast charger per 250 Electric vehicles is something which is only used to a lesser extent, or will not be used as a primary criterion. They believe it is more important to initially look at the distance between the charging stations, and what the EV density is like. The Ministry of Transport (SD) has tasked Transnova with developing a more uniform strategy and financing plan for charging infrastructure (in which all types of charging will be included) in Norway. Work on systems that safeguard the identification and settlement of payment transactions between charge stations operators, was started in August 2013 (http://www.transnova.no/leverandor-valgt-til-utredning-om-interoperabilitet).

5.4 Scope and localisation as of April 2013

5.4.1 Diffusion of charge stations in Norway

Overall 4,029 publically available normal charge points were available in Norway in April 2013 (note that a charging station/localisation can have several charge points) and 127 fast charge points was in operation or being established. Table 9 shows distribution according to county.

Using the ratio of 1 charger per 250 Electric vehicles from the fast charging strategy, the 127 fast charge points would be able to serve 30,000 Electric vehicles. Thus, infrastructure development is several years ahead of the sale of Electric vehicles based on this criteria. This can indicate a risk for over-establishment, or that the players are positioning themselves for the market of the future. However, a number of the points have been established by the Nissan dealerships, because Nissan requires that all dealerships install fast chargers before selling Leaf.

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Table 9: Charge points in Norway that or in operation or under establishment in April 2013 – normal charge points and fast charge points in different counties. Source: Grønn Bil statistics.

County	Normal charge	Fast charge
Akershus	771	32
Aust-Agder	99	1
Buskerud	241	11
Finnmark	14	0
Hedmark	79	6
Hordaland	565	13
Møre og Romsdal	84	3
Nord-Trøndelag	68	4
Nordland	57	2
Oppland	62	5
Oslo	977	13
Rogaland	242	18
Sogn og Fjordane	90	1
Sør-Trøndelag	283	5
Telemark	100	0
Troms	31	0
Vest-Agder	55	2
Vestfold	65	3
Østfold	146	8
Totalt	**4029**	**127**

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The map in Figure 23 shows fast charge stations in Southern Norway. Those in green are existing stations, and those in white with a blue dot are future stations. To the right the current status for fast charging stations is shown when the map is read online via the Internet. Green means that it is vacant, orange means that it is in use and red means that it is not in operation, or that there is something wrong with it. Those that have two dots have two fast charge points. As we can see, three of the charge points were in use in Billingstad and at Drammen (Kjellstad). Also other stations not shown on the right hand side in the figure, were in use at this time, at approx. 09:15 a.m. on 21/03/2013.

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Figure 23: Map of fast charge points in Southern Norway.
Source: http://elbil.no/elbilfakta/teknologi/444-hurtigladekartet. There is also a mobile application that can show status at the stations http://www.ladestasjoner.no/mobil/hurtigladestatus.php.

5.4.2 Propagation in Oslo and Akershus

There were 959 publicly available normal charge points in the Oslo Municipality as of April 2013. In Akershus that borders on Oslo, there were 761, see Figure 24. Oslo Municipality has had a support programme for establishing 400 charging stations in Oslo. In 2012 it posted a tender for a framework agreement regarding the building of 800 more publicly available charge points, as well as 720 charge points for the municipality's own vehicles, in February 2013. The tender runs over a two-year period with an option for a two-year extension. The background for the tender is that the municipality has approved an expansion of 200 publicly available stations per year, and that charging stations for the municipality's own vehicle fleet will be expanded in line with how fast EVs are introduced into the vehicle fleet. In Oslo, 13 fast charge points were established or were under establishment as of April 2013. In Akershus, this number was 32; see Figure 25.

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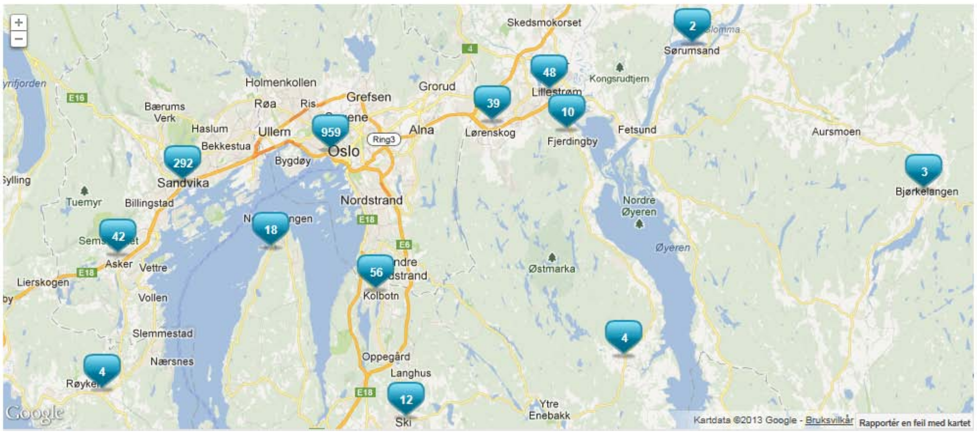

Figure 24: Charge points in the Oslo area. Source: www.gronnbil.no/Map data Google 2013.

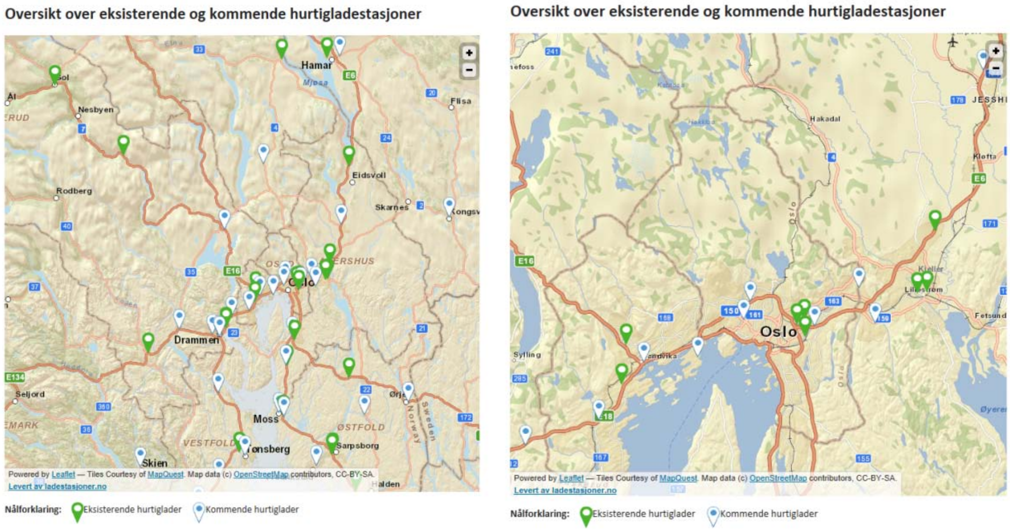

Figure 25: Map of fast charge points in the Oslo area. Source: www.ladestasjoner.no.

5.5 Costs for charging stations

5.5.1 Normal charging

TØI has analysed cost data for 1,900 charge points that were finance by Transnova between 2010 and 2011 (COMPETT 2013); see results in Figure 26. The programme was designed so that everyone who applied for support with a valid application, received support until the pool of 6.25 million € was used up. There was no geographic management of where the charge points would be set up. 100% of the cost up to 3,750 € was reimbursed. The programme was part of a larger Financial Crisis Package in 2009/2010. Overall, 1,126 of the points had sufficient data so that the costs could be calculated.

As shown in Figure 26, the average cost was approx. 2,500 €/charge point, i.e. approx. NOK 20,000 (excluding VAT). The most expensive points cost over 3,750 €. They were reimbursed with the maximum amount.

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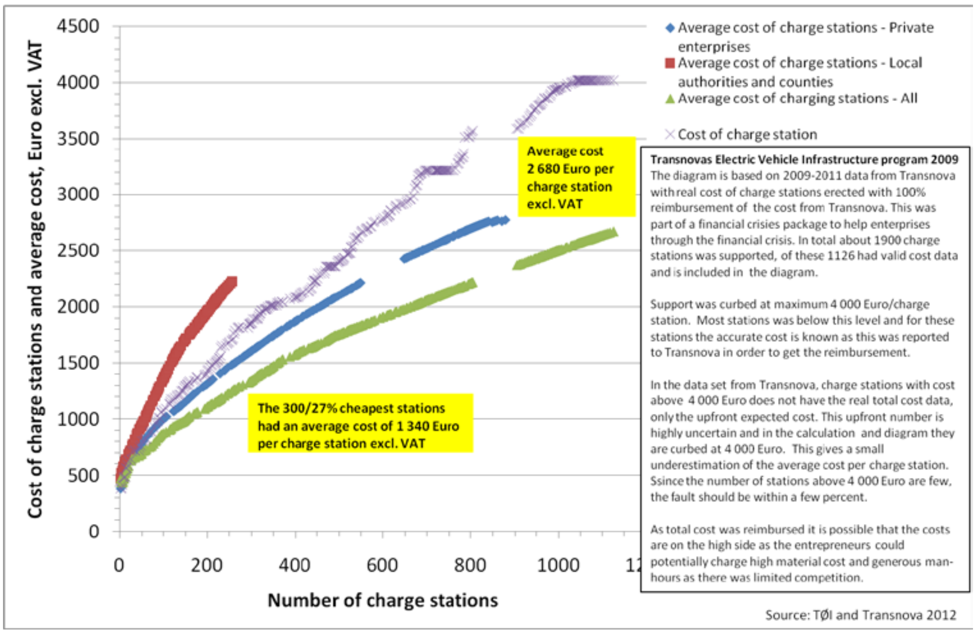

Figure 26: Costs for building out normal charge points: Source: TØI and Transnova 2012.

Nøkkeltall

Kommune	Vanlige ladep.	Hurtigladep.
Asker	42	6
Aurskog-høland	3	0
Bærum	292	1
Eidsvoll	1	1
Enebakk	4	0
Frogn	6	0
Lørenskog	39	0
Nannestad	10	0
Nes	6	0
Nesodden	18	0
Nittedal	8	0
Oppegård	56	0
Rælingen	10	0
Skedsmo	48	16
Ski	12	1
Sørum	2	2
Ullensaker	174	0
Vestby	13	5
Ås	17	0
Totalt	761	32

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Figure 27: EV parking place with charging at Aker Brygge in the centre of Oslo. EV charge points distributed according to municipalities in Akershus. Source: Wikipedia and Grønn Bil.

5.5.2 Fast charging

According to Transnova, the typical cost of establishing a Chademo type fast charge station in Norway is 62,000-125,000 € (excl. VAT). This estimate is based on application for support for more than 30 fast charging stations. This includes the charger itself, excavation, foundation work, signs etc. The greatest uncertainty when it comes to cost, is if "grid reinforcement contributions" must be paid. Grid reinforcement contributions may be required by the owner of the power distribution

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grid, if the installation of the fast charger results in a need to strengthen the power distribution grid that the charger is connected to. For the time being there is no data for maintenance costs, but the players seem to think that they can be around 3,750-5,000 €/year based on information they have provided in applications for support. Transnova's contribution was limited to approx. 25,000 € per fast charge station.

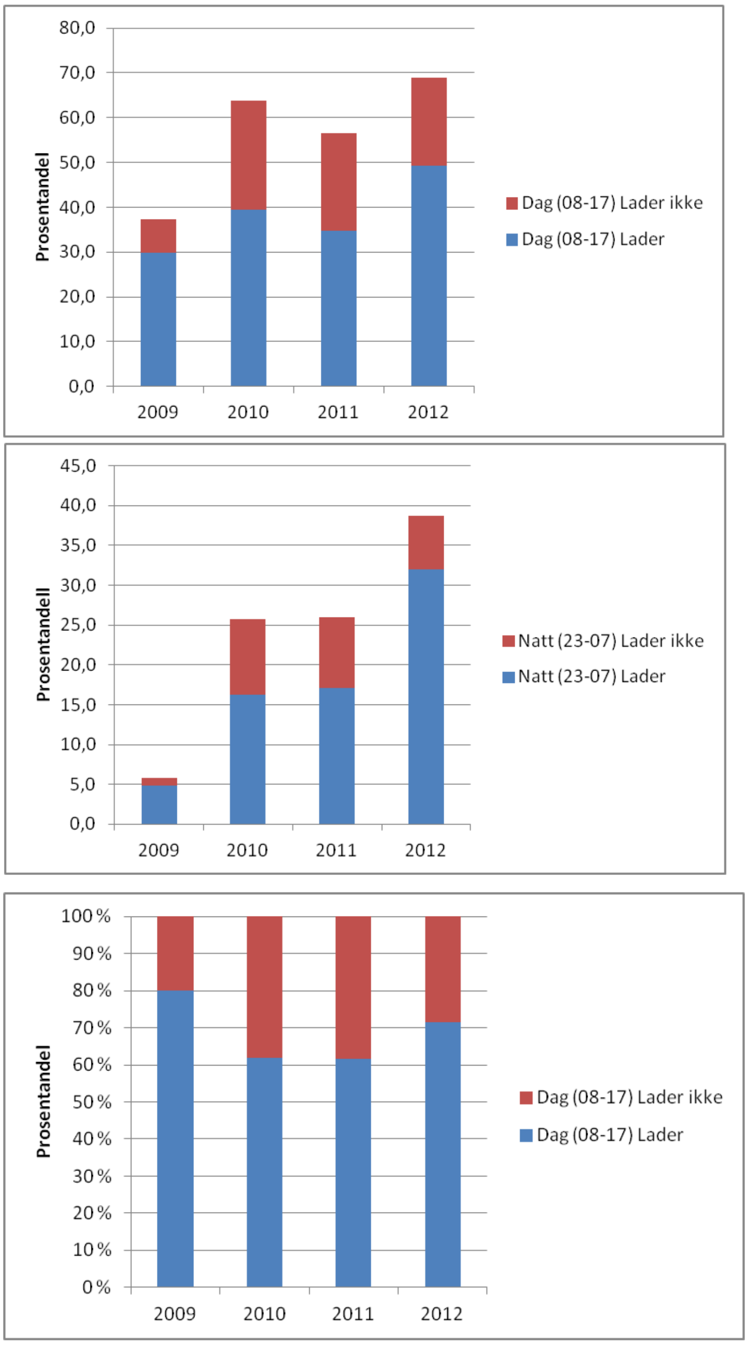

Figure 28: Average occupancy (not weighted in relation to number of points per station) for charging stations owned and operated by Oslo Municipality (red: Parked not charging, blue: Charging). Top, day time (8 a.m-5 p.m.; middle, night; (11 p.m.-7 a.m.); bottom, proportion charging (blue charging, red not charging) of those parked in charging stations day time. 2009-2012. Source: Oslo Municipality 2013.

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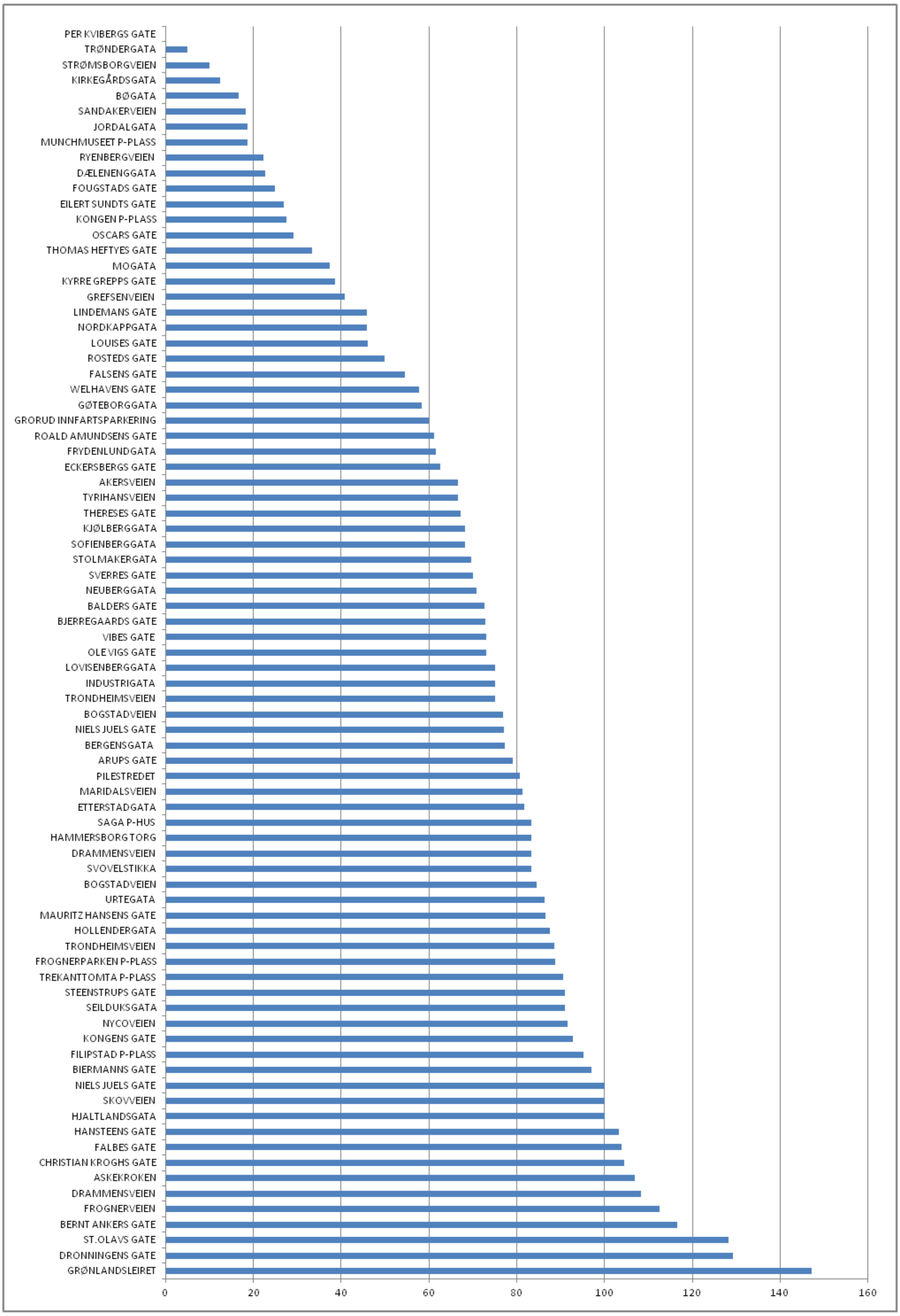

Figure 29: Occupancy at charging stations in Oslo Municipality in December 2012. Percentage of share of marked spots. (The fact that the number can be >100 is because to some Electric vehicles can and are allowed to park side-ways). Source: Oslo Municipality.

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5.5.3 Use of charging stations

Oslo Municipality has carried out occupancy measurements, i.e. has counted the number of vehicles charging or just parking (not connected to a charge point) at its charging stations; see Figure 28 and 29. Occupancy has been recorded during the day and night per marked spot, for a one week to one month sample period and over a period of 4 years, 2009-2012. Occupancy can be over 100% since the smallest Electric vehicles, those with a length less than 2.5 metres, are allowed to park sideways, giving space for 2 vehicles per marked spot. Occupancy has been on the increase between 2009 and 2010. Initially, the proportion of vehicles actually charging, dropped, but is now on its way up again; see Figure 28. Figure 29 shows average occupancy at all charging stations.

5.6 Cost benefits of charging system

The benefits of publically available charging stations can be:

1. To increase the market for Electric vehicles by:
   - Making the use of Electric vehicles possible for those that make long daily trips.
   - Reducing the number of days EV owners must adapt their travel due to the limited range of the EV, something that may make it possible for them to manage with an EV as their sole vehicle, in combination with a few days' leasing of a vehicle with an internal combustion engine for longer trips.
2. Getting more miles out of each EV to replace miles driven with a vehicle with an internal combustion engine, because the owner can use his/her EV for more trips, and dares to utilise more of its range.
3. Making it possible for the owner of a vehicle fleet to operate the vehicle all day long (applies in particular to fast chargers); something which will make Electric vehicles more competitive for this user group.
4. Increasing the length/number of kilometres that Plug-in Hybrids can run on electricity from the power grid.

It is difficult to calculate the benefit of charging stations separately from the benefit of the vehicle. Then we would have to know the incremental average increase in EV mileage for different charging infrastructure coverage, and how many more people would contemplate buying Electric vehicles if the charging infrastructure were to become more extensive and more easily available. We do not know this. We have indications that item 2 can be remedied with fast chargers base on statistics from the Tokyo Electric Power Company (Anegawa, T.), that measured the use of the Electric vehicles they owned, before and after installation of an extra fast charger in the area where they did a lot of driving. Figure 30 shows that before the extra fast charger was installed, the range of the vehicles was poorly utilised. None of the vehicles were parked with a charge status less than 50%. Range was much better utilised after the

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installation.

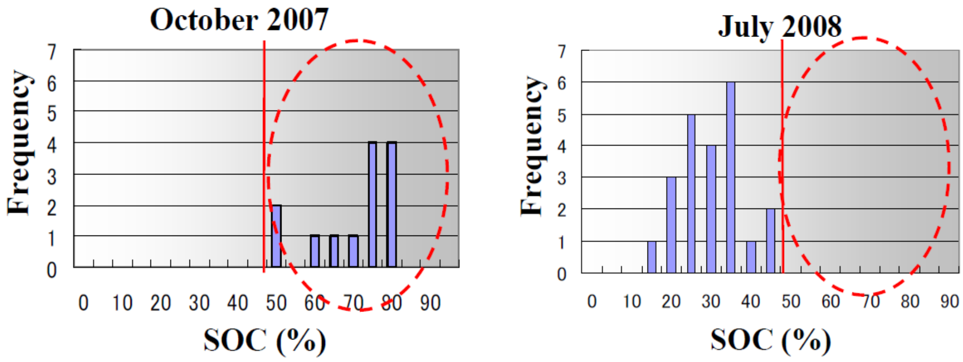

Figure 30: The state of charge (SOC) of the EV after driving before (on the left) and after (on the left) installation of an extra fast charger in Tokyo. (SOC = Battery State of Charge or charge capacity.) Source: Anegawa, T.

In Atlanta in the USA, researchers have monitored the use of 484 petrol vehicles throughout a period of a year, with continuous measurements of the movement pattern of the vehicles. Based on these measurements, it is possible to see that the number of days users must adapt their transport needs, by not travelling, by loaning another vehicle, or adapting in another way, will decrease if the daily mileage of the vehicle increases (Pearre et al 2011). One example might make this more evident. Figure 31 shows the percentage of vehicles that can be purely electric, as a function of the range of the EV, and the number of days of adaptation. Here you can see that when there is access to charging at the workplace, the daily mileage could double from 50 miles to 100 miles, and the number of vehicles that can be Electric will triple for the curves with 2-6 days of adaptation. This number of adaptation days can be a realistic number of days, when combining EV ownership with leasing a vehicle with an internal combustion engine when needed. For those belonging to households having several vehicles, it will be easier to tolerate more days with a need of swapping vehicles. Thus, access to a public infrastructure could increase the market for Electric vehicles and increase the use of the Electric vehicles that already exist in the vehicle fleet.

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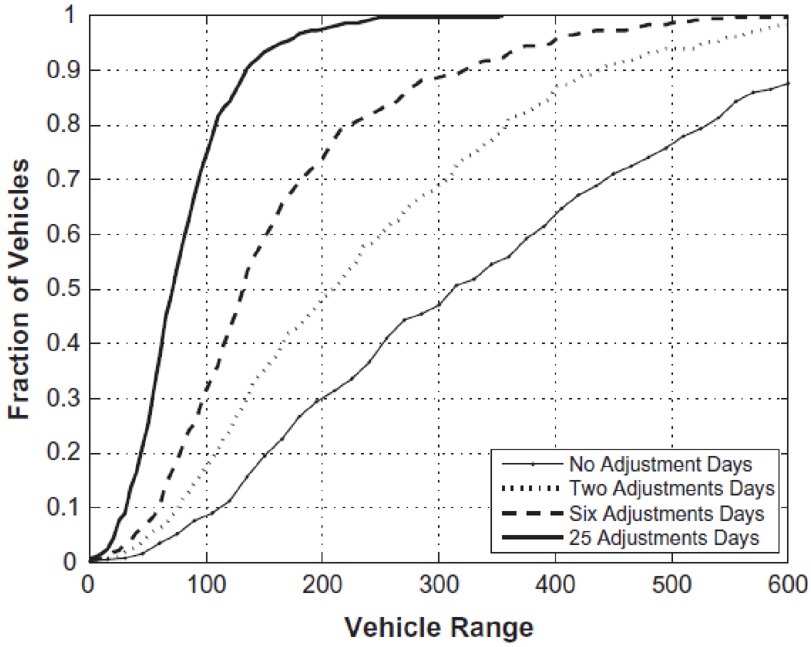

Fig. 6. Driving success surface by adaptation days. Fraction of the 363 vehicle fleet appropriate for varying vehicle ranges, with the four lines representing vehicle owners willing to make adaptations 0, 2, 6, and 25 days in the year.

Figure 31: Fraction of the vehicle fleet that theoretically can be an EV in Atlanta, as a function of range and the number of adjustment days. N=484 petrol vehicles tested throughout a year. Source: Pearre et al 2011.

Municipal vehicle fleets used in home nursing services require vehicles that can be used for two shifts. Practical experience in Norway, has shown that it can be difficult to achieve this with today's Electric vehicles, since range is halved during the winter. Access to fast charging or semi-fast charging can open up these areas of application to a greater extent.

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6 Vehicle sales and the vehicle fleet

6.1 Costs for vehicle ownership

Before 2000, the sale of Electric vehicles was negligible; see Chapter 2 about the history of the EV. Consequently, here we are looking at EV sales after 2000.

In 2010, there were was an assumption of increasing costs for vehicles with internal combustion engines and rapidly decreasing costs for Electric vehicles and Plug-in Hybrids (Klimakur 2010), i.e. the competition between Electric vehicles and vehicles with internal combustion engines would even out up to 2020. However, it was still assumed that there will be a need for incentives so that the Electric vehicle market can develop and become really competitive. Klimakur (2010) has produced some comparisons of the costs for vehicle purchasers; see Figure 31. Depreciation of capital costs was set at 60% over six years and the real rate of interest at 7%. In the cost alternative with battery replacement, it was assumed that the batteries would have a service life of six years. It was assumed that Electric vehicles would have the same tax relief as for 2010. The figures were partly based on assessments of production costs, partly on as assessment of what would be a real market prices based on the volumes vehicle manufacturers said they would sell. Thus, much emphasis was put on the asking price of vehicle manufacturers who were focusing strongly on the technology, and on getting started with mass production. It was assumed that these manufacturers would control the price on the market in a way that did not necessarily correspond to the production costs for manufacturers with less focus on the technology.

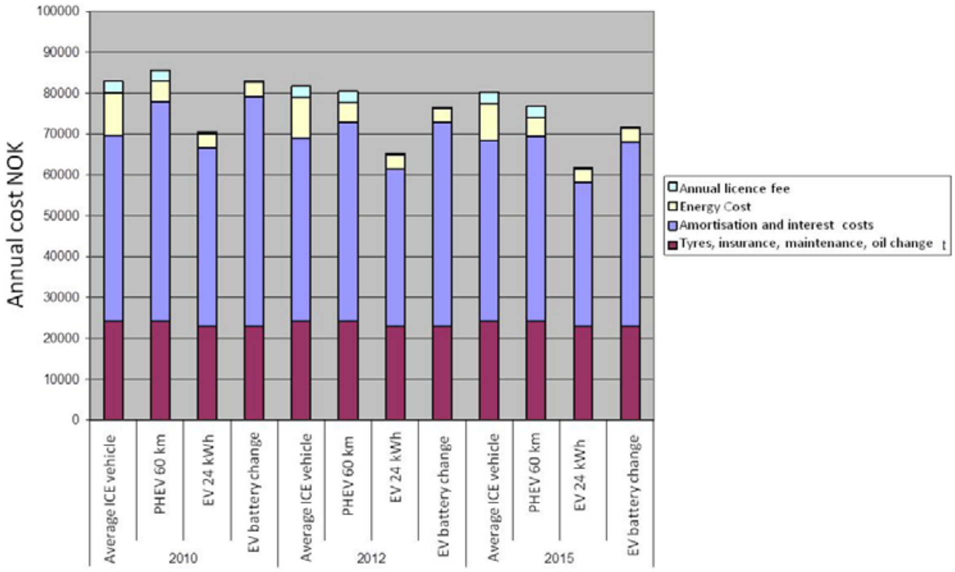

Figure 32: Different types of annual costs (NOK, 1 € = 8 NOK) for a vehicle purchaser according to Klimakur (2010). Source: Figenbaum et al 2010.

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Since 2010, the market price for Electric vehicles has been somewhat higher than the estimates in Klimakur, but Figure 32 still provides a picture of the relative magnitude of the different cost components. During the past year, prices have dropped even more so that from autumn 2013, prices are in line with the estimates from Klimakur.

An overview of prices and available vehicles can be found on the web page http://nybilvelger.vegvesen.no/. Appendix III shows the history of prices for Electric vehicles on the Norwegian market.

In 2010, Electric vehicles were launched for production in large volumes and with a scheduled escalation of production from 2010 to 2013. In the course of this escalation, it was assumed that the costs for Electric vehicles would drop significantly from today's level, while quality, durability, reliability and safety was expected to improve.

6.1.1 Passenger cars

Class MI electric passenger cars

Table 10 shows price and motor power for available electric passenger cars. During the course of 2013 the Volkswagen E-up and the Ford Focus became available. The Smart four two ed will be launched in 2014 and this vehicle has not been given an official Norwegian price yet. The BMW i3 will be launched in November with a starting price of 29,600 €.

In 2013, the Nissan Leaf was sold with a guaranteed buy back price of 15,360 € after 3 years/45,000 km. After adding on freight costs, a new vehicle sold for about 30,100 €. Based on this, one can expect a maximum loss in value of 4,900 €/year for the Leaf.

Table 10: Available electric passenger cars. Motor power and prices (NOK, 1€ = 8 NOK). Source: SVV New vehicle guide 2013

Model	Type of body	Price NOK	Doors	Motor power hp
Citroën C-Zero Seduction	Combi-Coupé	169,900	5	64
Mitsubishi i-MiEV	Combi-Coupé	168,300	5	67
Peugeot iOn Elbil Active 67 hp	Combi-Coupé	194,800	5	67
Renault Kangoo ZE Maxi 5-seater	Station wagon	204,000	5	60
BMW i3	Combi-Coupé	250,300	5	170
VW E-Up	Combi-Coupé	182,700	5	60
Nissan Leaf Visia	Combi-Coupé	219,700	5	109
Nissan Leaf Acenta	Combi-Coupé	242,500	5	109
Nissan Leaf Tekna	Combi-Coupé	265,000	5	109
Tesla Model S 60	Combi-Coupé	446,500	5	306
Tesla Model S 85	Combi-Coupé	506,700	5	367
Tesla Model S Performance	Combi-Coupé	595,000	5	422
Tesla Model S Signature	Combi-Coupé	620,200	5	367
Tesla Roadster	Convertible	667,500	2	302
Tesla Model S Signature Performance	Combi-Coupé	679,000	5	422

Source: http://nybilvelger.vegvesen.no, 06. Nov. 2013.

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Class MI Plug-in hybrid passenger cars

At the end of 2013/2014, the Mitsubishi Outlander PHEV (Plug-in Hybrid) will be launched on the Norwegian market. As of July 2013, the vehicles registration tax for Plug-in Hybrids, was reduced slightly due to in increased weight deduction.

Table 11: Available Plug-in Hybrids. 17 June 2013. Price (NOK, 1 € = 8 NOK), CO_2 emissions, fuel and motor power. Source: SVV New vehicle guide.

	Body	Price NOK	CO_2 emissions g/km	Fuel	Motor power in hp
Opel Ampera Cosmo	Combi-Coupé	379,900	27	Petrol	151
Opel Ampera Enjoy	Combi-Coupé	369,900	27	Petrol	151
Opel Ampera Campaign	Combi-Coupé	349,900	27	Petrol	151
Mitsubishi Outlander Instyle+	SUV	459,900	44	Petrol	
Mitsubishi Outlander Intense	SUV	434,900	44	Petrol	
Volvo V60 D6 AWD Momentum Plug-in Hybrid	Station wagon	610,400	48	Diesel	215
Volvo V60 D6 AWD Summum Plug-in Hybrid	Station wagon	625,400	48	Diesel	215
Toyota Prius Plug-in Advance	Combi-Coupé	327,300	49	Petrol	136
Toyota Prius Plug-in Premium	Combi-Coupé	372,300	49	Petrol	136

Source: http://nybilvelger.vegvesen.no, 06. Nov. 2013.

6.1.2 Class N1 electric vans

The Ford dealership, Røhne and Selmer have imported and sold the electric van, Ford Transit e-connect produced by Azure Dynamics, in collaboration with Ford. It is now being leased out on 2, 6 or 12-month contracts at a monthly price of 990, 860 and 740 € respectively (Røhne and Selmer AS). The Renault Kangoo is also on the market with a battery leasing scheme.

In the summer of 2013, the Peugeot Partner became available on the Norwegian market. The price is 30,100 €. Also its sister vehicle, the Citroën Berlingo, will come on the market.

Table 12: Available electric vans. Price (NOK, 1 € = 8 NOK) and motor power. Source: SVV New vehicle guide 2013. For Renault vehicles battery rent comes in addition (Table 13).

	Body	Price NOK	Doors	Motor power in hp
Mitsubishi i-MiEV	Delivery van	187,500	5	64
Peugeot Partner L1	Delivery van	241,000	4	
Peugeot Partner L2	Delivery van	241,000	4	
Renault Kangoo ZE	Delivery van	190,000	4	60
Renault Kangoo ZE Maxi	Delivery van	198,000	4	60
Renault Kangoo ZE Maxi 5-seater	Delivery van	204,000	5	60

Source: http://nybilvelger.vegvesen.no, 06. Nov. 2013.

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There is an additional cost for battery lease for Renault Kangoo; see Table 13.

Table 13: Price list for monthly battery lease (NOK, 1 € = 8 NOK) for Renault Kangoo according to mileage (km/year) and duration (måneder = months) of lease. Source: Renault Norway.

BATTERILEIE per måned - eks. mva
(inkl. veihjelpassistanse, Connected Services og batterigaranti*)

	Maks kjørelengde per år						
Avtalt vilkår	10 000 km	12 500 km	15 000 km	17 500 km	20 000 km	22 500 km	25 000 km
36, 48, 60, 72 og 84 måneder	715	730	745	800	855	920	985
24 måneder	795	810	825	880	935	1000	1065
12 måneder	875	890	905	960	1015	1080	1145

* Så lenge du eier/leaser bilen garanterer Renault en perfekt tilstand og tilstrekkelig ladekapasitet på Lithium-Ion batteriet (alltid høyere enn 75% av opprinnelig kapasitet)

Batterileien inkluderer veihjelpassistanse (inkl. tom for strøm) og Connected Services (eks mva.)
100 km over avtalt kjørelengde : 39 NOK eks mva/100 km. Minimum årlig kjørelengde: 10 000 km.

6.1.3 Other Electric vehicles – including 4-wheel MC (L7e)

In addition to these vehicles, the EV Mia is sold as an M1 passenger car (Mia and Mia L) as an N1 class van (Mia-U). Prices are from NOK 159,000-192,900; see Table 14.

Some vehicles that are on the market are registered as class L7e, 4-wheel Motorcycles. This applies to the 3-seater Buddy produced by Buddy Electric AS. This has a price tag of 21,000-22,500 €. The Tazzari Zero sells for approx. 22,500 € and the Maranello Superstar for approx. 17,250 €. These vehicles are not registered in the New Vehicle guide since they are not passenger cars.

Table 14: Price list for the Mia EV (NOK, 1 € = 8 NOK), Norway 2012. Source Enviro Bil 2012.

mia electric

PRISLISTE NORGE 2012

Enviro Bil Nesbru AS
www.envirobil.no

mia *3-seter*	
8 kWh	159 900
12 kWh	186 900
mia L *4-seter*	
8 kWh	165 900
12 kWh	192 900
mia U *1-seter. Ekstra sete kan velges som tilleggsutstyr.*	
8 kWh	153 900
12 kWh	180 900

Klargjøring- og registreringskostnader tilkommer kr 5.500,-
Rett til endring uten forvarsel forbeholdes.

In the summer of 2013, the 2-seater Renault Twizy, became available at a price of 7,500 € for the version that can be driven at 45 km/h and 8,750 € for the version with a top speed of 80 km/h. Battery lease will be an additional cost. This starts at 69 €/month for a 36-month lease and a mileage of 7,500 km/year (www.renault.no).

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6.2 Vehicle sales from 2000-2012

6.2.1 Electric vehicles

Up to 2010, the sale of Electric vehicles was estimated at between 200-500 vehicles per year. In the early 2000s, Think City, Kewets and French Electric vehicles were on sale. Distribution was limited, but Think was sold through Ford dealerships. In the middle of the 2000s, imported second hand French vehicles dominated as well as vehicles registered as 4-wheel Motorcycles, such as those from Kewet/Buddy and Reva. During that period, the Norwegian Think EV was not available for delivery.

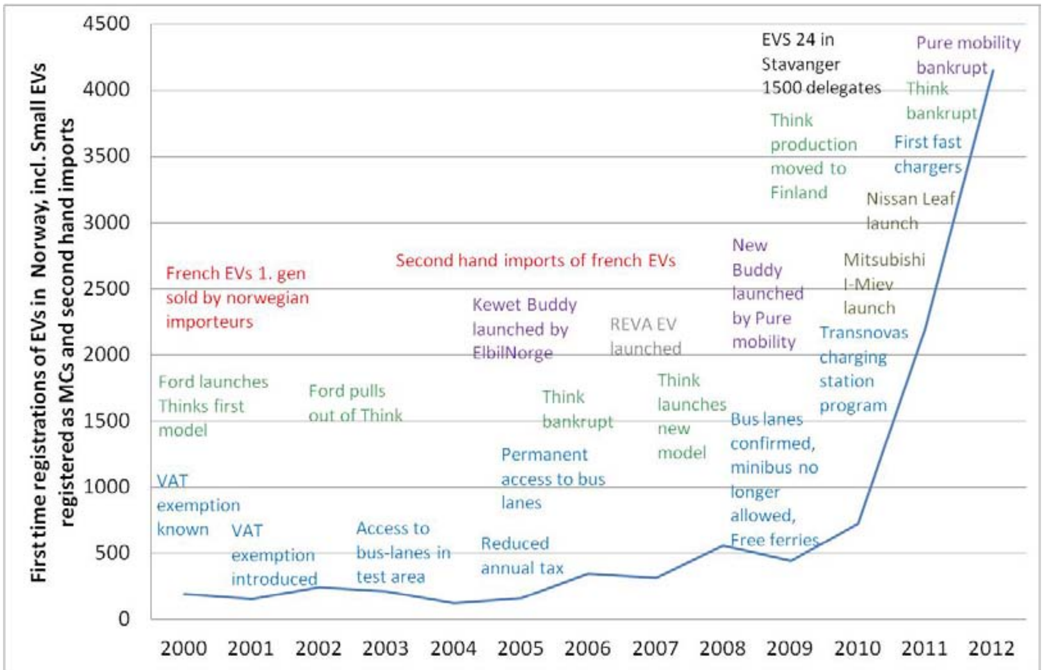

Figure 33: Estimate of sales of Electric vehicles in Norway from 2000-2013 and time of establishment of different incentives and important events. Source: TØI, based on fleet figures from Grønn Bil and OFVAS. Sales figures during the first yeas are uncertain.

In late 2010, the established vehicle manufacturers arrived on the scene with their Electric vehicles, and sales quickly increased. At the same time, also the number of dealerships increased significantly. Mitsubishi distributed its vehicle to all dealerships in Norway and, little by little, even Peugeot and Citroën did this. Initially, Nissan had nine Leaf dealerships but from the end of 2012, this vehicle has been sold by all Norwegian Nissan dealerships. Overall, there were about 245 dealerships for Electric vehicles in Norway in April 2013, both large and small; see Figure 34. This number increases as Ford, Volkswagen and BMW rolled out EVs into their dealer networks in the fall of 2013.

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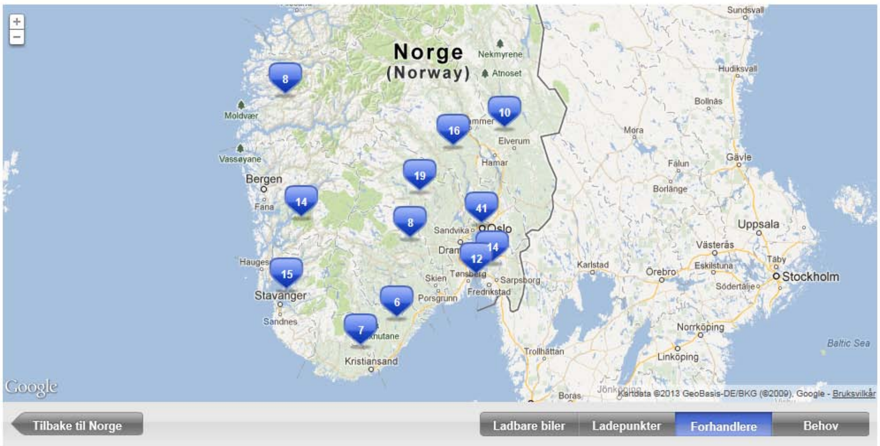

Figure 34: Number of EV dealerships (number in blue background) in Southern Norway in April 2013. Source: www.gronnbil.no.

Figure 35 show the sale of Electric vehicles in 2011 and 2012 distributed according to models. Sales in 2012 were dominated by the Nissan Leaf, while in 2011, the Mitsubishi 1-MiEV was the best-seller. The large fluctuations in the sale of the Mitsubishi i-MiEV were presumably due to the arrival of boat loads of vehicles from Japan.

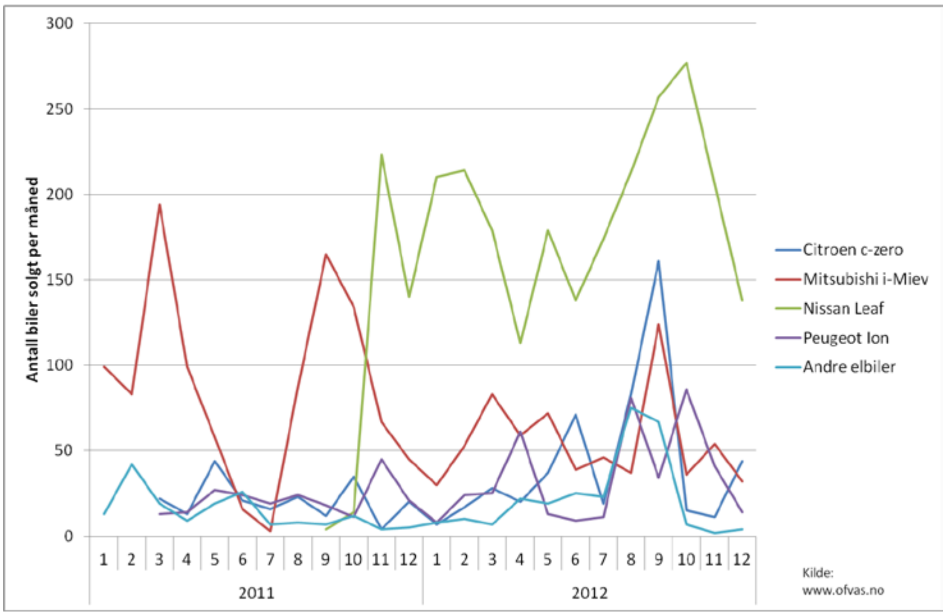

Figure 35: Sales of Electric vehicles (number of vehicles per month) in Norway in 2011 and 2012 distributed according to model. Source: OFVAS.

6.2.2 Plug-in Hybrid vehicles (PHEV)

Plug-in Hybrids were not sold prior to 2012. Toyota sold approx. 176 vehicles and Opel sold 159 Amperas, GM sold three Volts and six Fisker Karmas were sold; this gave a total of 344 rechargeable hybrids in 2012.

6.2.3 Electric vans.

Electric vans went on sale in 2011 when the Ford dealership, Røhne and Selmer in the Oslo area entered into an agreement with Azure Dynamics to import and sell a

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small electric van, the Ford Transit Connect, developed in collaboration with Ford. Meanwhile, Azure Dynamics has gone bankrupt and the future of this model is uncertain. At the end of 2012, Renault started selling the Kangoo van in Norway with limited success. 50 vans with electric motors were registered in 2012, and in 2011, 42 were registered.

6.3 Vehicle sales in the first 6 months of 2013

Sales (defined here as: vehicles registered for the first time, also including used imports) in the first 6 months of 2013 were dominated by Nissan Leaf; see Table 15.

Table 15: Vehicle sales for 2011-2012, and during the first 6 months of 2013, distributed according to models. Number of vehicles and share of new vehicle sales. Sources: Grønn Bil/OFV.

Brand	1.half 2013	1. half 2012	Change	Share sale 1. halfyear	Market 2012	Share sale 2012	Market 2011
Nissan LEAF	2 477	1 074	*131%*	*80%*	2 487	*57%*	381
Mitsubishi i-MiEV	257	338	*-24%*	*8%*	672	*15%*	1 050
Ford Connect Electr.	86	11	*682%*	*3%*	31	*1%*	41
Peugeot iOn	72	141	*-49%*	*2%*	447	*10%*	217
Citroën C-ZERO	61	183	*-67%*	*2%*	558	*13%*	210
Renault Kangoo Z.E.	61	0	*+%*	*2%*	24	*1%*	0
Renault Twizy	30	0	*+%*	*1%*	0	*0%*	0
Diverse	14	13	*8%*	*0%*	32	*1%*	17
Buddy	10	7	*43%*	*0%*	24	*1%*	125
Think City	7	11	*-36%*	*0%*	22	*1%*	133
Mia	4	0	*+%*	*0%*	13	*0%*	0
Smart ED	4	0	*+%*	*0%*	0	*0%*	0
Tesla Model S	2	0	*+%*	*0%*	0	*0%*	0
Tesla Roadster	2	22	*-91%*	*0%*	38	*1%*	34
Tazzari	1	8	*-88%*	*0%*	10	*0%*	34
Totalt	**3 088**	**1 808**	***71%***	***100%***	**4 358**	***100%***	**2 242**
Norsk Elbilforening / OFV							

Electric vehicles made up about 3% of total passenger car sales, while in the first 6.month period, Nissan Leaf was at 5th place in the list of the most sold vehicle models in Norway (2,477 Leafs were sold or imported as used). In March and June, the model was right up to 4th place. 80% of Electric vehicle sales (including used imports) consisted of Nissan Leafs. The import of used Electric vehicles is increasing and is dominated by Nissan Leaf, Peugeot Ion and Citroën C-zero.

Table 16 shows EV sales distributed according to county. We see that Akershus County consistently leads EV sales.

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Table 16: Vehicle sales for 2012 and during the first 6 months of 2013 distributed according to counties. Number of vehicles and share of new vehicle sales. Source: Grønn Bil/OFV.

EV sales 1. half year 2013, by county

Brand	1.half 2013	1. half 2012	Change	Share sale 1. halfyear	Market 2012	Share sale 2012	Market 2011
Akershus	661	458	44%	21%	1 175	27%	705
Oslo	610	328	86%	20%	852	20%	394
Hordaland	504	246	105%	16%	584	13%	213
Rogaland	278	177	57%	9%	379	9%	204
Sør Trøndelag	250	178	40%	8%	404	9%	158
Buskerud	167	108	55%	5%	241	6%	139
Vest-Agder	137	54	154%	4%	137	3%	72
Vestfold	106	37	186%	3%	88	2%	44
Møre og Romsdal	95	83	14%	3%	171	4%	61
Østfold	63	41	54%	2%	86	2%	81
Nordland	62	34	82%	2%	64	1%	44
Nord Trøndelag	51	15	240%	2%	43	1%	22
Aust-Agder	32	10	220%	1%	30	1%	23
Telemark	20	6	233%	1%	19	0%	14
Troms	18	7	157%	1%	15	0%	23
Oppland	12	6	100%	0%	27	1%	22
Finnmark	9	4	125%	0%	10	0%	5
Hedmark	8	10	-20%	0%	21	0%	13
Sogn og Fjordane	5	6	-17%	0%	12	0%	5
Totalt	**3 088**	**1 808**	71%	100%	**4 358**	100%	**2 242**

Norsk Elbilforening / OFV

First-time registration of Plug-in Hybrids amounted to 131 vehicles in the first 6 months of 2013. Of these, there was 1 Fisker Karma, 20 Opel Amperas, 101 Prius Plug-ins and 62 Volvo V60 Plug-ins. Toyota believes that the framework conditions for this type of vehicle are not good enough and that this explains the poor sales figures.

126 Electric distribution vans were registered in the first 6 months of 2013.

6.4 Record sales in the second half of 2013

In the second half of 2013, EV sales are booming. Tesla started deliveries of the Model S and this vehicle became the bestseller in the statistics of new vehicle sales in Norway for September month. Nissan Leaf was the best seller in October. The market share of EVs in September and October was 8,6% and 7.2% respectively.

6.5 The EV fleet

6.5.1 Development over time

There is a total of approximately 2.4 million passenger cars in Norway. Figure 36 shows the development of the EV fleet in Norway over the past 12 years. In all, there were just under 10,000 Electric vehicles in the vehicle fleet at the end of 2012.

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Up to 2010, the fleet increased by 200-500 vehicles per year. From 2011 and 2012 there has been a strong increase in the fleet, which is due to good vehicle sales combined with the modest scrapping of old vehicles. During the next few years there should be an expected increase in the scrapping of the oldest Electric vehicles that dates from around 2000, but the remaining number of these vehicles is small, so the vehicle fleet is expected to continue to grow rapidly.

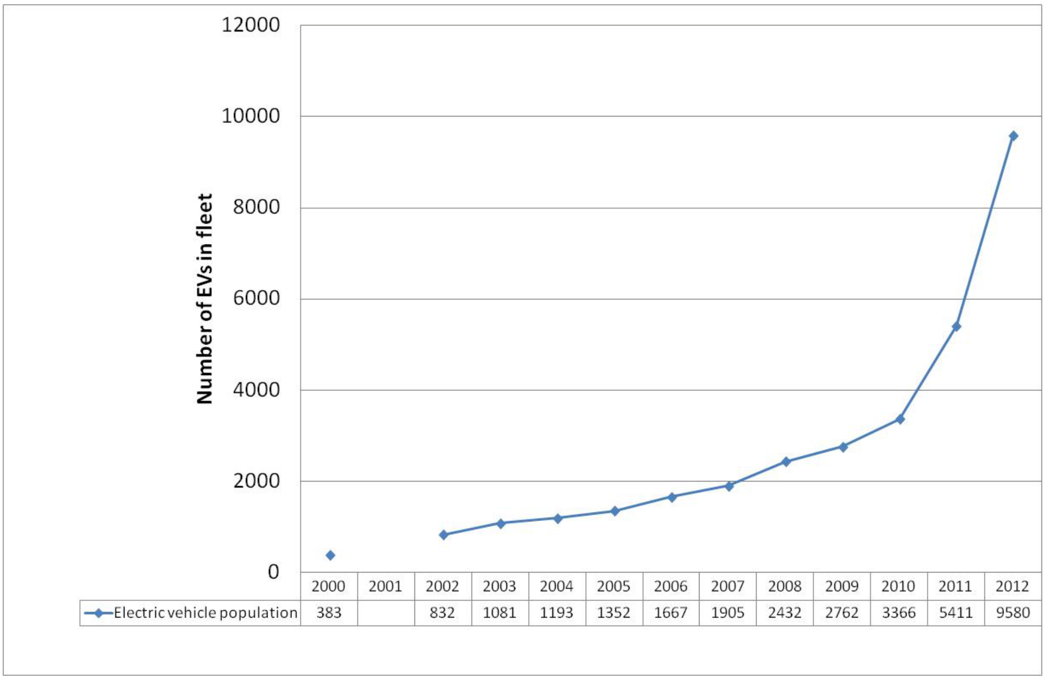

Figure 36: Vehicle fleet in Norway from 200-2012. Source: www.elbil.no and OFV AS.

Figure 37 presents a snapshot of the vehicle fleet in Norway as of June 2013, distributed according to counties, vehicle brand as well as gender and business share of sales (and sales up to July). These statistics include Plug-in Hybrids, but as there only about 500 of these in the fleet, they will be termed as Electric vehicles below.

As can be seen, there were somewhat fewer than 11,500 Electric vehicles in Norway at the end of March 2013. After the first 6 months of 2013, this number exceeded 13,000, and in the middle of September the fleet passed 15,000. 24% of Electric vehicles are registered to businesses and 76% to private individuals. Of these, men own 68% and women 32%. The fact that only every fourth vehicle in Norway is registered to a business is a situation that is different than in most other countries, indicating that businesses constitute an important potential market in the future in Norway. In the total passenger car market in Norway, 40% of sales goes to businesses and services (OFV 2010).

Oslo and Akershus (that surrounds Oslo) are the largest EV counties. Together they are home to 50% of the Electric vehicles in Norway. After these comes Hordaland (with the City of Bergen), Rogaland (with the City of Stavanger) and Sør-Trøndelag (with the City of Trondheim); see Table 16. Inner parts of Southern Norway (Oppland, Hedmark, and Telemark) and the northernmost parts of Norway (Finnmark, Nordland, Troms, North Trøndelag) have a very low percentage of Electric vehicles. This is most likely due to a combination of a cold climate, long transport distances and poorer access to vehicles. The same applies to Sogn og Fjordane, with its fjord landscapes where people live far apart, with long travel

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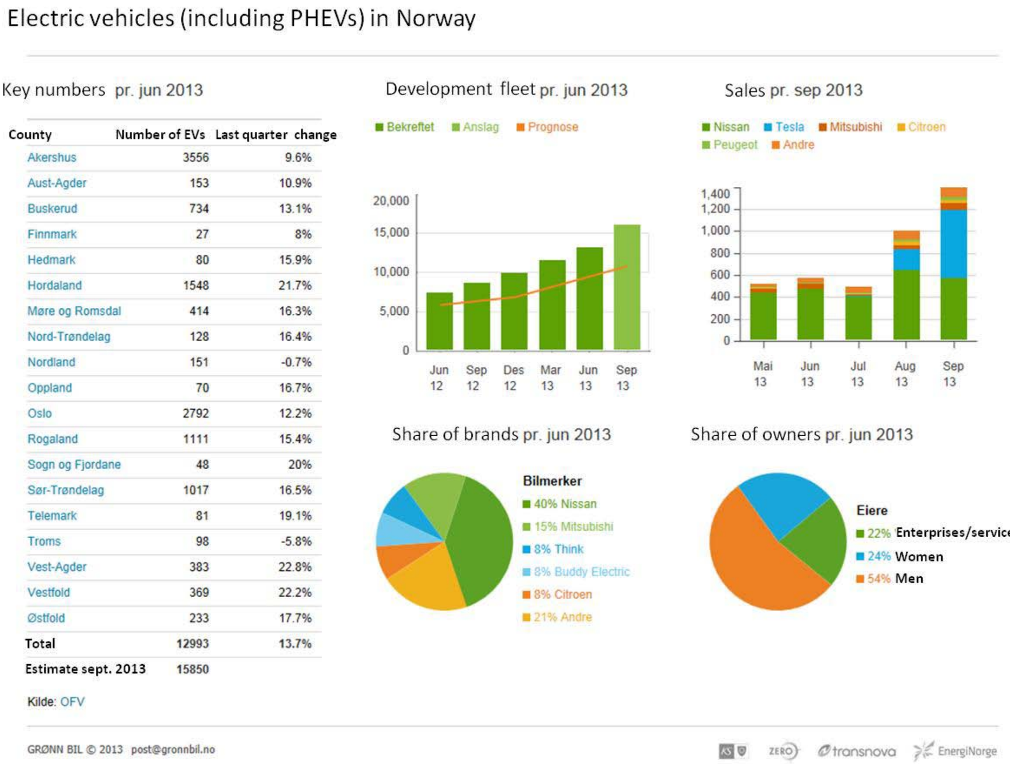
distances, even though winter temperatures are relatively high thanks to their vicinity to the coast. Those parts of Akershus County that are farthest from the Oslo Fjord has a climate (winter temperatures down to -30°C) that is similar to inner Southern Norway. There is also a low percentage of Electric vehicles in these areas.



County	Number of EVs	Last quarter change
Akershus	3556	9.6%
Aust-Agder	153	10.9%
Buskerud	734	13.1%
Finnmark	27	8%
Hedmark	80	15.9%
Hordaland	1548	21.7%
Møre og Romsdal	414	16.3%
Nord-Trøndelag	128	16.4%
Nordland	151	-0.7%
Oppland	70	16.7%
Oslo	2792	12.2%
Rogaland	1111	15.4%
Sogn og Fjordane	48	20%
Sør-Trøndelag	1017	16.5%
Telemark	81	19.1%
Troms	98	-5.8%
Vest-Agder	383	22.8%
Vestfold	369	22.2%
Østfold	233	17.7%
Total	12993	13.7%
Estimate sept. 2013	15850	

Figure 37: Electric vehicles in Norway distributed according to counties, make of vehicle and type of owner – key figures for June 2013. Source: www.gronnbil.no.

6.5.2 Distribution of makes of vehicles

When we look at the brands of vehicles in the EV fleet at the end of the year 2012/2013 in Table 17, we find an interesting development. Nissan and Mitsubishi did not have any Electric vehicles on sale in 2010. In 2012 their share rose to 30% and in March 2013 already 34% of all Electric vehicles in Norway were from Nissan, and consequently Nissan is the brand with the highest percentage in the EV-fleet. At the end of the year, Mitsubishi had an 18% share, but dropped to 16% three months later. In 2010, Think was at the top with a share of 34% followed by Buddy with a share of 30%. The shares of both these dropped to 12% in 2012. During this period, both brands have gone bankrupt (however, the production of Buddy is slowly starting up again). By and large, Peugeot and Citroën have maintained their shares of the vehicle fleet at approx. 10% throughout these years. Other brands are insignificant with the exception of Reva with a share of 3% in 2012 dropping from 9% in 2010. The vehicle has not been available on the market after 2010.

Tesla is becoming a significant brand in the EV fleet thanks to strong sales in late 2013.

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Table 17: Brand distribution in vehicle fleet in 2012. Source: www.elbil.no.

	2012	Share	2011	Sharel	2010	Share
Nissan	2 863	30%	380	7%	0	0%
Mitsubishi	1 728	18%	1 051	19%	8	0%
Think	1 153	12%	1 216	22%	1 161	34%
Buddy	1 108	12%	1 125	21%	1 018	30%
Citroen	1 047	11%	493	9%	321	10%
Peugeot	935	10%	510	9%	346	10%
Reva	302	3%	311	6%	307	9%
Diverse	111	1%	79	1%	64	2%
Tesla	102	1%	68	1%	36	1%
Renault	94	1%	77	1%	81	2%
Ford	83	1%	49	1%	6	0%
Tazzari	54	1%	52	1%	18	1%
Totalt	**9 580**	**100%**	**5 411**	**100%**	**3 366**	**100%**

6.5.3 Distribution according to counties and selected municipalities

Some interesting facts are discovered when looking at the distribution of the EV fleet between counties in 2012 (Table 18). Oslo and Akershus have been the top EV counties in Norway, but the share of the total EV fleet has started to drop from approx. 62% in 2010 to approx. 52% in 2012 (and to 50% in March 2013).

When it comes to the municipalities (Table 19), Asker and Bærum's (suburban municipalities to Oslo) total share has dropped from 44% to 34%, and the cities' (the total of Oslo, Trondheim, Stavanger and Kristiansand) has decreased from 43% to 39%. Thus, the share of the major cities is dropping, implying that EV sales are spreading to smaller cities and the rest of the country.

Table 18: Vehicle fleet in Norway distributed according to counties from 2010-2012, total number of vehicles and share of EV fleet. Source: www.elbil.no.

	2012	Share	2011	Share	2010	Share
Akershus	2 822	29,5%	1 742	32,2%	1 137	33,8%
Oslo	2 169	22,6%	1 366	25,2%	946	28,1%
Hordaland	1 029	10,7%	471	8,7%	275	8,2%
Rogaland	789	8,2%	393	7,3%	191	5,7%
Sør Trøndelag	732	7,6%	341	6,3%	207	6,1%
Buskerud	508	5,3%	298	5,5%	183	5,4%
Møre og Romsdal	300	3,1%	118	2,2%	56	1,7%
Vest-Agder	257	2,7%	153	2,8%	101	3,0%
Vestfold	227	2,4%	115	2,1%	60	1,8%
Østfold	165	1,7%	97	1,8%	40	1,2%
Nordland	114	1,2%	56	1,0%	15	0,4%
Aust-Agder	100	1,0%	47	0,9%	28	0,8%
Troms	98	1,0%	80	1,5%	57	1,7%
Nord Trøndelag	78	0,8%	31	0,6%	14	0,4%
Telemark	51	0,5%	34	0,6%	20	0,6%
Hedmark	49	0,5%	27	0,5%	12	0,4%
Oppland	45	0,5%	23	0,4%	13	0,4%
Sogn og Fjordane	29	0,3%	11	0,2%	8	0,2%
Finnmark	18	0,2%	8	0,1%	3	0,1%
Totalt	**9 580**	**100%**	**5 411**	**100%**	**3 366**	**100%**

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Table 19: Vehicle fleet in Norway distributed according to municipalities from 2010-2012. Source: www.elbil.no.

	2012	Share	2011	Share	2010	Share
Oslo	2169	22,6%	1366	25,2%	946	28,1%
Asker	1079	11,3%	745	13,8%	547	16,3%
Bærum	853	8,9%	609	11,3%	407	12,1%
Bergen	618	6,5%	281	5,2%	173	5,1%
Trondheim	477	5,0%	269	5,0%	176	5,2%
Stavanger	255	2,7%	152	2,8%	79	2,3%
Kristiansand	208	2,2%	129	2,4%	89	2,6%
Lier	136	1,4%	66	1,2%	44	1,3%
Oppegård	130	1,4%	69	1,3%	41	1,2%
Drammen	127	1,3%	67	1,2%	38	1,1%
Frogn	122	1,3%	58	1,1%	25	0,7%
Sandnes	121	1,3%	56	1,0%	25	0,7%
Røyken	96	1,0%	50	0,9%	30	0,9%
Lørenskog	91	0,9%	38	0,7%	14	0,4%
Averøy	90	0,9%	27	0,5%	6	0,2%
Totalt	**6 572**	**69%**	**3 982**	**74%**	**2 640**	**78%**

6.5.4 Electric vehicles in Oslo and Akershus counties

Figure 38 shows the number of Electric vehicles(including PHEVs) per municipality for the Oslo area. The region has EV sales that are more than double that of the average for the country as a whole. We can see that Oslo (2,4792) and the municipalities of Bærum (1,091) and Asker (1,208) in Akershus county, are the largest EV municipalities in the region. They are also the most populous municipalities. See also Figure 39 and 40.

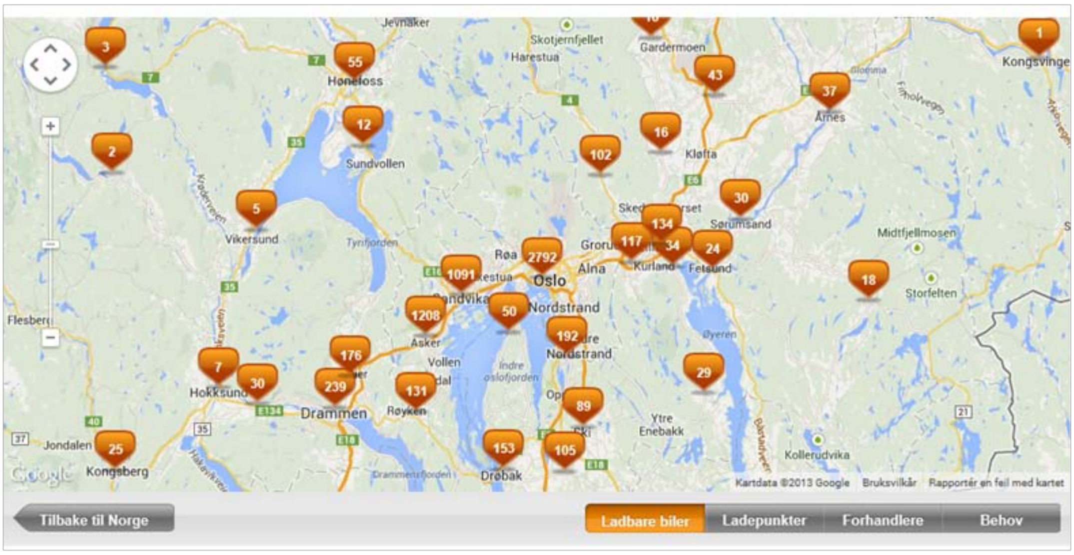

Figure 38: Distribution of Electric vehicles according to municipalities in the Oslo region, june 2013, Numbers located at the community centre. Source: www.gronnbil.no.

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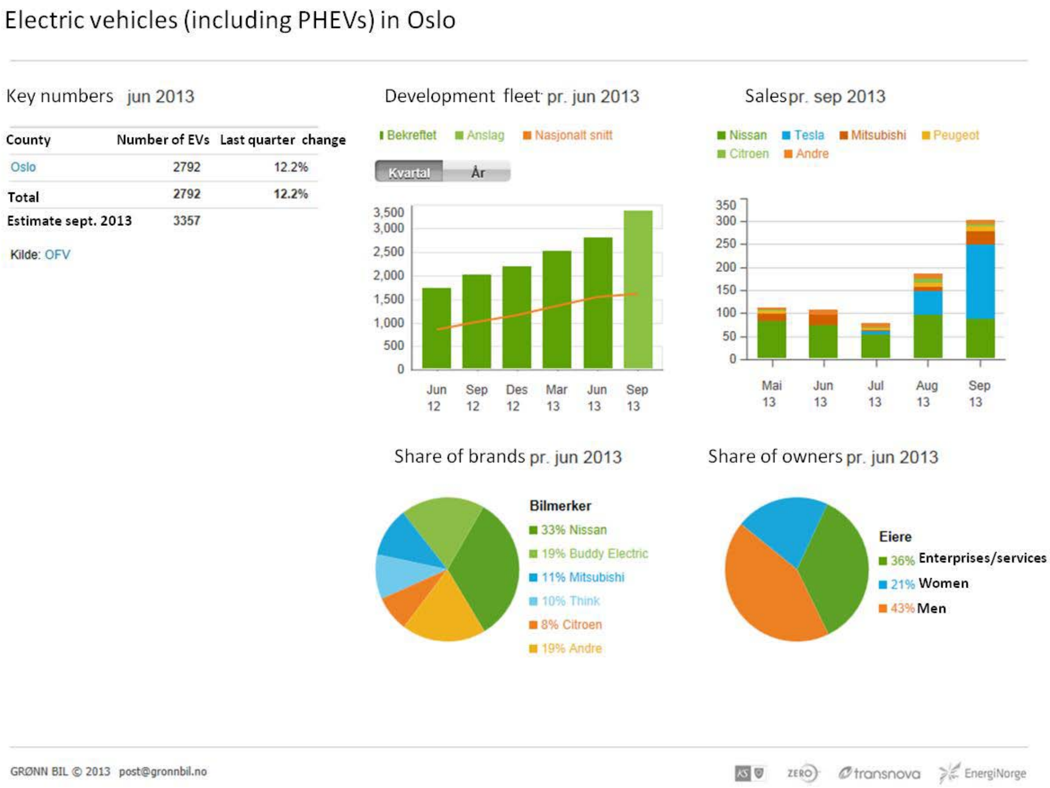
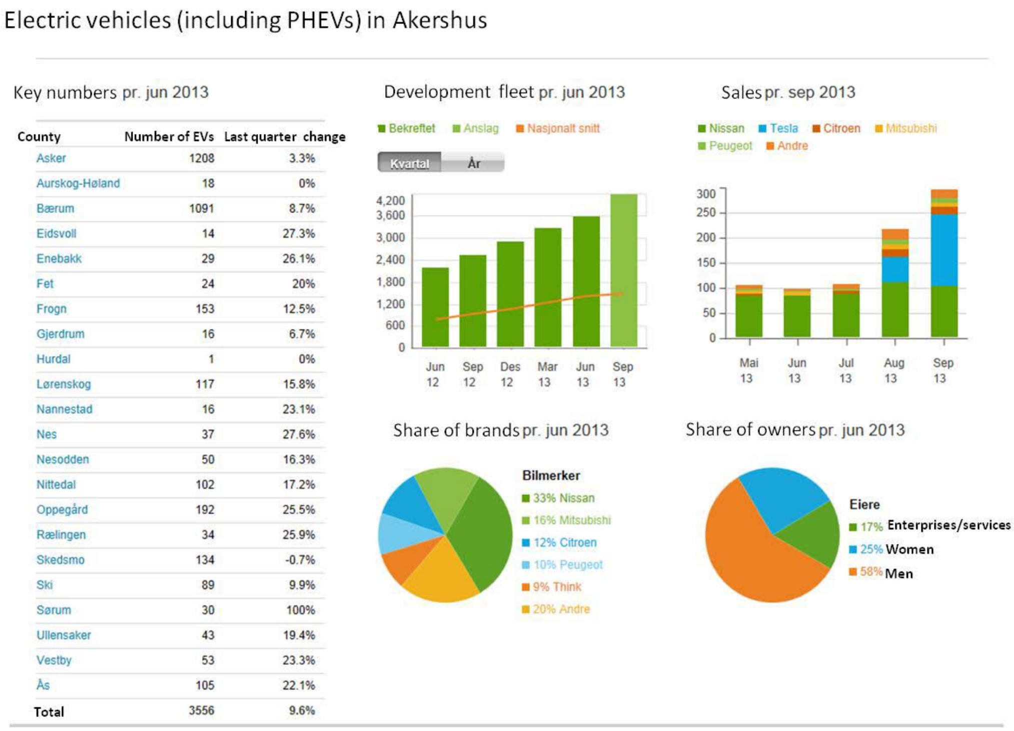


County	Number of EVs	Last quarter change
Oslo	2792	12.2%
Total	2792	12.2%
Estimate sept. 2013	3357	

Figure 39: EV fleet in Oslo, key figures for June 2013 distributed according to make of vehicle and type of owner. Source: www.gronnbil.no.



County	Number of EVs	Last quarter change
Asker	1208	3.3%
Aurskog-Høland	18	0%
Bærum	1091	8.7%
Eidsvoll	14	27.3%
Enebakk	29	26.1%
Fet	24	20%
Frogn	153	12.5%
Gjerdrum	16	6.7%
Hurdal	1	0%
Lørenskog	117	15.8%
Nannestad	16	23.1%
Nes	37	27.6%
Nesodden	50	16.3%
Nittedal	102	17.2%
Oppegård	192	25.5%
Rælingen	34	25.9%
Skedsmo	134	-0.7%
Ski	89	9.9%
Sørum	30	100%
Ullensaker	43	19.4%
Vestby	53	23.3%
Ås	105	22.1%
Total	3556	9.6%

Figure 40: EV fleet in Akershus, key rations for March 2013 distributed according municipalities, make of vehicle and type of owner. Source: www.gronnbil.no.

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6.6 Market development in Norway compared to other countries

In light of the many incentives of the Norwegian EV policy, it is interesting that Norway has a leading position both globally and in Western Europe, when it comes to market development. Table 20 shows that in Norway in 2012, Electric vehicles had a market share of approx. 3%, clearly the highest in Western Europe. The only other country with a share over 1% was the Netherlands (combined EV and Plug-in Hybrid), a country that has good incentives for Plug-in Hybrids. In the largest vehicle markets in Europe, France, German, Great Britain and Italy, the market shares are very low. In Norway, this development continued in 2013, but sales dropped in the Netherlands and rose slightly in France. In California, the vehicle share was 0.4% in 2012 and 1.1% in the first half of 2013. For Plug-in Hybrids, corresponding shares were 1.0% in 2012 and 0.7% in 2013 (CNCDA 2013).

Table 20: The EV market in some Western European countries. The share that Electric vehicles (purchased in Norway) have of the total new vehicle sales in 2012 and the first half of 2013 (at bottom). Source: The Norwegian Electric Vehicle Association and AID/Industry Sources 2013.

Western Europe Electric Passenger Car Sales

Market	Dec 2012 Electric	Dec 2012 TIV	% Market Share	12-Mths 2012 Electric	12-Mths 2012 TIV	% Market Share
France	231	160,314	0.14	5,663	1,898,760	0.30
Norway*	232	9,369	2.48	3,950	137,967	2.86
Netherlands	288	18,306	1.57	3,846	502,544	0.77
Germany*	276	204,331	0.14	3,755	3,082,504	0.12
United Kingdom	194	123,557	0.16	2,237	2,044,609	0.11
Sweden	105	26,687	0.39	947	279,478	0.34
Belgium	119	22,324	0.53	826	486,737	0.17
Switzerland	55	29,108	0.19	785	328,139	0.24
Denmark	45	10,707	0.42	537	170,763	0.31
Italy	57	86,735	0.07	513	1,402,089	0.04
Austria	32	18,421	0.17	427	336,010	0.13
Spain	12	51,197	0.02	399	699,589	0.06
Eire	0	316	0.00	137	79,498	0.17
Finland	8	6,410	0.12	116	111,251	0.10
Portugal	6	6,342	0.09	65	95,290	0.07
Greece	0	3,669	0.00	0	58,482	0.00
Western Europe	1,660	777,793	0.21	24,203	11,713,710	0.21

** = Germany includes Opel Ampera from April on, Norway sales adjusted from November to not identify imported used EV sales, United Kingom EV sales adjusted for 12-Months as official figures adjusted*

Source: AID/Industry Sources

Western Europe Electric Passenger Car Sales by Market

Market	Jun 2013 Electric	Jun 2013 Electric Share	Jun 2012 Electric	Jun 2012 Electric Share	% Electric Change	6-Mths 2013 Electric	6-Mths 2013 Electric Share	6-Mths 2012 Electric	6-Mths 2012 Electric Share	% Electric Change
France	903	0.47%	112	0.05%	706.3%	4,779	0.51%	2,271	0.22%	110.4%
Germany*	575	0.20%	350	0.12%	64.3%	2,612	0.17%	2,004	0.12%	30.3%
Norway*	372	3.40%	264	2.39%	40.9%	2,228	3.15%	1,716	2.47%	29.8%
United Kingdom*	276	0.13%	170	0.09%	62.4%	1,560	0.13%	839	0.08%	85.9%
Netherlands*	215	0.61%	418	0.55%	-48.6%	1,196	0.57%	1,876	0.57%	-36.2%
Sweden*	96	0.42%	35	0.14%	174.3%	837	0.65%	183	0.13%	357.4%
Italy	151	0.12%	98	0.08%	54.1%	398	0.05%	286	0.04%	39.2%
Switzerland	147	0.51%	74	0.19%	98.6%	354	0.23%	418	0.24%	-15.3%
Spain	65	0.09%	41	0.06%	58.5%	317	0.08%	209	0.05%	51.7%
Belgium	59	0.14%	98	0.21%	-39.8%	200	0.07%	405	0.14%	-50.6%
Austria	98	0.31%	15	0.05%	553.3%	189	0.11%	204	0.11%	-7.4%
Denmark	31	0.18%	39	0.26%	-20.5%	175	0.19%	290	0.34%	-39.7%
Portugal	16	0.13%	5	0.05%	220.0%	63	0.11%	33	0.06%	90.9%
Finland	4	0.05%	14	0.18%	-71.4%	48	0.08%	59	0.09%	-18.6%
Eire	1	0.06%	16	0.25%	-	20	0.04%	62	0.09%	-67.7%
Greece	0	0.00%	0	0.00%	-	0	0.00%	0	0.00%	-
Western Europe	3,009	0.27%	1,749	0.15%	72.0%	14,976	0.25%	10,855	0.17%	38.0%

** = Germany 2012 EV sales adjusted as Opel Ampera included, Norway 2012 EV sales doesn't identify imported EVs or used electric CV sales, UK 2012 EV sales adjusted as official figures adjusted, Netherlands 2012 revised figure, Swedish official figures adjusted in March to accomodate extra LEAF sales in February*

Source: AID/Industry Sources

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7 Purchase and use of Electric vehicles – experience and potential

7.1 User surveys – weaknesses and content

Even though a good number of surveys have been conducted in which both EV owners and different potential users have been questioned about Electric vehicles, it is not easy to estimate or calculate future potential. This is primarily because;

1. Most studies do *not have sufficient data regarding mileage* for different purposes per day, per week or year. Questions are asked about how the vehicle is used for different journeys and how often these take place, but responses do not provide the figures that are required to assess environmental affects or potential.
2. *The technology and the market is developing rapidly* and data before 2010 must be interpreted with caution both when it comes to understanding today's market and in assessing future market potential.
    a. In 2013, the Electric vehicles on the market have much better qualities than before 2010.
    b. Many Electric vehicles from the early 2000s were equipped with Ni-Cd batteries that were robust but required maintenance charging every 6,000 km and lost capacity without this being visible on the range display. The vehicles had more defects than traditional vehicles.
    c. Electric vehicles have become less expensive and the price the purchaser pays today is on a similar level as regular vehicles. Prior to 2009, they were much more expensive than corresponding petrol/diesel vehicles of the same size.
    d. Electric vehicles have become safer and are today on a level with regular vehicles. Before 2009, levels of safety were poor and Electric vehicles were not tested in Euro-Ncap.
    e. New market players have arrived on the scene. Electric vehicles are now sold by major professional vehicle importers and dealerships with long-time experience of selling vehicles and servicing customers and with a great degree of security for the vehicle purchaser. Previously, the vehicles were sold via small vehicle manufacturers with an insecure future.
3. *The response rate* is reasonably high in studies of owners of Electric vehicles, but low in the control groups. This means that the responses do not necessarily provide a good enough picture of the cross-section of the groups studied (cross-section of driving license holders, vehicle purchasers, members in different organisations or the entire population).

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We have data from 19 surveys in Norway (surveys with several samples counts as one study). We do not have reports from all surveys, as some are only presented at conferences, but have gained access to some data that exists as internal material in businesses and organisations. An overview with facts about the individual surveys (number and type of respondents, method of interview etc. can be found in Appendix IV. The most recent survey (Skavhaug 2013) was carried out on behalf of Transnova in August 2013. Only certain parts of the results from this study have been included in the report.

The surveys are different and consequently the results are not that easy to stitch together. Examples are:

- Different types of questions were asked about the same theme. Some studies use whole sentences and ask people to mark which ones they more or less agree with. Others ask respondents to assess the degree of importance of, or agreement with many separate aspects of the theme.
- Some studies use open response categories, while others give specified categories to choose between. The latter method usually provides more responses for each of the different categories.
- The sets of categories contain slightly different categories and all possible benefits/disadvantages are not included in all studies.
- Benefits and disadvantages of Electric vehicles are associated directly to questions about purchasing, to questions about usage and experience or to questions about expectations.
- Questions with an assessment about different characteristics of the vehicle are mixed with an assessment of incentives and some also include conditions (For example: *If they had the same price, would you…).*

Viewed as a whole, the Norwegian surveys represent about 20,000 people in Norway who have responded to questions on vehicle purchase and/or Electric vehicles from 1993 until today. We also have a study (Michelin 2013 a) in which citizens from the three Scandinavian countries were asked about their views on Electric vehicles. This is commented in the report, but otherwise we have not included direct comparison with international studies. Sometimes we have made referrals to similar tendencies in other studies. Hjorthol (2013) gives a summary of studies in other countries.

We have summarised results on the following themes:

- What factors do people think are important when buying a vehicle and especially an EV?
- What do users with experience and people in general think are the pros and cons of Electric vehicles?
- Who buys and uses an EV?
- What do the different incentives that exist mean for selecting an EV?
- What is the likelihood for different groups to buy an EV next time they purchase a vehicle? Does the EV match their wishes or needs? Are the disadvantages so great that those with experience will choose something else?
- How is the Electrical vehicle used? What kind of journeys are the vehicle used for and how long are these journeys?
- What adjustments and changes in behaviour can be traced? Do people use a car more or less after buying an EV?

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This are questions that are important in order to be able to assess the actual environmental effects that Electrical vehicles have or may have.

7.2 Benefits and disadvantages of Electric vehicles

7.2.1 Factors of significance when purchasing a vehicle during the 1990s

Early in the 1990s, TØI and Gallup agreed to conduct annual Car User Studies. This ended with a panel study in 1993 and 1994 among vehicle owners and a control sample (Ramjerdi et al 1996). The interesting thing here is;

1) that they included questions about new types of eco-friendly vehicles and
2) that games were conducted (Stated Preferences) that enabled them to look at the relative emphasis people made in different situations.

Figure 41 shows that reliability, driving characteristics, price and operating economy where those characteristics that were valued most highly when purchasing a new vehicle. There were not any major differences with regard to residence or income (Ramjerdi et al 1996). The environment and traffic safety were not included among the categories that were assessed.

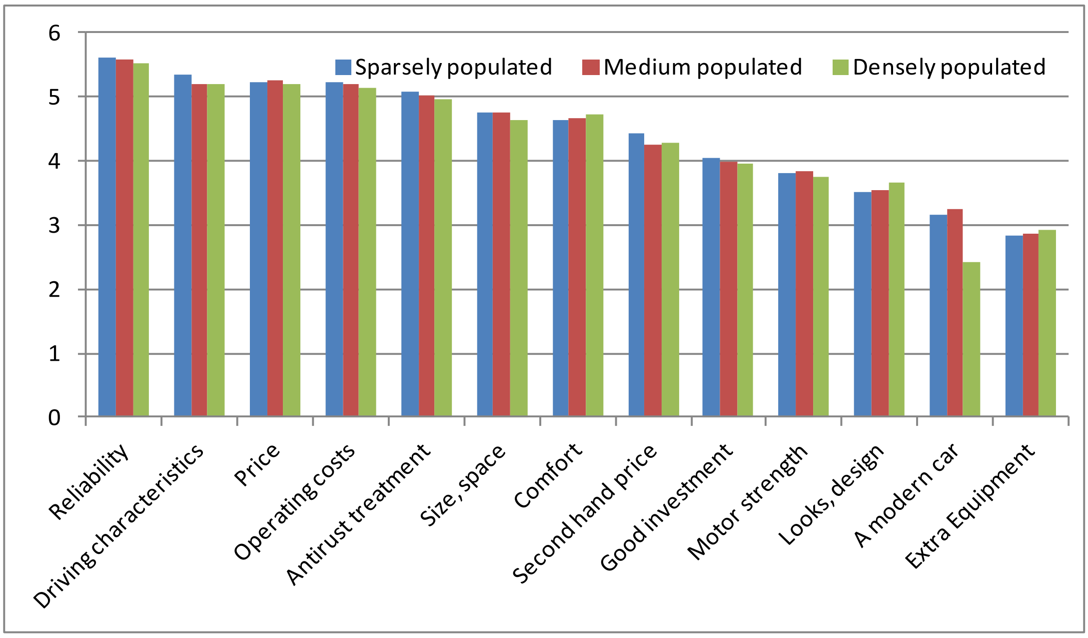

Figure 41: Vehicle purchasers' emphasis on different vehicle characteristics according to residential density. 1= very little value and 6 = very great value. Source: Ramjerdi et al 1996.

Altogether there were approximately 30% in urban areas and 25% in rural areas who might consider an EV. The figures for hybrids were about the same, 30% and 23%. The fact that may people wanted to buy Electric vehicles back in 1993 shows that it is not only incentives that affect the attitude of people. However, in the coming years we will see that incentives do have an impact in practice. Ramjerdi et al (1996) also asked about the minimum requirements for a household's primary and secondary vehicle. The most important requirement for both vehicles, and in the same order, was speed, range and horsepower. The three other requirements people could

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choose between (acceleration, vehicle size and luggage space) were of much less importance. Environmental aspects were not categories at hand.

TI (The Norwegian Institute of Technology) also conducted a small interview study in 1993. As part of their test programme for Electric vehicles, 36 EV owners/users, half of the country's EV owners at this time, were interviewed (Figenbaum 1994). One third mentioned environmental awareness as a reason for purchasing an EV. The same number said that it was coincidences such as having an EV at work or that they were interested in technology and wanted to experience an EV or thought it would be fun to try one out.

7.2.2 Significant factors for choice of car in the 2000s

Several Norwegian studies on Electric cars have asked both EV owners and different cross-sections of the population, (from the entire population, holders of driver's licenses, car buyers or members of organisations), about what they value when buying a car and what they specifically consider as benefits or disadvantages of Electric vehicles that may affect their choice of car. When it comes to choice of car in general, road safety, price and size are features of importance for everyone, both the majority of the population and Electric vehicle owners, see Figure 42.

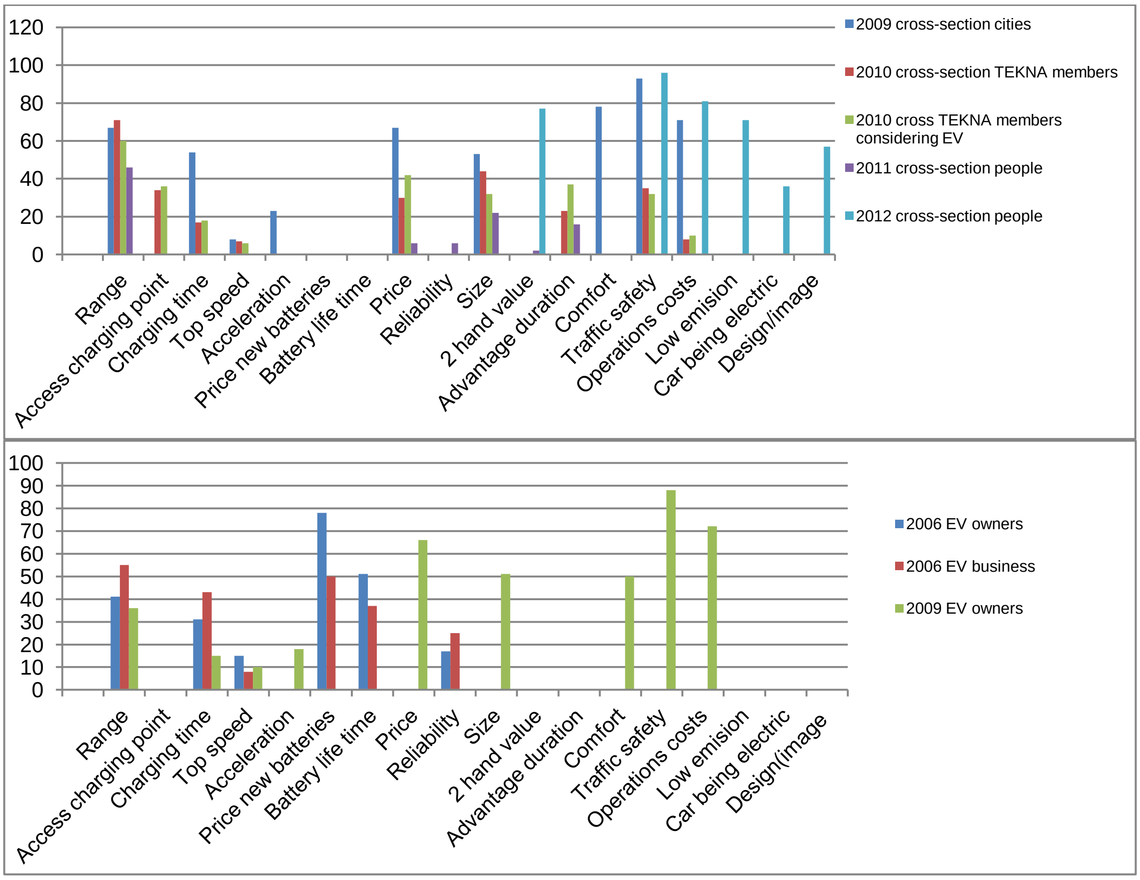

Figure 42: Properties considered as important or very important by different groups regarding vehicle purchase. Proportion (%) of respondents who ticked various categories. At the top are different cross-sections of the population, TEK = members of TEKNA. At the bottom are different Electric vehicle owners. EV Owners = private owner. EV Business = employees in businesses with EVs. (EV = Electric vehicle).

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Finance is fairly important, as can be seen from the fact that several aspects such as car price, battery price and operating costs are reported by quite a few persons. Comfort is also significant. Environmental properties have not often been featured as a category in earlier Norwegian studies investigating factors that influence overall choice of car.

The studies we are looking at concern Electric vehicles, and naturally enough they focus on characteristics of particular relevance to EVs, also when it comes to questions about choice of car in general. Thus it is not given that range will emerge in response to an open question in a general survey of what is important when purchasing a vehicle. However, an adequate range was mentioned by 40 – 60% of the respondents and more often by those who don't have an Electric vehicle. This difference is also found in responses to questions specifically regarding the purchase of Electric vehicles, see section 7.2.3. It seems like those who have experience with Electric vehicles are somewhat less concerned or worried about the range of the car. This illustrates the importance of good information regarding features and experiences with Electric cars. Another explanation is that the EV owners may have chosen an Electric vehicle because their driving needs and pattern are compatible with the EV range.

A survey of members of TEKNA (*The Norwegian Society of Graduate Technical and Scientific Professionals)* shows that they attach more importance to properties of car number 1 than to car number 2, see Figure 43 (Halsør et al 2010). This is interesting as Electric cars for most people are car number 2, see section 7.3.1.

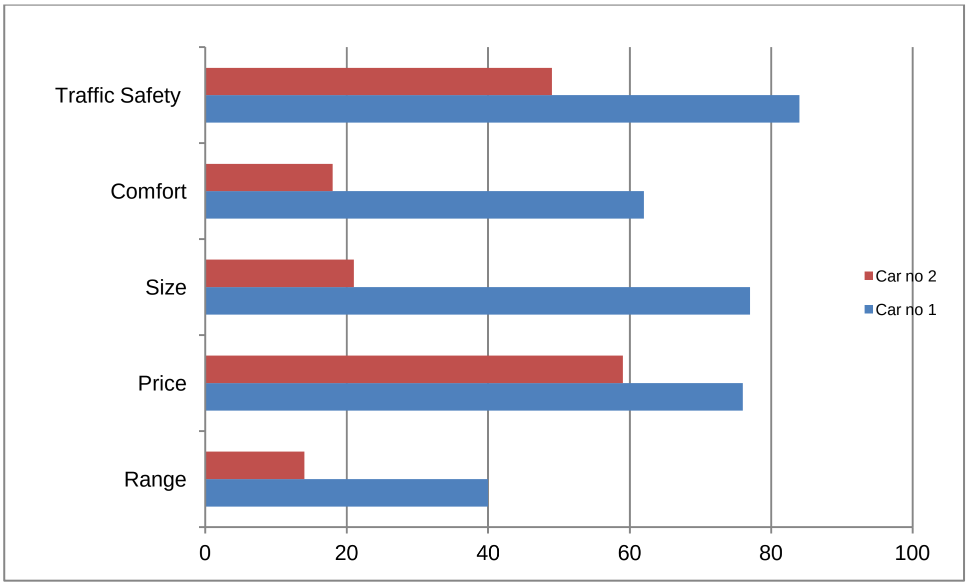

Figure 43: Properties considered as significant by different members of TEKNA (The Norwegian Society of Graduate Technical and Scientific Professionals) in purchasing vehicle number 1 and vehicle number 2. Source: Halsør et al. 2010.

7.2.3 Advantages of Electric cars

Questions concerning the benefits of Electric vehicles have been put in different ways; as reasons in consideration of apurchase, after a user experience and in an entirely general context. In Figure 44 we have selected one question concerning range from each survey.

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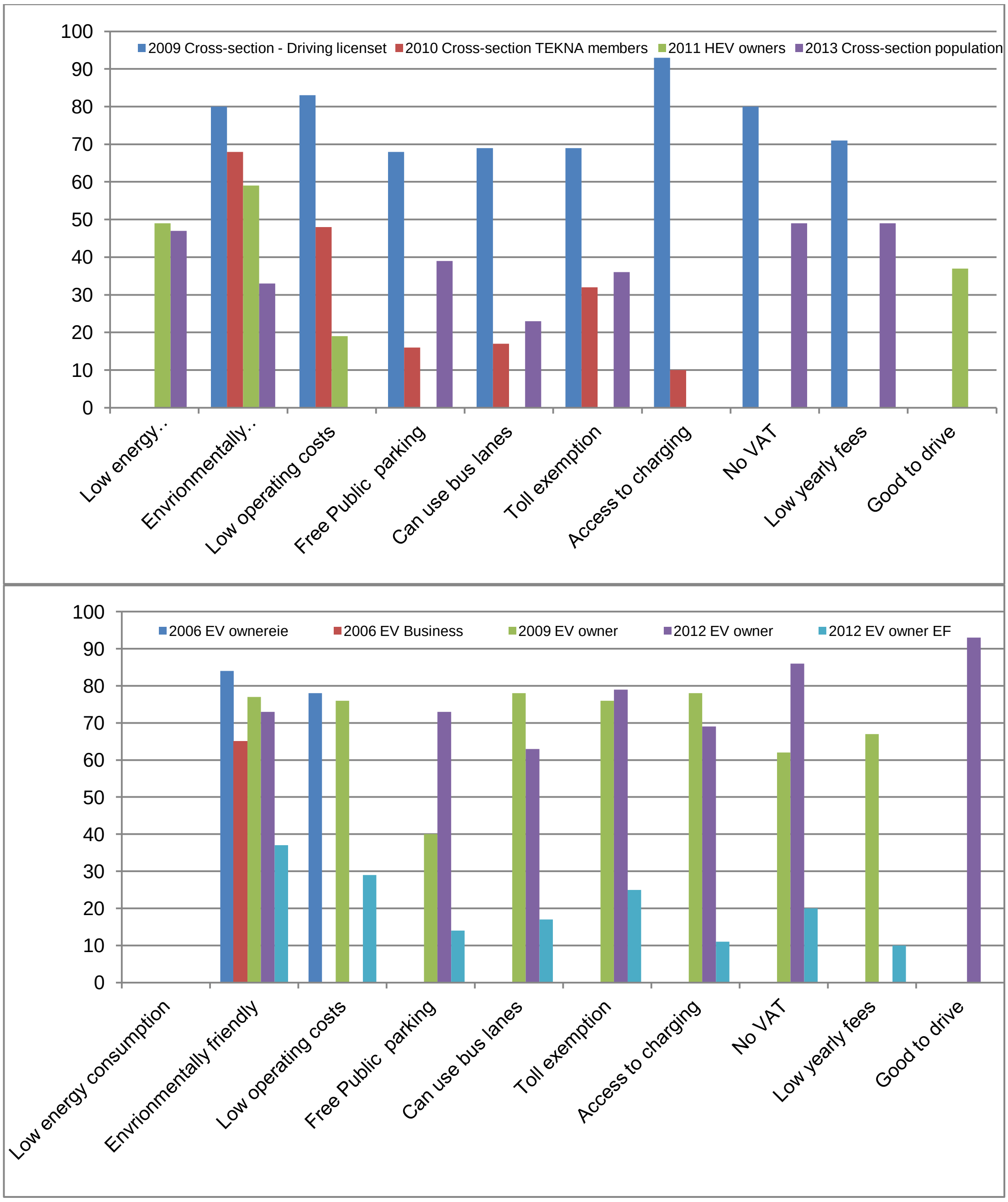

Figure 44: Benefits of Electric vehicles. Very important and important. Ticking off the scheduled categories or selection of the three most important. At the top are different cross-sections of the population, TEK = members of TEKNA. At the bottom are Electric vehicle owners. EV Owners = private owner. EV Business = employees in businesses with Electric vehicles. (EV = Electric vehicle, HEV = hybrid vehicle).

On the basis of the focus on Electric cars, it is somewhat strange that the environment is not included as a category in questions that ask what aspects are taken into consideration in vehicle purchases in general, but is only included when looking directly at the advantages of Electric vehicles. But here environmental friendliness, (or the environmental profile of the car, or the opportunity to influence one's own environmental impact), is clearly emerging as an important feature when considering a purchase. In evaluations of Electric cars, EV owners emerge as more environmentally aware than the cross-section samples from the population that has been investigated. We also see that members of TEKNA are less concerned with the

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benefits related to finance and the use of bus lanes. This is a user group in which 17% indicated that technical interest was the basis for the purchase of an Electric vehicle, (Halsør et al. 2010).

Other things that people see as benefits are those that are created through the actual incentives, (see Chapter 3). The economic benefits are emphasised as well as the ability to use available bus lanes, which enables shorter travel times. Other benefits mentioned in some studies are that it is easier to find a parking space and that the car is very quiet, (Mathiesen et al. 2010). Evaluations of the advantages/disadvantages of an Electric vehicle also provide an understanding of how the various incentives work, a theme which is returned to in section 7.3.3.

The emphasis on environment does especially apply to businesses. Mathiesen et al. (2010) found that environmental friendliness was the property given the highest priority by interviewees across five businesses. Companies are satisfied that the use of Electric vehicles means that the business is perceived as environmentally friendly.

Statoil Fuel and Retail/Response (2012) also have environment as a category when asking a cross-section of the Norwegian population about how important various factors are for future selection of transportation mode. The priority for this sample is more efficient, time-saving transportation which was mentioned by 82%. The environment is in last place amongst the factors these respondents were asked about. But there are still many, 62%, who find the environment important.

A recent study conducted by the The Electric Vehicle Association amongst its members (Haugneland 2012), provides a clear picture of why they choose Electric vehicles, see Figure 45. Environment, economy and practical reasons are the three factors of importance.

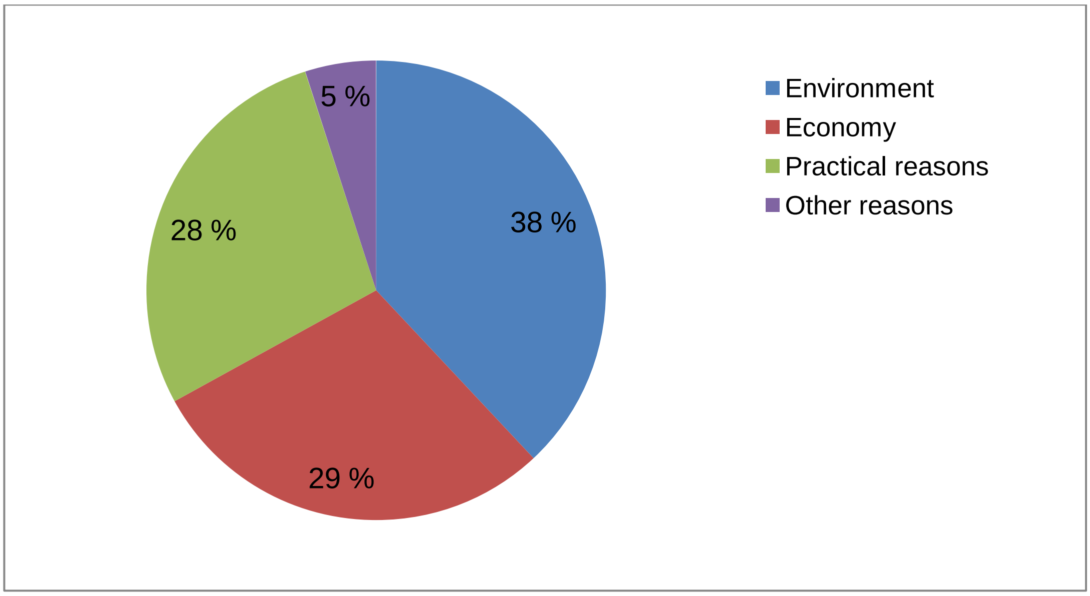

Figure 45: Proportion of EV owners providing various reasons for their choice of an Electric vehicle. Percentage. Source: Haugneland 2012.

Environment, economy and practical reasons also emerge as factors of importance in a Norwegian study by Zelenkova (2013) of motives for Electric vehicle purchases,

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see section 7.5.1. In addition, she captures a dimension related to the construction of self-image and the safeguarding of values of the social system surrounding the individual. The same underlying dimensions are also found in international studies, for example see Axsen and Kurani (2012), but they do not often appear in simple surveys regarding the use of Electric vehicles and advantages and disadvantages of this type of car..

We also have data on hybrid car owners. 78% of all hybrid car owner respondents place the highest value on the environment. In addition to the above factors, it was found that 29% mention that the car is easy/good to drive and 46% that the technology is interesting, (Hagman and Assum 2012).

7.2.4 Disadvantages of Electric vehicles

Electric vehicles and the framework for their use has been developing rapidly. For several years, cooperation between authorities, retailers and other market operators has focused on managing the problems highlighted by users. For example, this applies to the range, recharging time and price that were identified as the main disadvantages in several studies during the period from 2006-2011, see Figure 47. EV owners have, in the years before 2010, been especially concerned with price and life time expectancy for the batteries.

On the other hand, those who have an Electric car and use it are less troubled by 'range concerns' than others, see Figure 46. This illustrates that the comprehensive programme for development of recharging stations has had an effect, see Chapter 5, and that the Electric car probably has enough power for most daily travel.

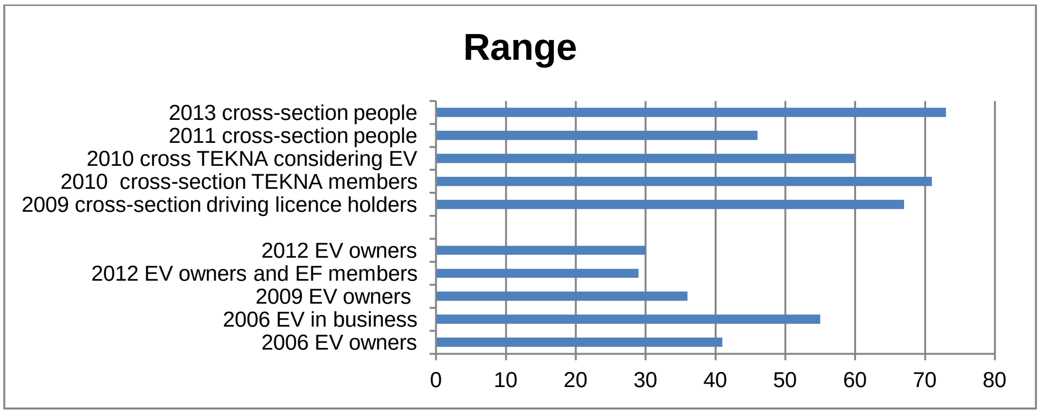

Figure 46: Proportion (%) of interviewees in different groups who identified the Electric vehicle range as a problem. At the top are different cross-sections of the population and lower down are various EV owners (EV = Electric vehicle).

Taking exemptions from the registration tax and VAT and lower prices as a result of market developments into account, see Chapter 6, the price of Electric cars is currently not higher than that of conventional small cars. The issue of traffic safety which is regarded by the majority as one of the most important factor in the purchase of a vehicle is also addressed; see Chapter 9. Three years ago there were no crash tests of Electric vehicles, the safety level was far worse and car purchasers did not have the opportunity to consider how safe Electric cars were.

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Other downsides are functionality in the winter when it is cold and uncertainty of what will happen with various future incentives, see Figure 47. In a study by Sentio (Hoen 2012) of a cross-section of the population, it was found that on average 16% state an uncertain resale value of Electric vehicles as a concern. However, in a similar study conducted in 2013, nobody mentioned this (Skavhaug 2013).

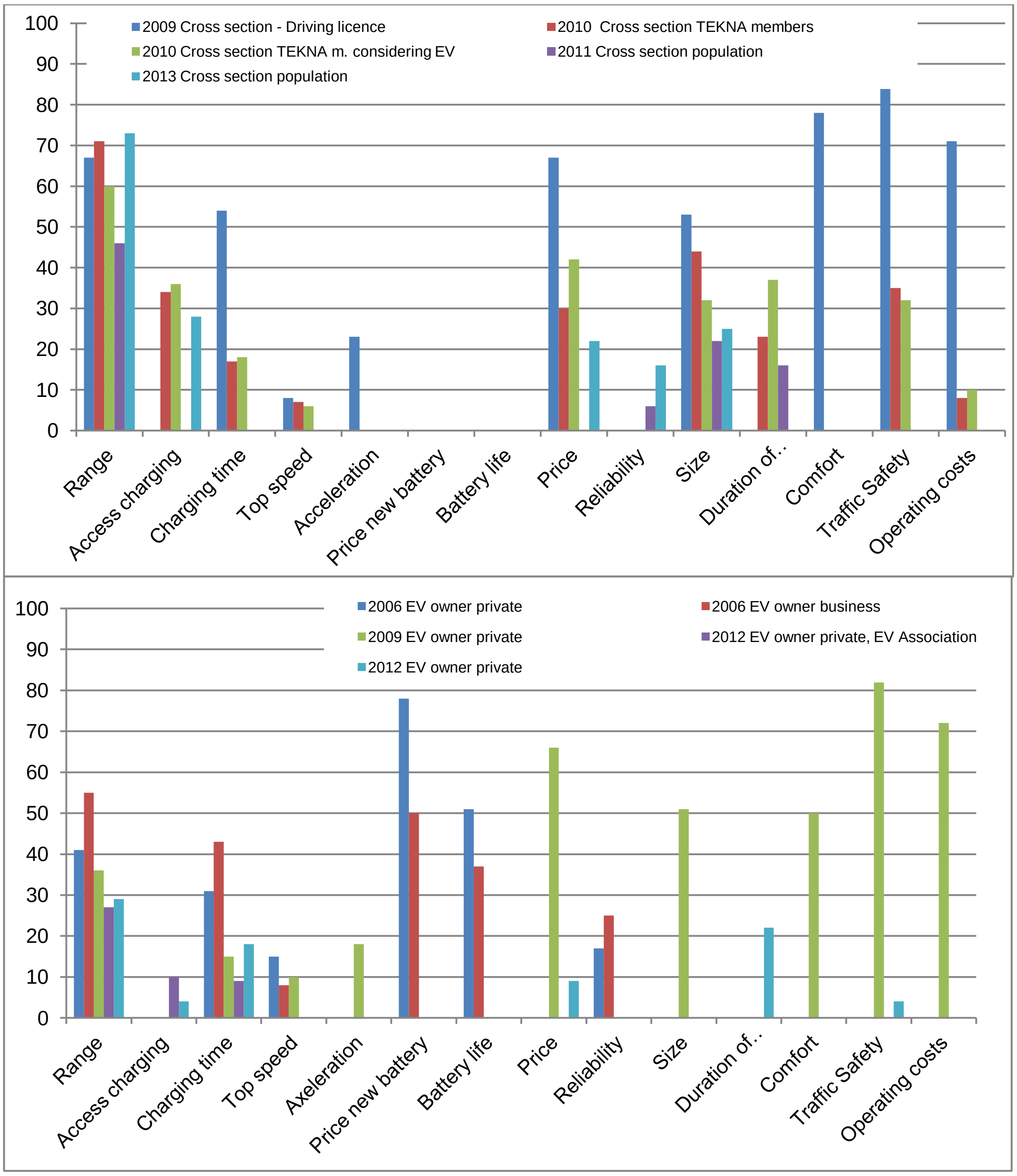

Figure 47: Disadvantages of Electric vehicles identified by different groups. At the top are different cross-sections of the population. Lower down are Electric vehicle owners. EV = Electic vehicle. Cross = cross section of different groups of the population, TEK = members of TEKNA. EF = EV members of the EV Association.

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7.3 Who purchases or consider purchasing an EV

7.3.1 The first Electric vehicle owners have access to resources

In Norway there are now (sept 2013) over 13 000 rechargeable cars. This means that it will become easier to find out more about the typical Electric vehicle user and therefore, more about the potential for future Electric vehicle usage. As long as there is a small number of users, we can only obtain knowledge about the innovators and early adopters .

Rogers (1962, 1995) differentiates between five groups of innovation users entering the process at different stages and with different consequences regarding distribution of new technology; early users (innovators), early adopters, early majority, late majority and laggards, see Figure 2. Section 1.5.2 provides a detailed description of the characteristics of the different groups.

The 1st generation of Norwegian users has characteristics that well match Rogers' (1995) description of early users or early adopters. Both groups include a higher proportion of married men in the 30-50 years age bracket with higher education, full-time jobs and a higher income than the population average, or in the control sample used. The early adopters live in or near major metropolitan areas and belong to households with more than one car. On average, Electric vehicle owner households have more cars than a cross-section of the population, see Table 21. No more than 7- 9% of Electric vehicle owners have only one car. Though few of the Norwegian studies investigate the socio-economic conditions, the picture is probably sufficiently correct since the same pattern is found in international studies (Hjorthol 2013).

Table 21: Proportion of Electric vehicle owners and multiple car owners in different socio-demographic groups. Source: Econ 2006 Vågane et al. 2011, Rødseth 2009, Haugneland 2012 and Mitsubishi 2012. RVU= the Norwegian national travel survey 2009.

Proportion with characteristics	EV owners 2006	EV owners 2009	EV owners 2012	EV owners 2012	RVU09 1car	RVU09 2 cars	RVU09 >2 cars
Male	65	68	76	69	50	53	59
30-50 years	61	60				50	48
36-45 years				41	17	23	17
46-55 years				30	14	20	25
Single		4		4	23	3	4
Married/co-habiting							
Married couple no children	70	72	70		62	84	65
Actively employed		91	94		59	73	78
Own income >500000	38				15	21	19
Household income >600000	72			82	38	69	67
Higher education	78	84	86	81	42	40	29
Oslo+surrounding					25	19	19
Electric vehicle only car	9	7	9	9			

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This is also in line with Rogers' (1962) theories regarding the characteristics of innovators and early adopters, which explains why they are important in the innovation process. It is this group who dare and can take risks and who are in an intermediate position relative to the groups that follow. Therefore, when considering the assessment of potential it cannot be taken for granted that a future Electric vehicle population will have the same composition as the first cohorts of Electric vehicle owners.

That society with its incentives supports those with access to resources, i.e. that incentives have distributional effects, cannot be seen as a problem. It is the first small user group who benefits from a society's Electric vehicle initiative that provides the basis for creation of a larger future market.

Most new technologies in the automotive industry are costly and usually only the most expensive cars are introduced in the early stages. For example, this applies to airbags, antilock brakes (ABS), anti-skid system (ESP), adaptive cruise control and emergency brake reinforcement, all of which were costly and attractive technologies that first appeared in luxury cars like the Mercedes S-class. Eventually, technologies are introduced down the model hierarchy and today it is not possible to get an approved car without airbags and few will find cars for purchase that do not have ABS and ESP. This would not have been possible if those with access to resources did not purchase the first cars while technologies were still very costly. Electric cars were not available in the luxury segment until Tesla unveiled its Model S. To a large extent, the features of Electric cars have come to benefit society more than vehicle purchasers. Therefore, there has been a need for incentives to make the cars attractive to vehicle purchasers, such as access to bus lanes which has proven effective in this respect. It can be said that access to bus lanes is given to compensate for status. It is good that someone who can afford it dares to try out new things – not least with regards to the environment. The early adapters, contribute to making it possible for more people to purchase Electric vehicles with better performance and at a more acceptable price at a later stage in the dissemination process.

Electric vehicle ownership is not more socially skewed than multiple car ownership, regardless of vehicle type. The nationwide RVU 2009 (the Norwegian national travel survey), shows that in a cross-section of the population, 42% own two or more cars (Vågane et al. 2011). Amongst multiple car owners, the proportion of men who live with a partner or family, are actively employed and individuals/households with high incomes is greater than among those who have no car or one car, see Table 21. There is also a particularly high percentage of the multiple car group who are not only actively employed but also working longer hours (Vågane et al. 2011).

With regards to education, we did not find an increased level of education amongst multiple car owners, like we did for Electric vehicle owners. But when looking at education amongst multiple car owners living in various areas, we find that approximately 50% of multiple car owners in major urban areas have higher levels of education, compared to approximately 30% among the rest of the population. As most EV owners live in urban areas, this means that on this dimension they are similar to the majority of multiple car owners. That multiple car owners have more resources than the average population is not surprising and given this, it is an advantage that some of them choose to use environmentally friendly vehicles for their daily travelling.

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7.3.2 Will users and others purchase an EV next time?

There have been a number of Norwegian studies investigating the evaluation of both Electric cars and Hybrid cars, some already in early 1993, cf. Section 7.2.1. Figure 48 shows the proportion of users who respond with a "definite yes" or "very likely" to the question regarding whether they will purchase or consider purchasing an Electric car next time. We do not get a clear picture of developments over time looking at the answers. This illustrates the difficulty in using hypothetical questions as the basis for forecasting actual buyer behaviour. There are a number of factors influencing peoples's behaviour, from access to cars, finance, motives and the advantages and disadvantages of different cars compared to others.

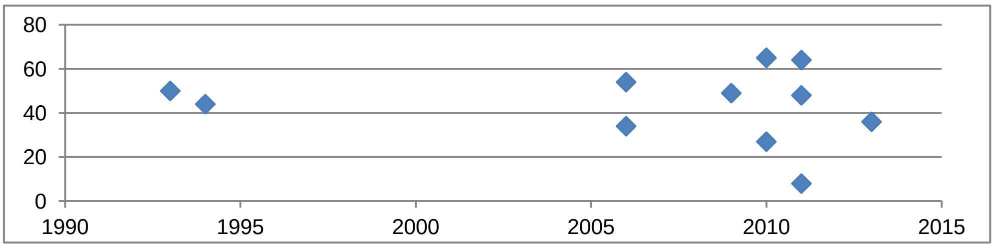

Figure 48: Proportion of Electric vehicle users in studies from different years who will consider purchasing an Electric vehicle or hybrid vehicle next time they buy a car. Percentage.

The disadvantages experienced with Electric cars do not appear to negatively affect buyer behaviour or future plans to purchase. Furthermore as mentioned, the disadvantages that have been pointed out have changed during the last couple of years. Among those who have experience with the use of Electric vehicles, whether as an individual or an employee of a company which uses Electric vehicles, the feedback is predominantly positive regarding continued use and ownership of Electric vehicles, see Figure 49.

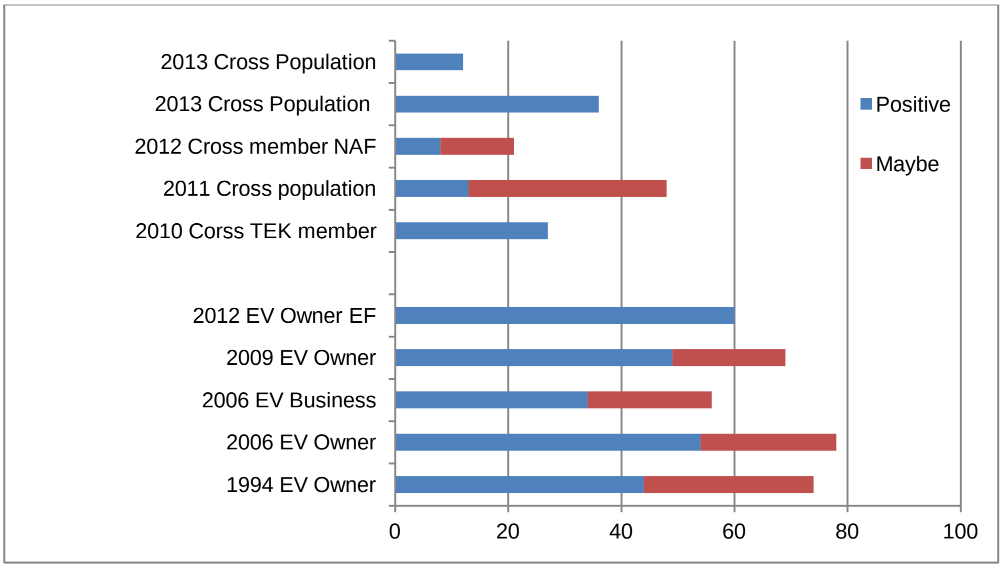

Figure 49: Proportion (%) of Electric vehicle owners (private or business) and different cross-sections of the population (organisational members or other) who responded positively or with maybe regarding whether they want to purchase an Electric car/would consider purchasing an Electric car the next time they purchase a car. (EV = Electric vehicle).

That the related questions or possible response categories are slightly different can affect variations in proportions between individual studies. However, it seems apparent that Electric vehicle owners are clearly more positive than other groups, (control groups from organisations and driver's license holders) who have been asked the same questions.

Entirely new data from 2013, (Skavhaug 2013), that are comparable to 2012, (Hoen 2012), show that the attitudes of the population are changing and that Electric cars are increasingly becoming vehicles for the majority of people. While in 2012, 48% said they would consider purchasing an Electric car if they should purchase a new car in the next two years, the 2013 figure increased to 58%. There are also more people who find it possible to use an EV as the household's primary vehicle. The proportion increased from 13% in 2012 to 21% in 2013. In 2013 there was also more younger people with lower incomes considering an Electric vehicle as an option, if purchasing a vehicle in the next two years, see Figure 50. This means that Norway is probably on the road towards a new phase in the innovation process, from the resourceful early adopters, c.f. Section 7.3.1, to the early majority becoming the largest buyer group, see Figure 2.

It is interesting that gender differences with respect to usage today do not seem to affect attitudes regarding future car purchases. Michelin's study (2013a, 2013b) of a cross-section of the population shows that women in Norway are nearly equally motivated to purchase an Electric vehicle as men. This is supported by findings from the Sentio studies (Hoen 2012 and Skavhaug 2013). This could be explained by women being more concerned with the environmental benefits of a car than men who focus more on the financial aspects and technology.

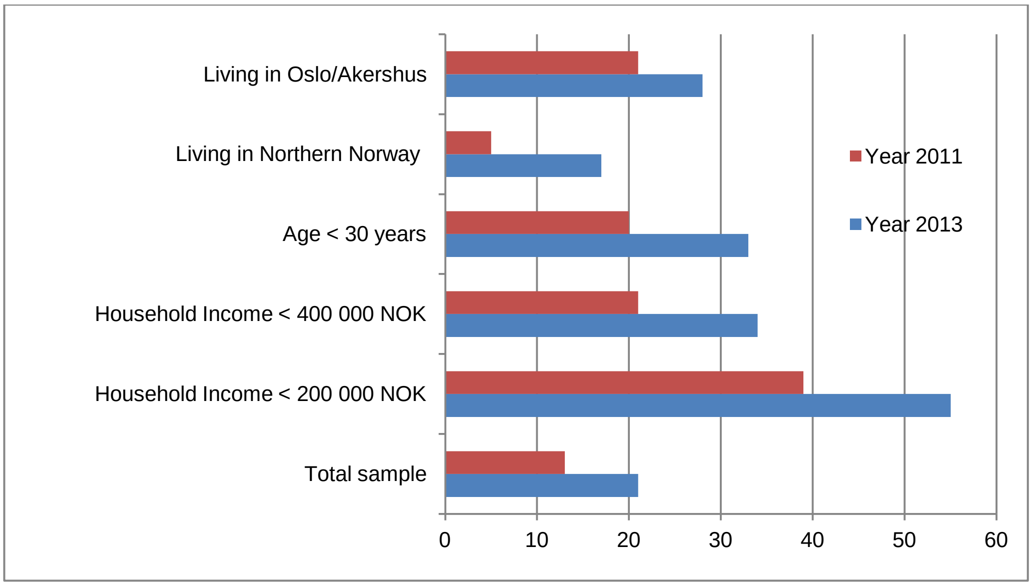

Figure 50: Proportion (%) of different groups in a cross-section of the population in 2011and 2013 that will consider purchase of an Electric vehicle if they are going to buy a car within the next two years. Source: Hoen 2012, Skavhaug 2013.

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7.3.3 What effect do incentives have?

In the 2000s different methods were used to ask approximately 15 000 respondents about their experiences with electric mobility, expectations of different types of cars and also what they will do in the future, see Appendix IV. It provides a basis for looking at the differences between EV owners and different groups of interviewees. Econ (2006) concludes that Electric cars primarily compete with petrol and diesel vehicles, not public transport. Among the influencing factors, the financial incentives are pinpointed as most important, along with access to bus lanes. In addition, access to recharging stations is also mentioned as important, see Figure 51.

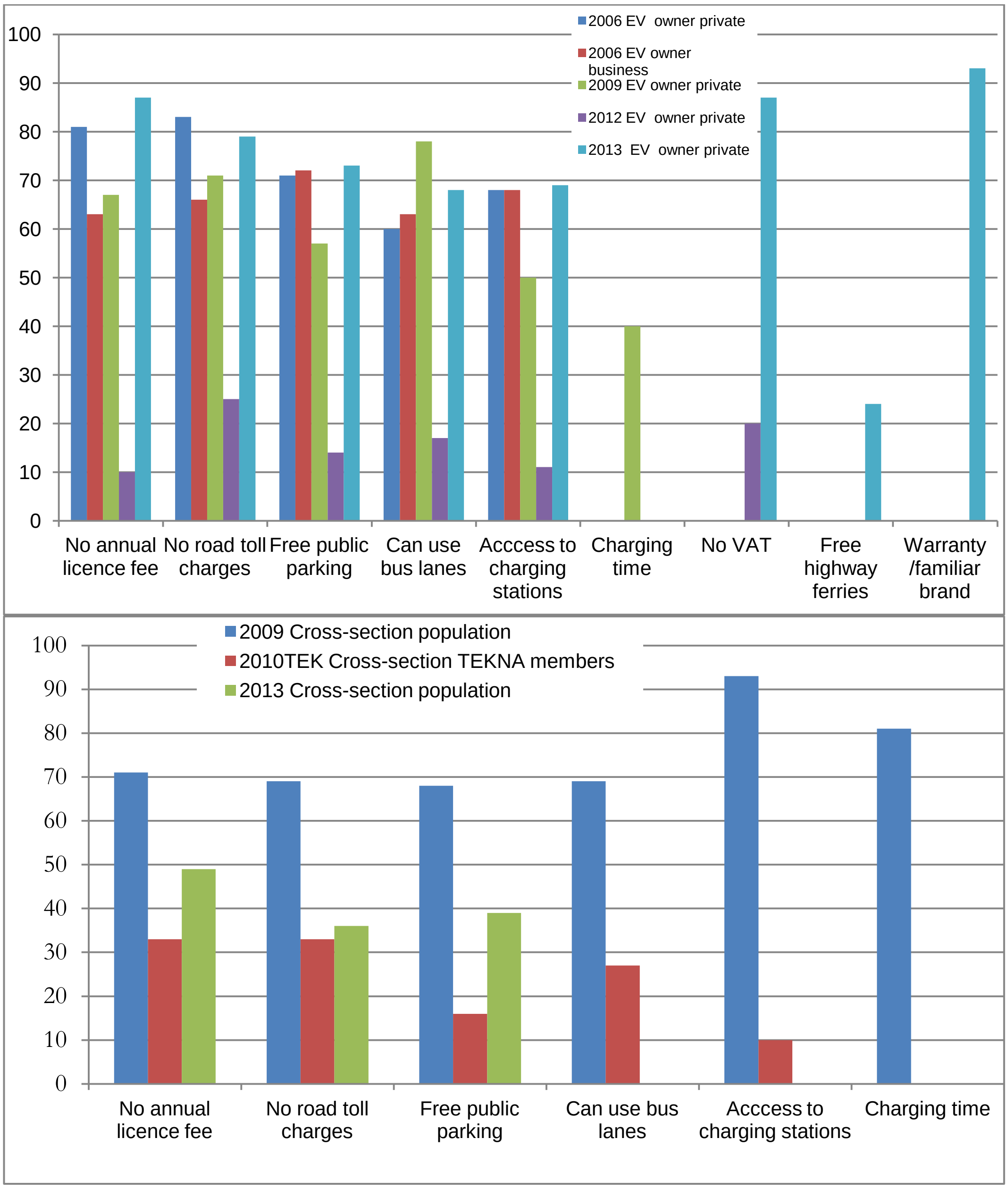

Figure 51: The importance of incentives to the purchase and evaluation of Electric vehicles. At the top are EV owners. EV owners = private owner. EV Business = employees in businesses with EVs. At the bottom are different cross-sections of the population, TEK = members of TEKNA. (EV = Electric vehicle).

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It is conceivable that some EV owners respond strategically to these kinds of investigations. They might be anxious that the answers should be interpreted wrongly, for example that some of the incentives are not important and therefore more easily will be removed by the authorities.

Figure 51 shows that there are no big differences between the owners of Electric vehicles and the cross-section of the population. However, members of TEKNA seem to be less interested in the actual incentives than most people.

With the entry of the large automotive manufacturing brands into the market, it is perhaps natural that in the Mitsubishi (2012) study of i-MiEV owners, the most important thing was found to be that the car comes from a known manufacturer with good warranties, i.e. private incentives. Perhaps this heralds the transition from broad government incentives to a purely private market for Electric cars? Or does this mean that new purchaser groups who have been sitting on the fence are now buying Electric cars? Only 12% of i-MiEV purchasers have had an Electric vehicle in the past.

7.3.4 Differences between the Scandinavian countries

Large differences in facilitation and incentives for Electric vehicle use between the Scandinavian countries are not entirely clearly reflected in the assessment of the average population regarding the likelihood of purchasing an Electric car at their next vehicle purchase. A study conducted by Michelin in 2013 in Sweden, Norway and Denmark shows that the proportions of people who think it is fairly or very likely that they will buy an Electric car are low in all three countries, averaging around 5 - 7%, and lowest in Norway, see Figure 52. Most positive, (quite and very likely), are found in the urban regions of Denmark and Norway, 10% in Copenhagen, 9% in the Trondheim region and 7% in Oslo/Akershus. In the Stockholm region, it is only 3% who would consider purchasing an Electric car.

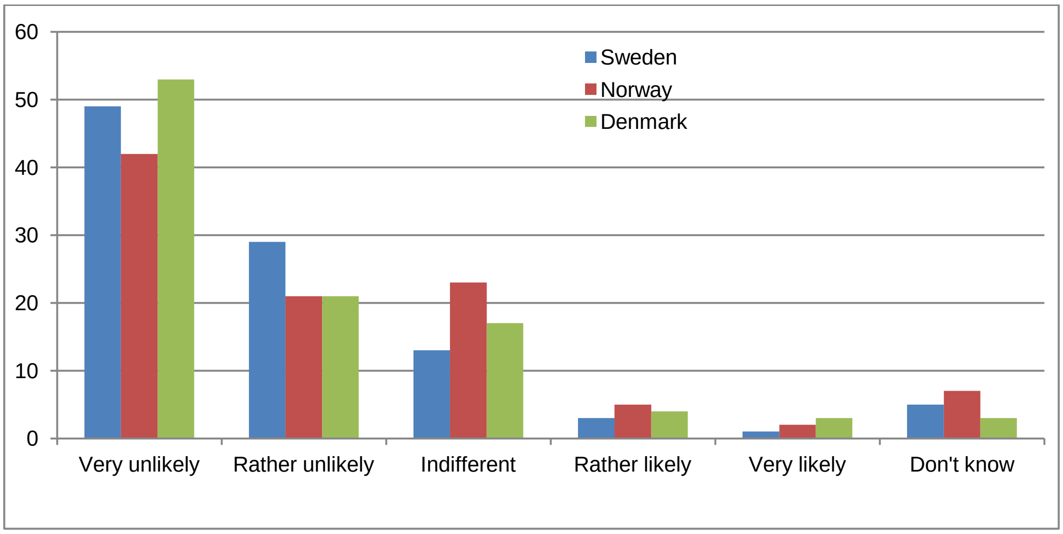

Figure 52: The likelihood of purchasing an Electric car at next vehicle purchase in Sweden, Denmark and Norway. Source: Michelin 2013a.

The most important reasons for purchasing an Electric car in all three Scandinavian countries are environmental friendliness, low operating costs and lower taxes, see Figure 53. While half of the Swedes surveyed emphasised the environmental

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friendless of the car, only one in three Norwegians considered the environment to be an important driver of the purchase of Electric vehicles. They put more emphasis on the financial and practical benefits. The Danes who also have toll roads and congestion charges are almost as engaged as the Norwegians regarding exemption from toll charges.

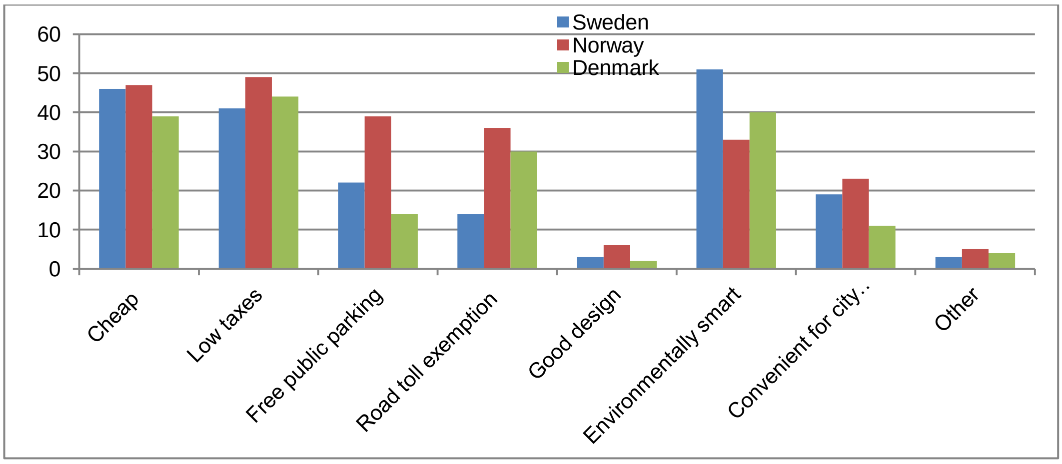

Figure 53: Reasons for wanting to buy an Electric car at next vehicle purchase in Sweden, Denmark and Norway. Source: Michelin 2013a.

Looking at the arguments against buying an Electric vehicle in the normal population across all three countries, it is concerns regarding vehicle range that are most prevalent, see Figure 54. As most everyday travel can be handled using current Electric cars, see Section 7.4.3, the automotive manufacturers and authorities have a big information task. However, with regards to the economy, it appears that the Norwegian incentives along with generally good economic conditions make it easier for Norwegians to purchase Electric cars.

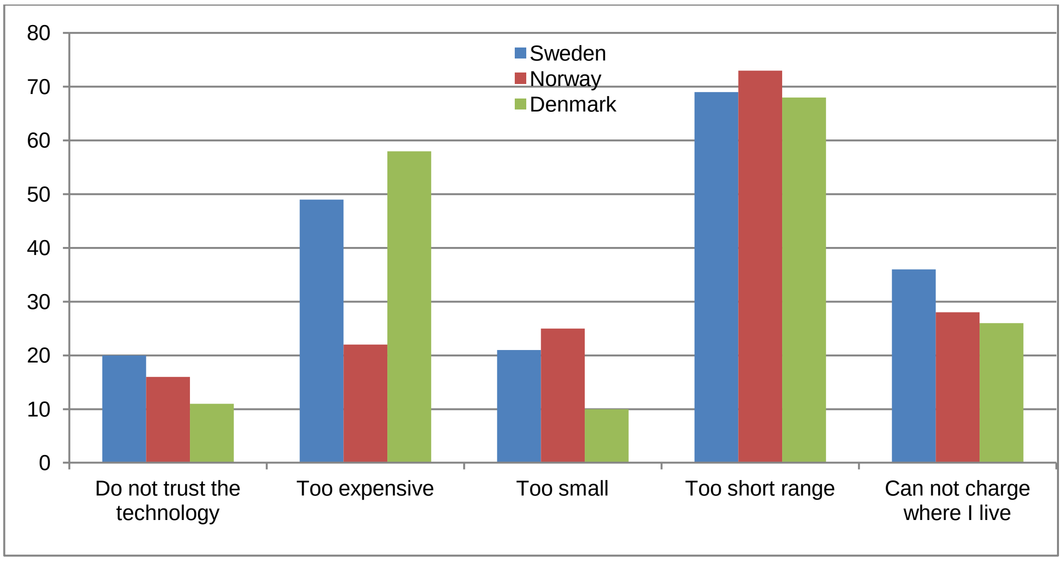

Figure 54: Reasons for not considering the purchase of an Electric car at next vehicle purchase in Sweden, Denmark and Norway. Source: Michelin 2013a.

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The significance of the economy can also be seen in the responses to a question about considering the purchase of an Electric vehicle if it costs the same as a conventional diesel or petrol vehicle. Here the proportions increase to 23% in Denmark, 22% in Sweden and 19% in Norway.

7.3.5 The need for recharging stations

As described in Chapter 5, Norway has an extensive recharging point programme for both normal recharging and quick recharging. This is an important incentive to address a wide range of vehicle and range issues. As of today, we do not have so many reviews regarding what users think they need.

In the study conducted by the Electric Vehicle Association, (Haugneland 2012), 41% of the respondents stated that they have access to recharging at home. This may indicate that there is a large majority of owners who live in urban areas that do not have access to parking spaces, or that the question has not been formulated clearly. 28% of respondents report that they have access to recharging at work and 26% use public recharging bays. Moreover, 4% have the possibility to recharge at community/apartment building cooperatives. 30% recharge Electric cars daily and 12% at public recharging bays. Some use the publically available recharging bays as free parking spaces without having to recharge the cars. This can create problems for other Electric vehicle owners who need to recharge their cars (c.f. Chapter 5).

50% of EV owners say that they could run 100% Electric vehicles if they had access to quick recharging on longer journeys, (Haugneland 2012). It is not known if those 50% have the technical possibility to use quick recharging for their vehicles. That many are not recharging at home and want more local recharging stations, also appears in the survey conducted by Mitsubishi (2012) of i-MiEV owners/purchasers, see Figure 55, which is focused on quick rechargers. Those who answered 'home' might have misunderstood the question. Home does not require quick recharging.

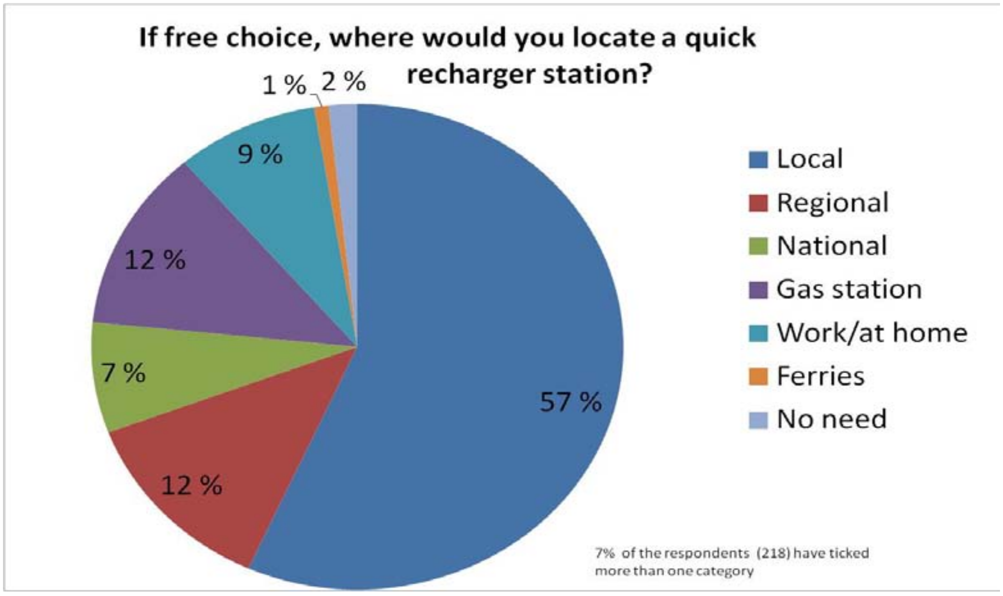

Figure 55: Desired locations for quick rechargers. Proportion of i-MiEV owners who provide different alternatives in response to an open question. Source: Mitsubishi 2012.

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7.3.6 Reasons to consider a hybrid vehicle next time

There are a few studies that also address the question of whether people would consider buying a regular or plug in hybrid vehicle. Hagman et al. (2011) found that 25% of hybrid owners clearly state yes to purchasing a new hybrid car next time, and 35% would consider taking a step further and purchasing a rechargeable hybrid vehicle, (therefore a total of 60% can imagine purchasing a hybrid variant again). The environmental aspect is of particular importance to those who will purchase a PHEV next time. This was stated by 50% and 22% stated lower CO_2 emissions. The corresponding figures for a regular hybrid car are 35% and 18%.

Halsør et al. (2010) found similar rates among members of TEKNA. 67% of members would consider a PHEV and 53% a hydrogen car. Far fewer (37%), would consider purchasing an Electric vehicle. The same difference, but with far lower proportions were found in the Gallup climate compass in 2013. When asked which car a cross-section of the population would purchase next time, 39% stated that they would consider purchasing a hybrid car and only 12% would consider purchasing an Electric vehicle, (Gallup 2013). The difference can be connected to members of TEKNA who are probably more informed and interested in technology and cars than a cross-section of the population.

The figures illustrate that the answers to hypothetical questions regarding future behaviour must be interpreted with caution. 67% was a high figure in 2010 as PHEVs were not on the market when the survey was conducted. And a few years after the studies there are still few Plug-in Hybrids on the Norwegian roads. This may be related to both supply and price of the vehicles and perhaps a lack of incentives.

7.3.7 Locations of importance when considering an EV

As shown in Chapter 6, there are large regional variations in the use of Electric vehicles. Some studies have investigated the willingness/likelihood that people will purchase an Electric car next time in different regions. Two studies (Hoen 2012, Skavhaug 2013) asked a cross-section of the population if they would consider an EV as car number one or two the next time they should purchase a car. Figure 50 and Figure 56 show that people in Oslo/Akershus are most willing to consider the purchase of an Electric vehicle. Otherwise, the difference in attitude between the regions is not that great. The differences are in line with the amount of usage. Figure 56 also shows that the willingnes to by an EV is increasing in all regions.

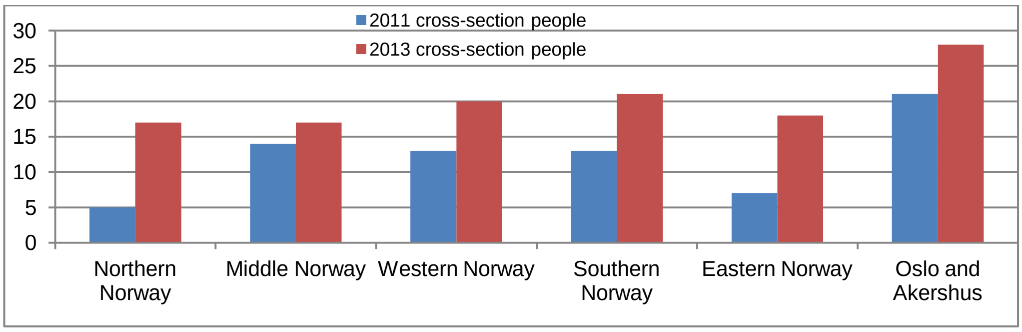

Figure 56: Likelihood of considering the purchase of an Electric vehicle as the families first car next time in Norwegian regions, amongst a cross-section of the Norwegian population in 2011 and 2013. Source: Hoen 2012 and Skavhaug 2013.

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Other Norwegian studies, one conducted amongst members of the Norwegian Electric Vehicle Association, (Haugneland 2012), and another conducted amongst a cross-section of the population in the Nordic countries, (Michelin 2013a), found the same differences between regions.

There seems to be larger differences between location types than between regions. In Oslo in 2011, 23% would consider an Electric car as the households first car next time they purchase a car, while this figure was 6% in rural areas (Hoen 2012). In 2013 these figures was changed to 36% vs 12% (Skavhaug 2013).

The range is seen as the biggest obstacle to purchasing an Electric vehicle across all regions. The challenge is naturally enough experienced as larger among the average population, than amongst those who have Electric cars and feel that they can handle everyday travel with an Electric vehicle, see Figure 57. This also applies to the latest study from 2013 (Skavhaug 2013), in which 47% of the population says that the range is the biggest problem with Electric cars. Other problems noted in 2013 is uncertainty about the duration of incentives, mentioned by 20% of respondents. Vehicle size is also mentioned by 20%. Price and second hand value are not perceived as problems by the respondents in this survey.

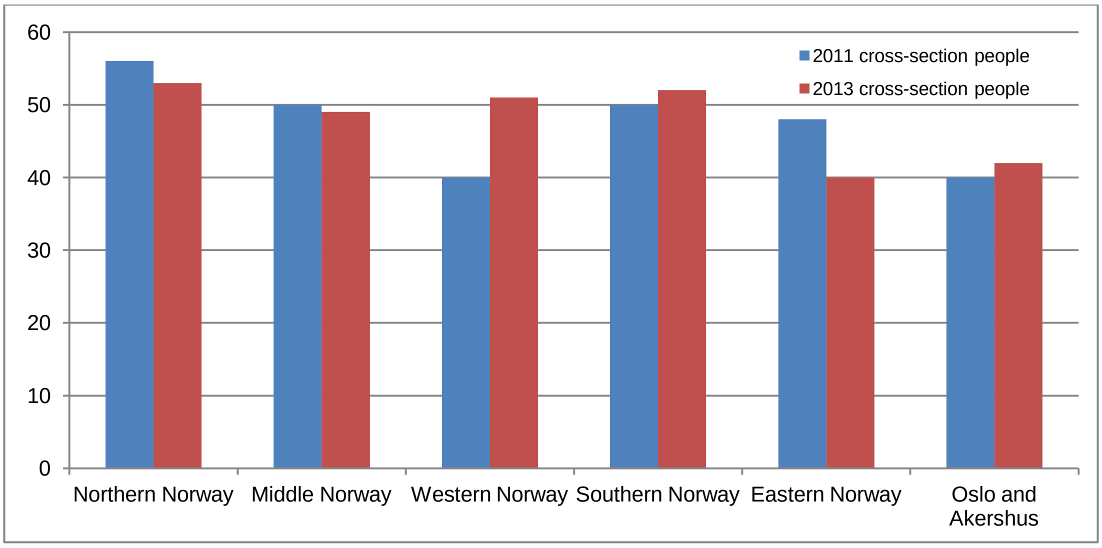

Figure 57: Proportion who state range as the biggest obstacle to the purchase of Electric vehicles in different Norwegian regions, amongst a cross-section of the Norwegian population in 2011 and 2013. Source: Hoen 2012 and Skavhaug 2013.

7.3.8 Knowledge of vehicle types

Knowledge of vehicle type is important in choice of vehicle. This fact constitutes a challenge for new types of cars. Already in the 1990s, about 30% of the population in urban areas and 25% elsewhere stated they would be willing to consider an Electric vehicle as their primary vehicle. 13% felt they had good knowledge of Electric vehicles, and 7% of hybrid cars. The level of knowledge increased with income (Ramjerdi et al. 1996).

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7.4 How Electric vehicles are used

7.4.1 Travel purposes for EV's

EVs Electric vehicles are especially used for daily travelling such as commuting to/from work, trips for provisions and in connection with shopping, see Figure 58. With regards to holiday travel, which is normally much longer, it is petrol, diesel or hybrid cars that are being used. 4% have an Electric vehicle as a company car, (www.elbil.no, 4th September 2012).

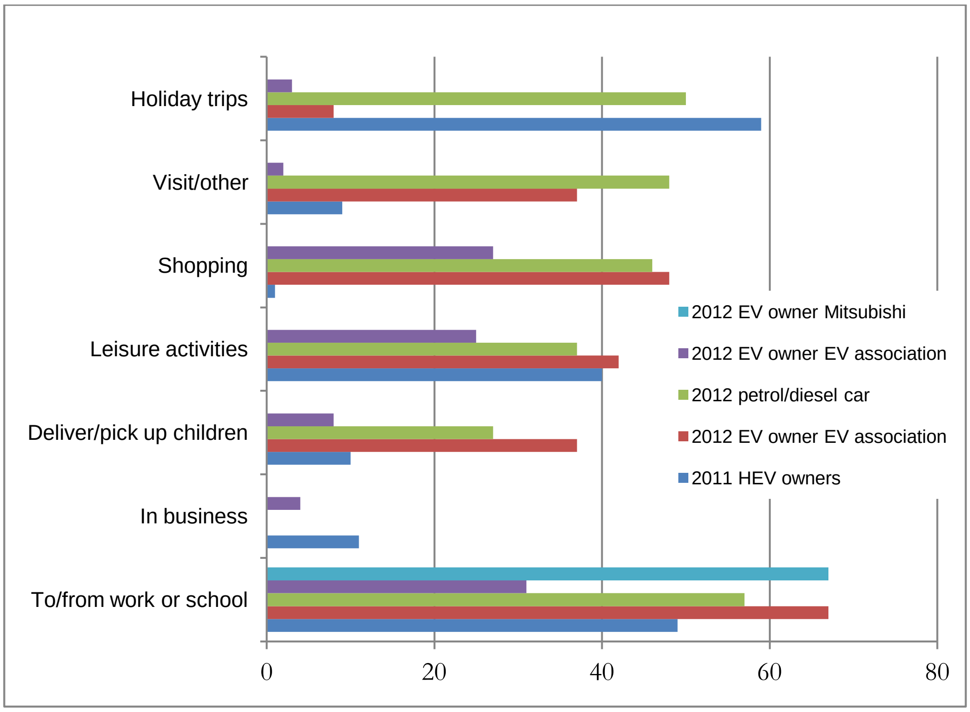

Figure 58: Proportion of Electric vehicle owners (EV ownership) or hybrid owners (HEV ownership) who state different purposes their Electric vehicle is used for. People could state more than one travel purpose. Sources: Hagman et al. 2011, Haugneland 2012, Mitsubishi 2012 and Kløchner 2012.

It also seems that once a person starts to use an Electric vehicle, it is used for an ever increasing number of journeys, (Kløckner 2012). This may perhaps be due to development of a more realistic picture of the vehicles range and/or better journey planning.

7.4.2 Frequency of use of Electric vehicles

Electric cars are used often used for short daily trips. Most cars are used daily. ECON (2006) showed that 78% of Electric cars were used 6-7 days per week and 19% 4-5 days a week. The Electric Vehicle Association survey (Haugneland 2012), shows that 93% use the car daily. The Mitsubishi (2012) investigation of i-MiEV owners shows the same, reporting that 94% stated that they use the car daily. This shows an increase in usage from 67% who did so in 2006, (Econ 2006), which in

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turn is associated with improved quality and performance. The Electric car has become a regular daily driving vehicle that meets everyday transportation needs.

7.4.3 Length of daily vehicle journeys

The average daily distance travelled as a car driver in 2009 was 23.4 km. The daily work yourney in Norway in 2009, (which included travelling by all modes of transport), was an average of 14.9 km long. The daily work yourney as a driver, for which Electric cars are particularly used, was 16.4 km long, (Vågane et al. 2012).

We have found few studies that provide information about the length of the daily journeys by Electric vehicle. Figure 59 shows the length of the 'daily fixed journey' in kilometres for EV owners, (Econ 2006). We have also included daily mileage for people with a driver's license who drove a car on the date of registration of the RVU (National travel survey) in 2009, (Vågane 2013).

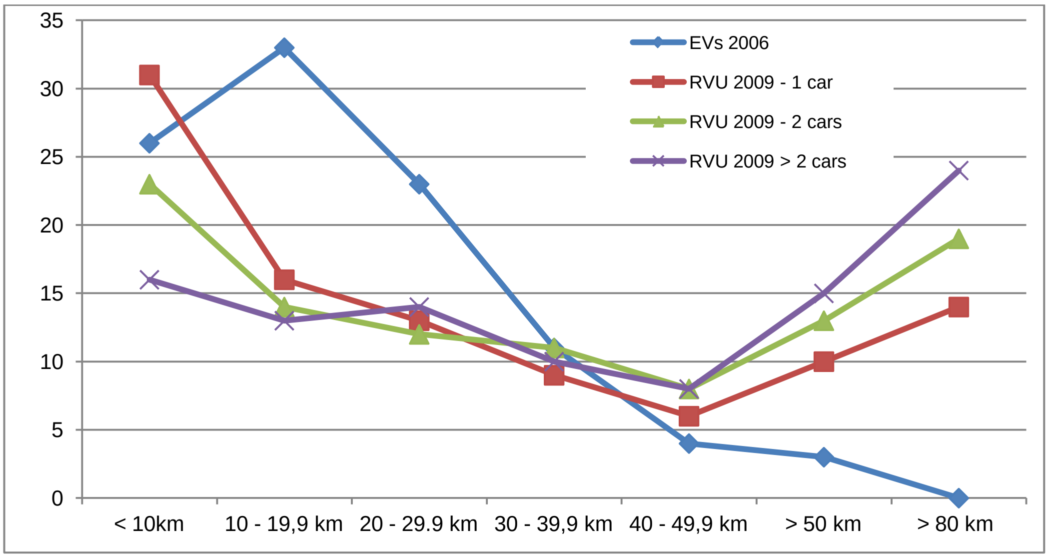

Figure 59: Length of fixed daily journey for Electric vehicle owners in 2006 and the daily mileage among those who had a driver's license and travelled on the date of registration of the RVU (the national travel survey), 2009. Source: Econ 2006 and Vågane 2013.

Figure 59 illustrates several important points;

- In 2006, Electric cars were mainly used for half long trips under 30 km.
- The range of Electric vehicles will cover the bulk of daily journeys, also during winter. 14% of those who have a car, 19% of those with two cars and 24% of those with multiple cars, drove distances longer than 80 km during the day they reported.
- The daily mileage increases with the number of cars.

It is also the case, c.f. section 6.4.4, that Electric cars are so far particularly used for work commute by multiple car owners. They have a longer distance to work than the average for the population. The average daily mileage for all drivers in 2009 was 13.6 kilometers, however drivers with two cars and free parking at work, drove much longer distances, see Table 22. It is among those we find persons who can save, if

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not distance in kilometers, then time by purchasing an Electric car that can be driven in bus lanes. Those driving long distances with an Electric vehicle saves more fuel than those driving short distances. Thus, high mileage could offset all or part of the extra costs of purchasing the car.

Table 22: Daily mileage for drivers with two or more cars and free parking at work in 2009. Km. Source: Vågane 2013.

City	Daily mileage
Greater Oslo area	58,4 km
Areas surrounding Bergen, Trondheim and Stavanger	43,6 km
Six other 'major cities'	57,7 km
Oslo	36,5 km
Bergen, Trondheim and Stavanger	40,4 km
Smaller towns	57,4 km
Rest of the country	61,1 km

From research investigating Plug-in Hybrid vehicles, (PHEVs), there exist test data on mileage, (Hagman and Assum 2012). For these cars, potential mileage with pure electric power alone is approximately 20 km. Although the test cars are not necessarily used in the same way as regular cars, the figure for the proportion of trips below 20 km is also interesting for the evaluation of pure Electric vehicles. Figure 60 shows that 66% of the trips over 5 km are under 20 km long and can be handled with the rechargeable electric capacity of the hybrid. 88% are less than 50 km and thus, could be handled by a pure Electric vehicle with a normal range of 160 km and 80 - 100 km in winter.

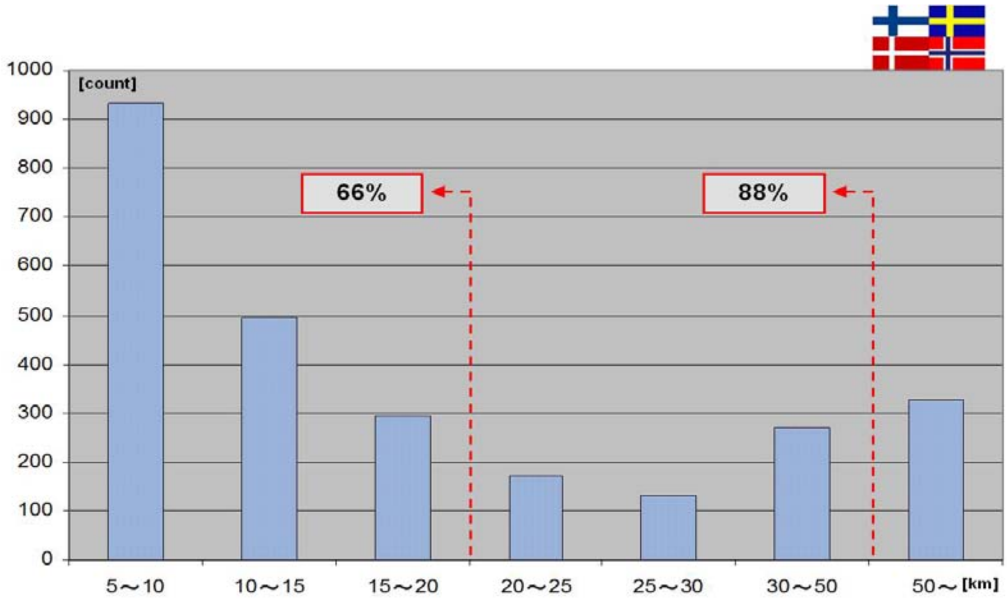

Figure 60: Number of trips of different lengths in km for plug in hybrid vehicle, (PHEV), test cars in four Scandinavian countries. Source: Hagman and Assum (2012).

Another source is electronic diaries from 12 EVs used in various companies, (Mathiesen et al 2010). Approximately 10% of the trips during the day were less than 1 km and the average journey length was 5.2 km, (82% were less than 10 km and 98% below 50 km). On the basis of this, the authors conclude that the majority of

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customer visits happen in the close surroundings of the business and that Electric vehicles manage the actual distances well. The numbers correspond reasonably well to the numbers for business travel from the RVU 2005 , (Engebretsen 2006).

7.4.4 Annual mileage

In Norway in 2012 cars were driven on average 12 969 km per year, (SSB 2013). The length varies by inter alia, fuel type and age of vehicle. Petrol-powered cars between 0-5 years old drive an average of 12 600 km per year, while the corresponding diesel cars drive 18 500 km per year.

We do not have much data regarding annual mileage for Electric cars. In 2006 average mileage was approximately 10 000 km per year, (Econ 2006). This is slightly less than the national average for petrol-powered cars, and may be related to the type of Electric vehicle in the fleet of cars at this point in time. They had only half the range of current Electric cars and lower levels of comfort and safety. At this time, 75% of cars bought were used and must be compared to vehicles that are a few years older. The ECON (2006) study also showed that there was little seasonal variation between Electric vehicles and that privately owned vehicles generally run slightly longer than those owned by an organisation, see Figure 61.

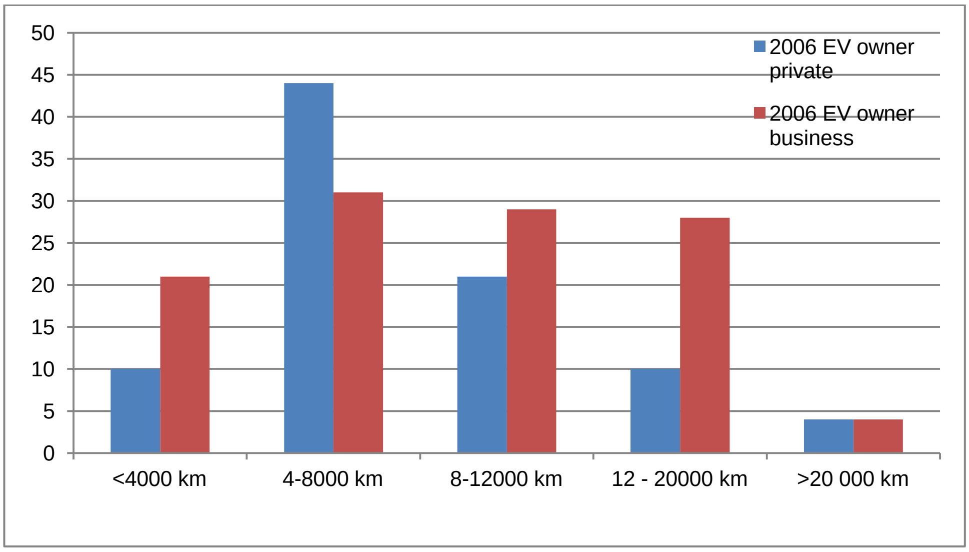

Figure 61: Annual mileage for privately owned Electric vehicles and for business use of Electric vehicles in 2006. Source: Econ 2006.

Hybrid cars are driven on average 14 245 km (Hagman and Assum 2012) and seem to have a higher yearly milage than the average car. However, if taking into account that most hybrid vehicles, are comparatively new, they are driven somewhat less than the average for newer vehicles.

Data from insurance companies and/or brokers may provide a foundation for more precise data on annual mileage as the basis for calculation of the environmental benefits. The project has not allowed for the collection of such data. The possibilities may be illustrated by some data from the USA regarding the use of a total of 4 240 Nissan Leaf vehicles distributed in 16 different areas in the first quarter of 2013 (EVP-project 2013).

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In the current quarter, these cars were driven an average of 46.5 km, (ranging from 41.5 to 50.7) per day when used and a total of 2 870 km, which is equivalent to annual mileage of approximately 11 500 km. In comparison, the average annual mileage for passenger vehicles in the USA is approximately 17 000 km, (FHWA 2011). The number of journeys averaged 254 with a journey distance of 11 km, (journey is defined as the distance travelled between consecutive key on and key off events). Leaf owners drove an average of 3.7 trips per recharge and then recharged 1.1 times per day when the car was in use. 74% of recharging was done at home, 21% outside the home and 5% at unknown locations. Battery recharge level at the beginning of recharging is shown in Figure 62. Few people utilize the entire battery capacity.

There is also data from the same study for 1 766 Chevrolet Volts, an Electric vehicle with range extender (EREV). On average they were driven 63 km per day when in use and a total of 3 981 km in the current quarter. Estimated annual mileage is 15 900 km. 72.5% of the time the vehicles were operated in plain electric mode with an electricity consumption of 218 Wh/km. Average journey length was 13 km and total number of trips 297.

Ford (Ford Media 2013), state that owners of the C-Max Energi, a rechargeable hybrid vehicle with a range of approximately 30-35 km, runs on electricity charged from the power grid for 60% of kilometers driven. Interestingly enough they say that this is an improvement on the proportion during the course of the first month in which new users start using the car.

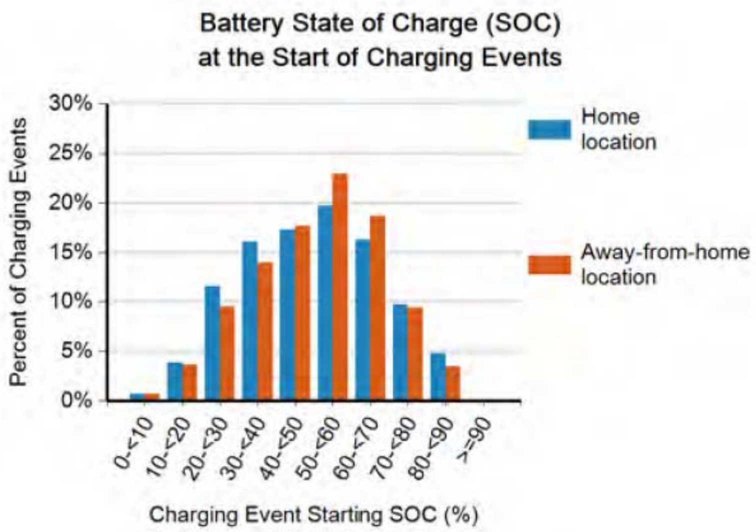

Figure 62: Percentage distribution of the recharging status at the start of recharging. Source: EVProject 2013.

7.4.5 Driving behaviour and driving culture

The effects of how cars are driven are also important to consider. The Norwegian studies of Electric vehicle use have not examined changes in driving style and culture. However some other studies, (Hjorthol 2013), suggest that people who drive Electric vehicles change their driving style and plan their travel so they become more effective.

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The Electric vehicle is energy efficient, meaning that almost all the energy is used for propulsion and operation of necessary equipment such as lighting. Moreover, it is the case that energy consumption increases with speed. This means that in principle, the range can be extended by driving slowly. We are not aware of any studies that have evaluated the environmental and safety impact of this.

The Norwegian studies show that the Electric car is mostly being purchased as a second car but is often ending up as the main vehicle for daily transportation. Some people report that they make more daily trips by Electric vehicle once experience with the vehicle has been gained and the range anxiety has been overcome. This may mean that more travel becomes more environmentally friendly. Eimstad (2013) found the same in a study of organizations using the Move About fleet of Electric cars (EV pool). Here 25% of users state that the Electric car fleet has changed their travel habits and 45% state that their experience with Electric vehicles has increased their interest in purchasing an Electric vehicle privately.

On the other hand, it may have the opposite effect if the overall number of journeys increases, or if certain incentives for Electric vehicles lead to a transition from public transport/cycling and walking, to individual transportation by Electric vehicle, see section 7.4.6. The 'visible' marginal cost of driving an Electric vehicle is low relative to petrol and diesel-powered vehicles because electricity is cheap and Electric vehicles are also very energy efficient. Add insurance and wear on the vehicle and battery, the difference are not so great, but these are costs that are less visible.

7.4.6 EVs mainly replace fossil fuel-powered cars

An environmental effect is achieved if Electric vehicles replace the traffic work which is otherwise done using a vehicle powered by petrol or diesel. The environmental impact of the introduction of Electric vehicles can be reduced if they are introduced in addition to and not as a replacement for existing cars. Figure 63 shows that the Electric vehicle essentially replaces another car, but also a proportion of travel via public transport and bicycle travel. 10-20% have previously travelled with public transport, cycled or walked. These figures suggest that the purchase of an Electric vehicle in most cases provides an environmental benefit.

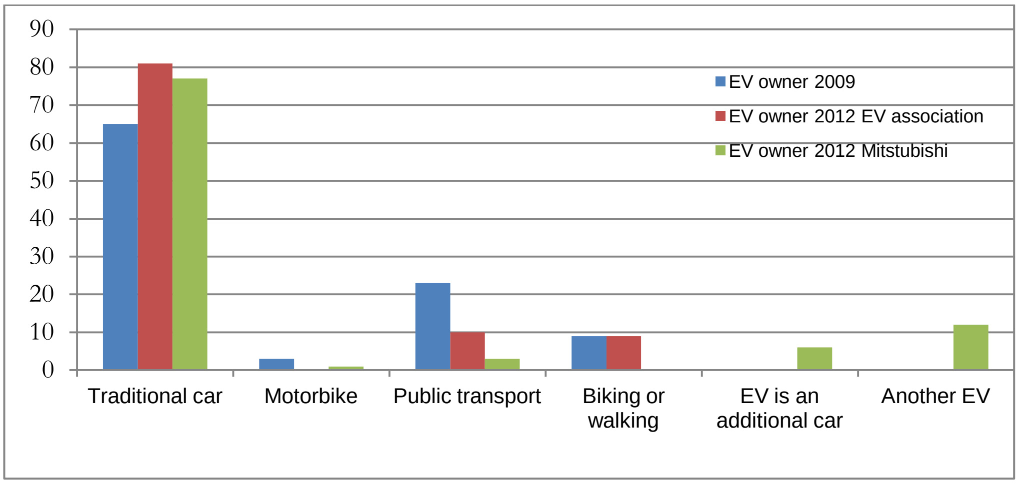

Figure 63: Use of transport mode before people got an Electric car. Source: Rødseth 2009, Haugneland 2012 and Mitsubishi 2012. (In the latter survey, not all respondents had had their vehicle delivered yet. Thus, there is a mixture of EV owners and future EV owners who have responded).

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It seems that once an Electric vehicle has been acquired, the number of journeys it is used for increases, (Kløckner 2012). Perhaps because a more realistic picture of the range is developed and the journey planning is improved. Does this mean a slight tendency towards an increase in private car ownership or to transport with poorer environmental properties (car instead of public transport and bikes)? We do not believe there is any basis for such a conclusion. It is not known which type of public transport that was used or how long the journeys that are being replaced were. Neither do we know what people would have done if they had not purchased an Electric vehicle as a second car. Would they then have purchased a regular petrol or diesel-powered vehicle? The Econ study (2006) found that on the environmental plus side, having a rechargeable car means that people are increasingly moving towards a more eco-friendly way of driving.

To date, Electric vehicle owners have mostly been men aged 30-50 years, with good financial positions. They belong to a group who otherwise express less concern for the environment and believe that other factors are more important than the environment when purchasing a vehicle. It is therefore interesting that the choice of Electric vehicle purchase allows people with Electric cars to become contributors to improving the environment, (c.f. Statoil 2012). This may seem like the discovery of a product that is possible to connect the financial and practical motivations for environmental friendliness by virtue of a marketing strategy.

7.4.7 Short journeys are connected in travel chains

Electric vehicles are mostly used for short daily journeys. When looking at the potential for multiple Electric vehicles, it is therefore interesting to see the extent of short driving journeys in the RVU (The Norwegian national travel survey). In 2009, only 17% of the daily driver journeys were > 20 km, (Vågane et al 2011). Thus, most daily travel is well below the range of 160 km that can be expected for a typical Electric vehicle. (For Plug-in hybrids this is estimated to be 200 - 600 km). This is also well below the reduced winter range which can be between 80 and 100 km. Thus we can assume that most daily journeys could be transferred to Electric vehicles.

Daily journeys occur in chains. We may drop off or pick up children on the way to and from work and shop with the children on the way home. The journeys mentioned comprise five individual journeys within a travel chain. A travel chain is necessarily longer than an individual trip. Most chains are fairly simple. 60% of all chains consist of two links and 48% of all journeys are included in chains of two links, (Vågane 2012).

Figure 64 shows that 48% of car driver journeys of 1 kilometer or less are part of chains that are more than 5 kilometers long. For journeys between 1 and 2 kilometers we find that 43% of the journeys are more than 5 kilometers long.

The national travel survey (RVU) also shows that 91% of daily travel chains as a driver is over 20 km long and 44% are over 50 km. With a winter range of 80 km, most travel chains can still be completed using an Electric vehicle.

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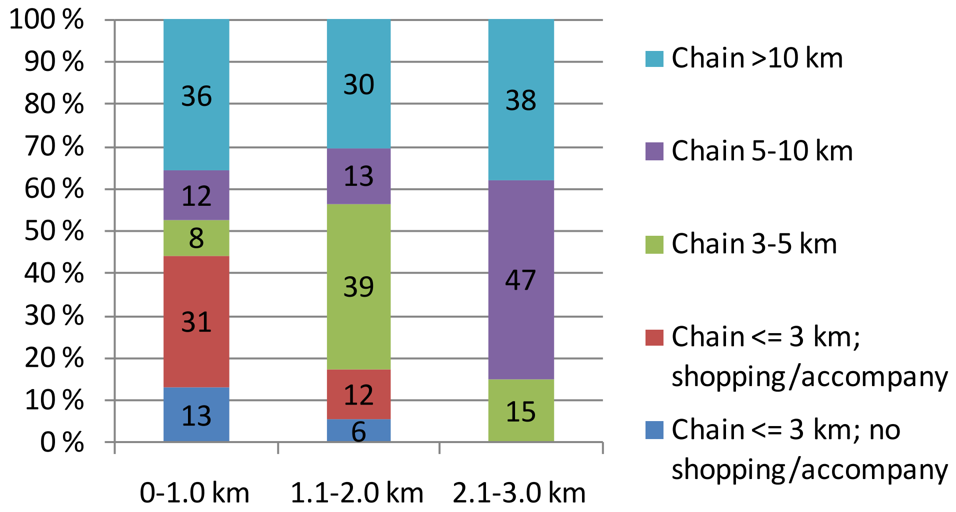

Figure 64: Chain length of car driver trips by length of journey. Car driver travels in chains with at least two links. RVU, (the national travel survey) 2009. Source: Vågane 2012.

It is the long chains that are most significant to energy efficiency and environmental and climate impact. Chains in which all journeys by car drivers are 20 kilometers or more, account for only 39% of all trips, but account for 83% of kilometers. Similarly, the 39% of the chains that are shorter than 10 kilometers represents only 7% of the total amount of kilometers driven.

For the short journeys an Electric vehicle will be seen as environmentally competitive with cycling and walking. Approximately one in three of the shortest journeys are parts of chains over 10 kilometers, and therefore will be difficult to replace with travel on foot or bicycle.

13% of car drivers travel a maximum of 1 kilometer are part of chains that are of maximum 3 kilometers length, which include neither purchases nor following children as the primary purpose of any links. This is a travel chain group that is well suited to be taken over by cyclists and pedestrians. They should therefore not be included in a calculation of the potential for Electric cars, but perhaps for Electric cycles, cf Chapter 9.

7.5 Potential for Electric vehicle usage

7.5.1 Big market for Electric vehicles

Based on our review of the ratings given by people to the pros and cons of Electric cars and actual data regarding travel habits from RVU 2009 (the national travel survey), we believe that there is large potential for further development of Electric vehicles in the private market. Especially in metropolitan regions and amongst multiple car households. The main points regarding the basis for the market are related to;

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Vehicle range

- The range is good enough for most daily journeys. 85%, 80% and 75% of daily mileage for car drivers is less than 80 km for those with respectively one, two or multiple cars. This is well below the Electric vehicle range, even in winter. With daily mileage as a goal, one also includes all types of travel during one day, (i.e. travel chains and not just travel units). However, this figure says nothing about how the cars are used throughout the year.
- That the range is good enough, also applies to work commuting that have so far been the purpose for which Electric cars have been mostly used. Work commuting also represents the longest daily journeys.
- Greater potential among those with multiple cars and parking space at work. The vast majority of Electric vehicle users have Electric cars as a second car. It is natural to think that for those who have two cars, it would be easier to replace one car with an Electric car.
- As Electric vehicles are largely (circa 90%) household vehicle number 2, the problems with the longer daily journeys can be handled with the second household vehicle.
- Recent data indicate that more and more people believe that Electric vehicles are able to meet their transportation needs. The proportion of the population who think so increased from 52% to 57% between 2012 and 2013. In the same periode the proportion of people who may consider an Electric car as the main vehicle increased from 13% to 21%, (Hoen 2012 and Skavhaug 2013).

The economy

- 42% of the Norwegian population belongs to households with access to two or more vehicles. Amongst those who have cars, as many as 49% have access to two or more cars, (Vågane et al 2012). This means that they have an economic basis upon which to replace one of the cars with an Electric vehicle. In the Statistics Population and Housing Census from 2011, it is stated that 635 000 households have two or more cars. If each of these replace an internal combustion engine (ICE) vehicle with an Electric car, many environmental goals would be reached, jf calculations on the number of Electric cars we need to reach different goals, (Figenbaum et al 2013).
- In 2013 Electric cars were found available for purchase at a competitive price relative to comparable vehicles, see Chapter 6. This may make use of incentives that people today perceive as significant value for their choice, less important in future years.
- Uncertainty regarding the resale value and a less developed used car market, may reduce the interest for choosing an Electric vehicle. Generally, about 75% of vehicle purchasers purchase a used vehicle. ECON (2006) found that this also applies to private Electric vehicle purchasers. The existence of a second hand market for Electric vehicles is an important element in the further electrification process. Organisations/companies purchase used cars to a lesser degree (35%), but their cars helps to increase the used car market.
- The same uncertainty applies to battery life expectancy and the cost of purchasing a new battery.

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Everyday practicality

- One challenge is the practical advantages that an Electric vehicle can have. This is particularly true with regards to saving time by being able to drive in bus lanes near larger cities. The potential seems to be particularly large in urban regions.
- RVU shows that parking facilities also are of significance to explain transportation mode. Of those who have good access to parking spaces, 70% drive to work, but where it is lacking the figure is only 9%.
- Parking facilities are probably important, whether they are provided free or not. On average in Norway 67% of the working population has access to well positioned free parking spaces, (Vågane et al 2012), and the proportion is decreasing. There are major differences between the cities and the rest of the country. In Oslo, for example, only 45% have good parking facilities.
- Recharging station support programmes have already reduced the number of problems associated with range that emerged as challenges for Electric vehicle drivers in earlier studies. This trend will continue with regards to both batteries and recharging stations, see Chapter 5.

Knowledge

- Whether people have information and knowledge about the new technology is a key element in the assessment of potential. Here we have little data.
- Answers to some questions indicate there is a potential to better information regarding the different Electric cars. For example, that they now meet important security requirements, the actual range, what different types of recharging means etc.

Based on the facts discussed above the ground should be paved for increasing the number of Electric vehicles in Norway. But, will the potential be used?

The positive willingness to try new cars as expressed in surveys, is far from equivalent to the actual proportion of Electric vehicles in new car purchases or of the fleet of cars. The real market potential and real environmental impact are lower than what is stated in surveys, and could be estimated to 10-15% given the current Electric vehicle technology. For vehicles that have a significantly longer range, there will be another assessment of market potential.

7.5.2 Motives for Electric vehicle use

In a Master's thesis Zelenkova (2013) studied the underlying motives behind the choice of purchasing and owning an Electric vehicle. 121 respondents from Oslo were asked to evaluate 12 different statements that made it possible to assess whether people follow economic, altruistic, self-reinforcing or practical motives for the purchase of Electric vehicles. On average, the economy and altruism, (e.g. environmental and social awareness), were the main motives for choosing an Electric vehicle. Electric vehicle buyers are primarily motivated by the comparative economic advantages that the vehicle has compared to a conventional car. The environmental aspect is found in both an altruistic motivation and as a subject of importance to their own identity.

Zelenkova finds that several socio-demographic factors influence selection and are reflected in the individual's design profile. This includes age, gender, income, family

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situation and degree of stress. But when it comes to understanding the motivating factors behind peoples' choice of an Electric vehicle, more knowledge is required. Zelenkova's findings support the designs and dimensions found by Axsen and Kurani (2012) with regards to purchasing rechargeable Hybrid vehicles, see Table 23.

Table 23: Motivational factors for purchase of rechargeable hybrid vehicles in California. Source: Axsen and Kurani 2012.

Motives	Functional	Symbolic
Private	Save money Reliable Fun to drive	Expression of self-identity Convey personal status to others Attain group membership
Societal	Reduce air pollution Reduce global warming Reduce oil use	Inspire other consumers Send message to automakers, government, oil companies

Motivating factors behind the purchase may also change along the way and become something other than originally thought. Kløckner (2012) studied motivations, intentions and actual use of Electric cars. His results indicate that most purchases gives an additional vehicle and not a substitute for another vehicle. However, it is not clear whether interviewees would otherwise have bought another car number 2. This is something new studies should seek to clarify.

Purchasing a vehicle influences both use and attitude. Once an Electric car has been acquired, it is used for a large proportion of journeys, which is related to the fact that owning an Electric car can change intentions to reduce car use. The motives to reduce car use might be weaker for some persons. If the use of Electric cars is only motivated by the opportunity to drive in bus lanes, pass free through toll areas and get free parking, electrification of the car fleet will not necessarily be a sustainable measure. These incentives are important in the beginning to stimulate market development, but may result in increased vehicle ownership.

In a Move About (car pool organization) user study in the knowledge enterprise DNV (The Norweegian Veritas), employees were asked to rate some statements about the importance of Electric vehicles. Interesting to note is that over 50% agreed that the Electric car sharing scheme has changed their travel habits, (17% strongly agree). Moreover, experience with Move About increased peoples interest in a private purchase of an Electric vehicle, (44% strongly agree), (Eimstad 2013).

Based on interview studies and actual vehicle purchases it can be seen that;;

- Electric vehicle owners - and also hybrid owners - are loyal to their choice. They will purchase Electric vehicles in the future.
- In different cross-sections of the population, more people will consider purchasing a Hybrid car than an Electric car. This may be related to the evaluation of range and comfort for previous models of Electric cars.
- 9% - 30% can imagine considering the purchase of an Electric car next time they purchase a vehicle. Based on an assumed equal price, the figure is 19%.
- At the same time, it can be seen that the environmental benefits of the Electric car are not at the very top of the list. Price, safety and efficiency, time-saving transportation is often more important to people.

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- The positive choice as expressed in surveys is far from the actual proportion of Electric vehicles a new car purchases and in the fleet of cars.

A basis for the assessment of real potential and real environmental impact should therefore lie in the lower part of the surveys estimates, for example 10-15%. It is worth noting that those who were asked responded in terms of their knowledge about the types of Electric cars available on the market at the time they were asked. Therefore caution should be exercised in assessing future potential only on the basis of surveys.

7.5.3 Potential environmental impact

Electrification means that Electric vehicles and Plug-in hybrid vehicles will replace cars with internal combustion engines. In this context, electricity is considered as zero emission, (electricity production is part of the EU's emissions trading market and also belongs to another sector). Each Electric vehicle that replaces an internal combustion engine vehicle reduces CO_2 emissions by 100%. Plug-in hybrid cars are likely to deliver emission reductions of 44- 68% (Figenbaum 2010).

Klimakur (2010) estimated the potential environmental impact of an increase in Electric vehicles. It was assumed that Electric vehicles may constitute approximately 7% of the new car market and Plug-in hybrid vehicles about 8% of the car market in Norway by 2020, (higher proportions than in the EU). Emission reductions were estimated at approximately 200 000 tonnes of CO_2 equivalents. This was based on the assumption that petrol and diesel cars will be significantly more effective, thus reducing the potential for emission reductions by Electric vehicles. Assessing the realism of calculating market potential and environmental impact requires more knowledge regarding motives, attitudes and behavioural changes.

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8 Safety

8.1 New Electric vehicles meet Euro NCAP requirements

The Electric vehicles of today meet safety expectations for modern cars, with the Nissan Leaf being awarded five stars under Euro NCAP requirements, while the Mitsubishi i-MiEV, (and Peugeot and Citroën versions of the same car) were awarded four stars. The Plug-in Hybrid cars, Opel Ampera and Volvo V60 have both been awarded five stars.

A selection of accidents with EVs in Norway are described in Appendix VII.

8.2 Traffic accidents

There have been several accidents involving Electric cars in Norway and in the Oslo region. None of the traffic accidents have resulted in death. The new Electric cars have high levels of safety with 4-5 star ratings from Euro NCAP, which in practice has proved to provide protection in collisions even in the small Electric cars. Some older cars and EVs registered as 4-wheel MCs have also been involved in collisions without fatal consequences.

8.3 Fires

Older Electric vehicles and illegally converted/rebuilt Electric vehicles have been involved in several fires. The fires are often related to lack of expertise in the rebuilding of older Electric cars to using the new Li-Ion battery chemistry. In some cases, safety equipment is for isolation measurement purposes is disconnected by some of the users due to the salt fog on the roads causing the isolation measurement equipment to detect an isolation fault, leading to vehicle shut down. This may have been the cause of fires in several older electric vans. The most serious incidents have been when an electrical fire broke out on one of the ferries between Oslo and Denmark and some fires that have started in garages attached to houses. Luckily the fires in the garages did not occur during the night so no one was injured

There have not been any fires in the cars that were launched by major automotive manufacturers in the past two to three years, so this must be regarded as a transitional problem when phasing out the oldest generations of Electric vehicles.

The Norwegian Directorate for Civil Protection, in collaboration with the Norwegian Public Roads Administration (NPRA), have published a brochure on electrical and fire safety related to the ownership, use and recharging of Electric vehicles, (dsb og Statens vegvesen 2013). The brochure is targeted at Electric vehicle owners. In addition, more detailed information is available on the NPRA website: http://www.vegvesen.no/Kjoretoy/Eie+og+vedlikeholde/Elbil

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9 Electric bicycles and scooters

9.1 Little knowledge of electric two-wheelers

Electric cycles have two significant purposes:

- They can be an important tool for increasing the proportion of bike trips in line with national targets for increasing the cycling share in transport.
- They can be a useful form of assistance for those who would otherwise have trouble getting around by bicycle and on foot. We know from the RVU, (Vågane et al. 2011) that 11% of the population have physical problems which make it difficult for them to use one of the means of transportation. Among these people, 81% have difficulties with walking and 74% have difficulties with cycling.

Electric cycles were first legally offered for sale in 2003 in Norway, through an exemption from traffic regulations. We have not so much awareness and knowledge about electric cycles and scooters in Norway, as we have about Electric vehicles. However, ongoing projects such as InnoBike at TØI, will change this. Electric cycles are also described by Fyhri (2013) in a chapter in www.tiltakskatalog.no (website with information about measures for transport, environment and climate). Here, there is also data regarding electric cycling in several countries. With a few exceptions we here restrict ourselves to using information regarding electric cycling in Norway.

With regards to electric scooters, we have extracted information from the Norwegian Electric Vehicle Association (2012) and retailers for typical electric scooters and scooters for people with limited mobility.

9.2 Electric cycles important for increasing proportion of bikes

The proportion of biking as a transport mode in Norway is currently about 4% (Vågane et al 2011). An increase in the proportion of biking is a stated national goal. Both the Climate Report (Ministry of Environment 2012) and the recent government proposal for a National Transport Plan (Ministry of Transport 2013), state that the growth in transport in cities must be done by increased public transport, cycling or walking. An increase in bicycle use will have beneficial effects for both the local environment and CO_2 emissions. Electric cycles could be an important contribution to achieving this. In Norway, with its many hills and low proportion of biking, electric cycles are relevant to getting more people on bikes.

A Norwegian study found that those living in areas where elevation difference relative to the city centre is higher than 50 meters, will make 40-50% fewer bicycle trips than those living in areas where the elevation difference relative to the city

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centre is less than 15 meters (Ellis et al 2012). Cities like Oslo, Bergen and Trondheim have many steep hills that make cycling difficult. Electric cycles will make it faster and less physically demanding to ride uphill.

The traditional bicycle is most competitive over shorter distances (Vågane et al 2011). Increasing the range of the bike could lead to more people choosing the bicycle. An electric cycle may contribute to expanding the practical distance for cycling to many users.

9.3 Design and performance of electric cycles

Electric cycles that follow the common requirement of the EU for electric cycles are formally called EPAC (Electric Pedal Assisted Cycle), but they also go by the name Pedelec. Motor power is limited to 250 watts and the motor will not be able to drive the bike faster than 25 km per hour. All EPACs have pedal sensors and brake sensors. All electric cycles require that you step on the pedals to activate the motor. But how suddenly and with how much power the motor kicks in varies.

The motor is powered by a rechargeable battery. Lithium batteries are the most common (lithium-ion polymer (Li-ion) or lithium iron phosphate (LiFePO4). Recharging time of an empty battery varies from three to eight hours and the range between recharges varies between 20 and 140 km. The range is affected by both temperature and strain. Several tests of electric cycles have been carried out. One of the major tests in Norway was conducted by the Cyclists' Association (http://www.slf.no/Nyheter/arkiv_2011/stor_elsykkeltest). It showed that most of the bikes had a range of 40-55 km on a relatively hilly test track.

Figure 65: Electric bicycle.

The bike weighs approximately 8-10 kg more than a bike without a motor and is somewhat heavier to tread than a normal bikes without motorized assistance. Most types of cycles, (hybrid-, mountain- bikes and classic bikes) are available as electric cycles. It is possible to retrofit an auxiliary engine onto a regular bicycle. Figure 65 show an example of an electric bicycle.

9.4 Market development and incentives

The electric cycle market is growing rapidly. In Europe, 2 million electric cycles were sold in 2012, up from 800 000 in 2008. Of the European countries, Switzerland was the biggest market for electric cycles in 2012 with 60 000 sold, which amounted to 20% of all new bike sales (www.ebwr.com). In many ways, the incentives available

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for electric bikes in Switzerland are comparable to the Norwegian incentives for Electric cars.

9.4.1 Electric cycles in Switzerland

Switzerland has its own organization, NewRide (www.newride.ch) which has been actively promoting electric cycles. NewRide is an independent foundation supported by the government energy conservation program EnergieSchweiz. One of the tools they use is road shows which allows the audience to try out an electric cycle. For example, there were 161 road-shows held in 2008. NewRide also works with distributing information through mass media and with retailer support. Their experience is that retailer expertise is a significant factor in attracting customer interest.

9.4.2 Recharging stations

In Norway there are no recharging stations for electric cycles as there are for Electric cars. Electric cycles have a range that covers regular daily use, and the battery, being a valuable part, can be taken out for indoor recharging. The batteries can also be recharged at the recharging stations offered in some cities in other countries, see Figure 66.

Figure 66: Sanyo solar powered charging station in Tokyo, located at the train station.

9.4.3 Competitiveness

In principle, the bikes have a range of several tens of kilometers. Fyhri (2013) has assessed the potential of the electric cycle in Norway and highlights a number of challenges;

- Top speed of 25 km per hour increase the use of time. As a typical work yourney in a Norwegian city takes less than half an hour (Vågane et al 2009), the real potential competitive usage for electric cycles are daily trips of less than approximately 15 km.
- Electric cycles are more expensive than regular bikes and in Norway, cost from approximately NOK 10 000 - 35 000. It is not clear what this means for potential increase in use.

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Fyhri (2013) also highlights the benefits of electric cycling;

- Motorists can save money by switching to electric cycles. Given a new price of 2,600 €, seven-year depreciation and total cycle length of 1 200 km per year, along with no costs for electricity, (it costs 0.08 € for a full charge), an electric cycle costs 0.25 € per km to use. For someone who travels to work by car and has 10 km of travel, replacing three car trips per week with an electric cycle means a saving of about 11 € per week.
- Electric cycles are particularly well suited for journeys with children or shopping trips. At workplaces where there is no access to a cloakroom or shower, an electric cycle will give employees who want to cycle without getting sweaty, the opportunity to cycle which they would otherwise not have.
- International experience suggests that electric cycles can give people who would otherwise not have started cycling, an impulse and possibility to start cycling which will benefit public health.

A subsidy, including tax exemptions amongst other things, (such as for Electric vehicles) and a hire scheme, like the city bike scheme could be measures to increase electric cycling.

9.5 Effects of electric cycling

We have little knowledge of what kind of environmental impact electric cycles have. If increased use of electric cycles can lead to more persons choosing to cycle instead of using a car and public transport, this will have positive environmental and climate impacts. If the consequences are that fewer people walk or cycle using conventional bikes, the environmental and climate impact will be negative if battery production has a negative impact. In practice, with the Norwegian energy mix, climate impacts of electricity production will be close to zero.

Fyhri (2013) suggests a possible explanation as to why the electric cycle has not yet achieved a critical mass in Norway, It might be that people believe there is less exercise involved with an electric cycle. However in practice, it may be such that the reduced effort is counterbalanced by the fact that you cycle more often, or for longer distances with an electric cycle. The key question is whether more people would choose to cycle if they had access to an electric cycle and what happens in terms of their health. There is not so much known about this. In a 2003 study, 20 healthy but inactive adults were given access to electric cycles for use in daily commuting. All cycled at least 6 km three times per week and the results showed that their physical condition was significantly improved during the six week study period (Lataire et al 2003). See also Simons et al. (2009).

Electric cycles are believed to have an adverse traffic safety impact, both because the bikes have a slightly higher uphill average speed than conventional bikes and because the risk associated with cycling is higher than for other vehicles. There are no studies documenting the safety impact of electric cycles in Norway or Europe.

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9.6 Electric scooters

9.6.1 Characteristics and areas of use

An electric scooter is a two-wheeler which can be powered by an electric motor. It can replace other motorized two-wheelers such as mopeds, motorcycles, Vespas and vehicles available to people with disabilities.

An electric scooter in the moped class can be operated by anyone with a moped license and holders of driver's license endorsed for class B. It has around a 16 kilometer radius between recharges. The speed ranges from 45 - 100 km per hour for the light variations. An electric scooter is both energy and space-efficient and causes no noise or local emissions. It is reasonable to operate, costing about 0.03 € in 'fuel costs' per kilometer. It can be recharged and parked free of charge at recharging stations. There are models that have removable batteries which are able to be recharged at home or the office desk. Price ranges from 1,200 to 6,300 €.

9.6.2 Electric mopeds for people with mobility impairments

Having the ability to control their lives and be independent is seen as valuable to most people (see for example, the BISEK report on arrangements for those with mobility impairment; Nordbakke and Hansson 2009).

A moped electric scooter see Figure 67, is easy to handle and use and has a simple and operationally safe structure. They are equipped with magnet brakes which means that they stop when the accelerator is released. They can be operated by everyone, without requiring a driver's license and can be ridden on footpaths, cycle lanes and roads. The electric moped is recharged using a standard wall outlet, simple, cheap and environmentally friendly. In Sweden they are defined as electricity-powered wheelchairs and can therefore be insured for a low cost.

Figure 67: Example of an electric scooter for people with mobility impairments. Source; Etac web store.

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Etac is a Swedish company that provides products for people with reduced mobility, as well as products and services to hospitals and nursing homes. They aim to provide smart assistance devices for anyone requiring help in everyday life. Electric scooters are available for purchase online at prices ranging from 1,250– 3,750 €. The scooters are delivered assembled at the front door and come with a one year warranty.

We have not investigated the kinds of support that may exist for this type of Electric vehicle in Norway. Neither have we found any such material via a simple web search on the needs and assessments of this user group.

9.6.3 Centre for el scooters underway in Oslo

The metropolitan population across Europe has to a great extent realized the impossibility of using of large petrol/diesel vehicles for city commuting. The el scooter therefore has a significant and natural place in the urban landscape. With a top speed of 45 km per hour, it is faster than the queue of cars.

The Norwegian Electric Vehicle Association (2012) introduces the electric scooter, see Figure 68, as an optimal solution for urban mobility, in line with the ambitions of politicians in Oslo. They will also establish a centre for elscooters in Oslo.

Figure 68: The electric scooter as a potential solution for congestion problems. Source: Press image from Norwegian Electric Vehicle Association.

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10 Assessment of changes in policy and government incentives

10.1 General agreement on EV-policy

There is a general political agreement regarding Electric vehicles and vehicle taxation policy in Norway. The Climate Policy Settlement signed in the Parliament in June 2012, includes all political parties except the Progress Party. The settlement includes the preservation of the tax benefits of Electric cars, until the end of 2017 (the next parliamentary term), unless the total number of Electric vehicles in the fleet exceeds 50 000 before then. The local incentives (free parking, access to bus lanes, free passage through road tolls), may according to the settlement, only be altered in close consultation with affected local authorities. The Climate Policy Settlement cannot be interpreted as implying that after 2017 Electric vehicles should lose all of their benefits: The agreement is merely stating what will apply until the end of 2017.

In the national budget for 2011 the Ministry of Finance stated that in 2015, an overall assessment of car taxes will be carried out and that in principle, all alternative fuels should have fees imposed that match the 'road user costs' (accidents, traffic jams, air pollution, greenhouse gas emissions, noise, road damage). Note that electricity is not a fuel, but is in the document referred to as one of the options that have hitherto been exempt from 'road user charges'.

> *'In principle all road users pay a fee equal to the cost to society in terms of accidents, congestion, noise, air pollution and road wear. Most of the cost of using private cars is related to accidents, congestion and noise. These are costs that are incurred regardless of choice of fuel. This suggests that the alternative fuels, which today are free of charge, should also be subject to a cost in the long term, a road user charge'.*
>
> *Source: Statsbudsjettet 2011, Skatter og avgifter 2011, Prop. 1 LS*

Incentives for Electric cars in Norway are primarily about tax that is not taken in, not about subsidies provided. The same applies to user incentives. A benefit is awarded to a group who either do not have a cost (use of bus lanes as long as the number of Electric vehicles does not hinder transportation by bus), or the cost is covered by those who pay having to pay a little more (annual license fee) or over a longer period (road tolls financing a particular road/transport package). This implies that there is a distributional impact on the economy, but the incentives does not particularly strain public budgets to any great extent. This makes it easier to gain acceptance for policies compared to using tax revenues to subsequent distribute subsidies for Electric vehicles. An example can illustrate this. Today, Electric cars have low annual fees of 51 €, while petrol-powered cars have fees of 361 €. Electric cars total approximately 15 000 of the total fleet of 2.4 million cars (fall 2013). This is a ratio of about 0.6%. Therefore the proceeds from the annual fee will be 0.6 % lower, circa 4,2 million €,

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or alternatively, the fee for those who pay will be about 2 € more than it otherwise would have been, if the government choose to maintain the total income of this tax. However, exemption from VAT is an example for which it is hardly relevant to increase the fee to fund the exemption for Electric vehicles, so this causes a revenue loss to the state. It can be generally stated that governments secure the revenues needed to fund its operations. In doing so, the EV-policy does not necessarily have national financial implications, but will have a distributional impact on the economy which can lead to negative impacts.

There are those who do not agree with this policy. The following are some critical reports and articles (in Norwegian language):

- Funding for the introduction of electric and hybrid vehicles. (Econ 2009). Commissioned by the Norwegian Petroleum Institute.
- Electric vehicle policy - Does it work as intended (Holtsmark 2012).

The Criticism of the Electric vehicle policy is directed at the extensive Electric vehicle incentives, and the cost of these. The underlying cause of the disagreement is probably founded on a different understanding of how market dynamics in the automotive industry interact with incentives. Supporters of the current policy believe incentives and support for infrastructure enable the introduction of new technology, by reducing the risk and cost to private operators, and making it possible for consumers to make use of the technology. Getting the market going reduces cost over time, and eventually the market will be self-supported. Critics believe that the market will take care of this on its own as long as all operators face the same taxes and price signals and therefore, it is wrong to give special incentives to selected technologies. Furthermore, they believe that there is a risk of supporting the wrong technology. However, this can also be turned on its head. Failing to support new technology may involve de-facto support for existing technology, that has the advantage of amortized costs for production and distribution assets, optimal placement of filling stations, etc.

There are not as many evaluation reports and no systematic research on the impact of Electric vehicle policy incentives in Norway so far.

10.2 How to reach the 85 g per km target?

TØI has on behalf of the Ministries of the Environment and Transport and Communications, investigated how it might be possible to reach the Climate Policy White Paper target that new cars should not emit more CO_2 than 85 g per km by 2020 (Figenbaum et al 2013). The main conclusion here is that there is great uncertainty as to how big a contribution can be expected from Electric cars and Plug-in Hybrid cars. These types of cars have been selling poorly in all countries except Norway, and it is thus not given that the car manufacturers will continue along these paths unless sales pick up.

In view of this uncertainty, four scenarios were created regarding how the sales of Electric vehicles and Plug-in Hybrid vehicles, may go. In one scenario it is assumed that both technologies breakthrough across Europe, so Norway can use the tax system to phase as many Electric and Plug-in Hybrid vehicles into the national car fleet as possible. Then there is a scenario in which only Electric vehicles succeeds,

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another where only Plug-in Hybrid vehicles succeeds, and one in which none of the technologies succeed. In the latter case, the target of 85 g per km will not be possible to achieve, without a radical restructuring of new car sales in the direction of almost exclusively small diesel vehicles, hybrid vehicles and a much lower proportion of 4-wheel drive vehicles than today. There will be different ways to reach the target within each main scenario. A market share of up to 20% for Electric vehicles may be necessary if no Plug-in Hybrid cars are able to make a market breakthrough, while a market share of 30 % may be necessary for Plug-in Hybrid vehicles if no Electric vehicles are able to make a market breakthrough. In the alternative scenario in which both technologies succeeds, the necessary market shares of each needed to reach the target, will be lower.

The main instrument for achieving the goal will be to increase the vehicle registration tax on CO_2 emissions, making cars with high emissions more expensive. At the same time, this will also make Electric cars and Plug-in Hybrid cars more cost effective compared to petrol and diesel powered cars. Over time, vehicle purchasers will have an increased choice amongst vehicles with low emissions. The proposal implies that the tax increases roughly in line with the increased options, so that car buyers can choose vehicles with low emissions, thereby avoid paying more tax.

10.3 Changes to the tax system

In several projects conducted by Vista Analyse AS, the impact of car sales on the Norwegian tax system has been analyzed. The study clients were the Norwegian Public Roads Administration, the Ministry of Transport and Communication, and the Ministry of Finance.

In the report, 'Virkninger av endringer i insentiver for kjøp og bruk av ladbare biler' (Rasmusen 2011), an estimate is made of how sales of Electric cars and Plug-in Hybrid vehicles will change with various changes in the regulatory framework and incentives, see Table 24. This is evaluated relative to a baseline scenario with conservative estimates of technology, prices and purchasing interest, and a more optimistic technology scenario. An econometric computation model is used as the basis for the opinion, and estimates vehicle sales based on observed historical sales through changes in fees that have been implemented from 2007.

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Table 24: Effect of Electric vehicle sales tax changes and incentives. Source: Rasmussen 2011.

	Reference scenario	Technology optimistic scenario
Removing bus lane access	Electric vehicle sales is reduced by 40-50%, because in this scenario it is highly dependent on this incentive, in municipalities in which a lot of Electric cars are sold.	Electric vehicle sales is reduced by 20% (because in this scenario the cars are cheaper and a smaller share of Electric vehicle sales are motivated by access to bus lanes)
Removal of VAT exemption for Electric cars	Electric vehicle sales fall by 5-10% (because the volume of sales in this scenario, is more driven by access to the bus lane, which has high value for the user).	Electric vehicle sales fall 12-16%, and there is an impact on sales, towards cheaper Electric cars. The reduction is stronger in this scenario because Electric vehicles are a substitute of equal value on price before the change, but then become 25% more expensive.
Reduce the vehicle registration tax on Plug-in Hybrid vehicles, to a minimum contribution of NOK 3 447.	Sales of Plug-in Hybrid vehicle will increase but the impact is difficult to estimate: inter alia, it depends on market competition, how much of the tax reduction will fall to the vehicle purchaser, and how much will be lost to increased dealer/manufacturer profits.	
Removal of access to free parking	Difficult to assess with large local differences. It is believed that the impact is limited, subordinate compared to the access to bus lanes.	
Removal of free passage through road tolls	May cause major impact locally, but limited impact nationally. In cities, bus lane access is more important. Could be that the free passage through road tolls becomes more important if the bus lane access is removed.	

The introduction of the exemption from the value added tax (VAT), can be seen in the context of Ford's plans for the production of Electric cars in the Think Nordic factory located in Aurskog outside Oslo, as an action taken to provide Think with improved domestic market opportunities. Thus the fact that Ford owned Think probably influenced this decision. The problem became acute when Thinks Electric car proved to be more expensive than expected and consequently sold poorly. VAT is also a disincentive for a new technology, as it makes the product even more expensive. If the costs to produce an Electric car is 10,000 € more than a conventional car, then imposing 25% VAT will make it 12,500 more expensive for the customer. 2,500 € of this extra cost would be the VAT. This would constitute a large disincentive to buy an EV.

10.4 Monitoring bus lane access

In the initial phase, access to bus lanes was contested. Early work was carried out by the Norwegian Public Roads Administration in the early 2000s on new rules for bus lanes. They wanted to ban mini buses from the bus lanes. This gave rise to a discussion of who should be allowed to use bus lanes. The Electric vehicle environment lobbied hard for Electric cars to have access, as a far more environmentally friendly option than mini buses. Eventually the Ministry of Transport and Communications stated that they wanted to conduct a pilot scheme

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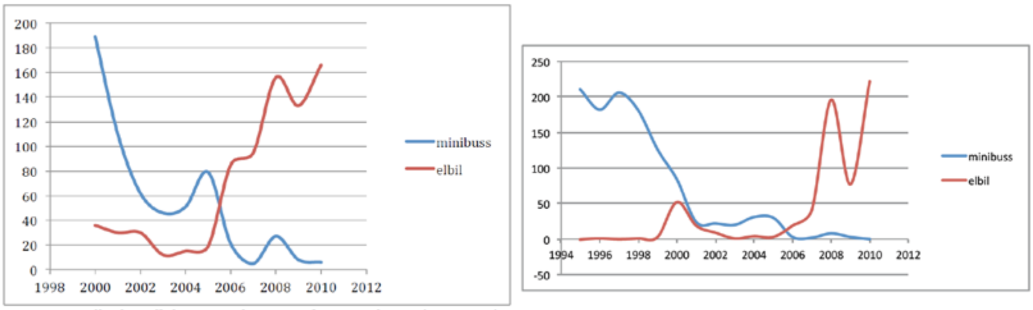
on three small stretches of road. During the hearing of this proposed regulation, there was increased pressure to expand the pilot scheme. Finally in 2003, it was decided that Electric vehicles would be given access to all bus lanes in Oslo and Akershus, with some minor exceptions in Oslo's inner city.

One aspect may also be that Electric cars was a small enough group of vehicles to be allowed access to bus lanes, without impairing the accessibility of public transport. The trial lasted until 2005, and there were no problems identified. From 2005 the scheme was launched nationwide, as a permanent initiative. Mini buses were permanently banned from bus lanes from 2009. Figure 69 shows that this had an impact on sales of Electric vehicles and minibuses in Oslo, and the municipalities of Asker and Bærum close to Oslo.



Figur 3.4 Antall solgte elbiler og minibusser i Oslo, 2000 til 2011 (t.o.m mars) **Figur 3.5 Antall solgte elbiler og minibusser Asker og Bærum, 2000 til mars 2011**

Figure 69: Yearly sales of Electric vehicles and mini buses 2000-2010 in Oslo, Asker and Bærum. Source: Rasmussen 2011.

The 2003 experiment created a huge demand for Electric vehicles in the market,. But the challenge was that few manufacturers were able to deliver. Think struggled to restart production of its new model, ElbilNorge (Kewet/Buddy) had little capacity, while Enviro Car in Drammen hunted down all the used French Electric vehicles available on the European market. However, Electric car sales were still down right after the introduction, but this was likely not due to lack of demand. After Mitsubishi launched its i-MiEV Electric vehicle in late 2010, there was a particularly strong demand for Electric vehicles in the Asker municipality, where the advantage of driving in the bus lane is of particular high value.

PROSAM (National and local government liaison body for better traffic forecasts in the Oslo area) was established in 1987 to strengthen and coordinate work with traffic data and forecasts in the Oslo area. In 2009, it prepared a report on the traffic flow in the bus lanes (Rødseth 2009). The following hypotheses were initially formulated:

1. 'Competition for the use of bus lanes will increase, and the increased number of other vehicles in the bus lanes may have a significant and increasing negative impact on the efficiency of the public transport. Increased access for others will quickly have a negative effect on buses in bus lanes.

2. Users of Electric vehicles drive such types of vehicle to avoid travelling by public transport. We want to shed light on the extent to which Electric vehicle purchase leads to decreased use of public transportation, and thus increase the use of individual means of transportation.

3. Frequent changes in regulations for use of the vehicle/road system, could lead to negative reactions from groups that have chosen to acquire vehicle types that under current regulations are authorized to drive in bus lanes.'

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Hypothesis 1 was partially investigated by a review of international theoretical and empirical literature, partly through traffic surveys, and development of speed profiles for selected stretches of bus lanes in Oslo and Trondheim. Transportation capacity, especially in the downtown bus lanes, is relatively sensitive to impacts, particularly in places where other traffic is mixed in with the flow of public transport. This is typical of the points in the network at which buses must stop or slow down (stops, intersections and ramps), and where the traffic lane configuration is changed.

They conducted traffic surveys of the number of different types of vehicles in selected bus lanes, and concluded that in the current situation, Electric cars did not occur in such volumes (2009), that they presented an obstacle to the efficiency of bus services. If the proportion of Electric vehicles expands according to the range of projections for the next decade, (some sources say 10% of the car fleet by 2020), it is highly probable that it may contribute to a substantial capacity reduction for bus transport, especially at peak hours.

Recent data from the road toll ring around Oslo, indicates that Electric vehicle use along the main entrance roads to Oslo is rapidly increasing, see Figure 70.

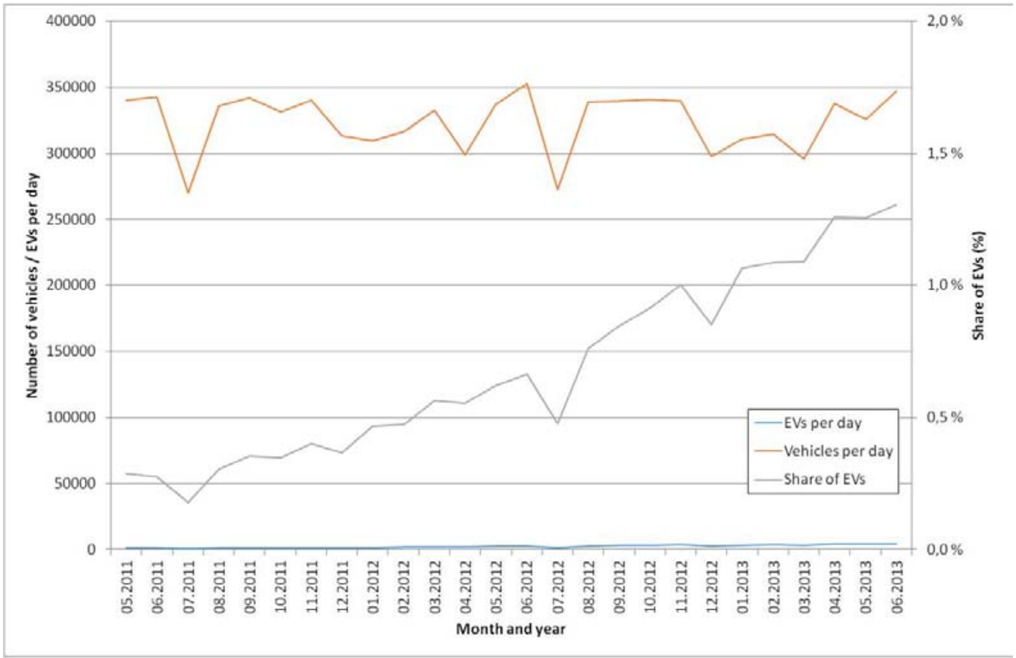

Figure 70: Number of vehicles and EVs and share of EVs in Oslo/Bærum road toll charge area per day during the period May 2011 - June 2013. Source: TØI/Oslopakke 3 Secretariat.

Hypotheses 2 and 3 are investigated through a survey of a sample of 600 people drawn from Electric vehicle owners, and compared to a general population sample drawn from equally many people with a driver's licenses from Oslo, Bergen and Trondheim (Rødseth 2009). As shown in Chapter 7, Figure 63, the current owners of Electric cars changed their travel habits as a result of acquiring an Electric vehicle, mainly (65-80%) by using the Electric vehicle instead of a car with an internal combustion engine - but also (5-20%) using Electric cars instead of public transport, and approximately 10% instead of walking or cycling. Rødseth (2009) found that

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Electric vehicle owners walk, cycle and use public transport less, and individual car transport more often, than the average across driving license holders in the three cities. However, it is not known if they did this also prior to acquiring an Electric vehicle or not. As shown in section 7.3.1, it is probably more appropriate to compare the Electric vehicle users with other multiple car users, rather than a cross-section of the population. That car users are switching to a more environmentally friendly vehicle, will normally be positive for the environment.

Those who own Electric vehicles today, state that they see Electric vehicle incentives such as, exemption from road toll charges and parking fees, as well as permission to use bus lanes, as important, or essential, to the decision to acquire and use Electric vehicles. It is likely that many of these people will react negatively if the incentives are reduced or removed, and they may go back on their choice of vehicle. Regular car users in urban areas are however relatively positive towards considering an Electric vehicle as an environmentally beneficial option, regardless of the current incentives. This group is primarily awaiting technological changes that increase vehicle range and battery life, and increased access to recharging points as well as lower purchase price. This reasoning is supported by several studies showing that Electric vehicle owners clearly state that they will continue to buy Electric cars, see section 7.3.2.

10.5 Road tolls and parking charges

Road toll is a charge levied by local governments to provide funding to build roads along with grants from the government. The exemption of Electric vehicles from toll charges, means that either the charge increase for fees paid by other vehicles, or the tolls will remain in place for longer than originally planned, so that it generates the revenues necessary to pay for the development financed by the toll. On the other hand, the number of Electric vehicles will be low for many years relative to the total number of vehicles in the fleet, so the effect is so far small. Figure 79 shows data from the toll company 'Fjellinjen' of the total number of vehicles, the number of Electric vehicles, and the share of EVs that pass through the road toll charge areas per day for selected months in 2011-2013.

The Oslo road toll has been around since 1990, while the Bærum road toll that is on the border between Oslo and Bærum, was established in 2008. In May 2013, more than 4,000 Electric vehicles passed through the road tolls in Oslo and Bærum, about a fourfold increase since May 2011. This amounted to 1.3% of the total flow of traffic into the toll area.

In comparison, the population of Electric vehicles in September 2013 in municipalities in which commuters pass through toll areas in Oslo and Bærum, was 2,792 in Oslo, 3,556 in Akershus and 734 in Buskerud, (Source: Grønn bil 2013, may include a few PHEVs). It can be assumed that it is primarily car owners in Akershus who commute to Oslo who pass through the toll area, but it may also be som commuters travelling from Oslo to the new industrial area at Fornebu and along the E18 towards Asker in Akershus. These would be subject to the toll on the way back to Oslo. It is also possible that some Electric vehicle owners commute to Oslo from the closest municipalities in Buskerud. Some drive through both the toll gates at the Bærum/Oslo border and the one closer to Oslo City centre. They are thus counted twice. A rough estimate of the size of the proportion of Electric vehicle owners who, on average receive the benefit of no toll charges in Oslo, may therefore be around

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50%. A relatively high proportion of these may also have the benefit of access to bus lanes. In Bærum and Asker municipalities there are many large enterprises along the E18, which has a bus lane. It is possible that some Electric cars owners work here and benefit from access to bus lanes, but do not pass into the toll areas which are closer to Oslo and thus are not registered in the toll gates. Also, there may be more Electric vehicle owners who are reaping the benefits of both incentives because EV owners on average will not take advantage of the benefits every day (some are on business trips, holidays, working from home, etc.). Last but not least, there may be uncertainty regarding the numbers passing through the toll areas.

The exemption for parking fees in municipal parking spaces also came early. This is a fee that is controlled by local authorities and was initially contested in Oslo, due to the fact that the local electric utility company, Oslo Energi, began offering free parking and recharging on their own land, while the environmentalists in Bellona took action by driving their own Electric car around Oslo and parking without paying. In Stavanger free parking was introduced for Electric vehicles in many places. The most important factor was probably when a majority in the Oslo City Council wanted to introduce free parking, and asked the Minister of Transport and Communications to amend parking regulations to make it possible. This measure results in municipalities either receiving lower revenues from parking fees, or make it more expensive for owners of regular cars to park if total revenue is to be kept constant. The measure has potentially great value for users (but probably concerns a limited number of cars). A lot of Electric vehicle purchasers have parking at home and access to free parking at work, regardless of the type of car they drive. For those who do not have access to parking at work, this incentive may be particularly interesting and influential in the choice of vehicle type. This would still represent a limited number of Electric vehicle owners, as the majority of public car parking spots, have time limits, and the number of recharging stations where there is no such time limit, is relatively modest.

Table 25: Parking charges 2011 prices in NOK. Source: Rasmussen 2011.

Parking costs examples	Yearly costs	Cost 5 years (5% interest rate)	Cost 15 years (5% interest rate)	Comment
Aker Brygge Oslo	46,800	202,620	458,768	EVs park for free on public parking lots. Time limitations apply for EVs. In Oslo about 977 places are available, some may be non public or with time limits
Grønland Oslo	13,500	58,448	140,125	
Low cost Oslo	6,000	25,977	62,278	
Occational fee, 20 NOK/hour, 10 hours per week	10,400	45,027	107,948	
Parking Stavanger, 12 months rent Torgveien	8,225	35,610	85,373	

10.6 Transnova to be continued

An evaluation of the Transnova organization and its support programs, has been conducted (Nivi analyse og Urbanet analyse 2010). The main conclusion of the evaluation is, that Transnova fulfills a mission amongst the Norwegian government funding agencies, and that it is natural to continue operations as of today, with a gradual increase in activity and strengthening of the role of knowledge and competence. Transnova should focus primarily on demonstration projects that are

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close to market introduction, and ensure to the greatest extent possible, that there is knowledge transfer from implemented projects, so other actors may receive more benefits from the projects undertaken.

10.7 Reviews of the significance of the incentives:

Roughly speaking, the policy instruments and incentives for Electric cars can be seen as having five purposes:

- Make purchase economically feasible.
- Remove barriers for use of Electric cars.
- Provide purchasers with benefits of value, that compensate for the disadvantages over and above the more expensive cost of the vehicle
- Compensate for the risk of adopting a technology at an early stage of development, for example, risks related to battery life and resale value of the Electric vehicle after a few years.
- Faster development of critical market mass to lower costs, and for new user groups to become familiar with the technology.

Electric cars have previously been small cars with poor comfort and safety level and in some cases poor quality. Early Electric vehicle owners seem to have exchanged comfort and safety for user benefits, such as no road toll charges and access to bus lanes, although some have probably also been motivated by an interest in the technology. Table 26 contains an overall assessment of the most important incentives.

New technology in the automotive industry is generally introduced in the luxury segment, and then introduced down through the model hierarchy of ever smaller and cheaper cars. Purchasers in the luxury segment have a great interest in new technology, and the means to pay for it. However, Electric vehicle technology fits better into small cars, and here the situation is quite the opposite. Customers who buy small cars, are keen to purchase an affordable car that offers great value. In this case, the user benefits replaces the luxury image and give Electric vehicles a positive image: The user benefits are perceived as having a different but high value. User benefits will also alleviate some of the risk a user is exposed to by getting in early, given that the extra benefits have an economic value that makes the car appear to be repaid quickly. By waiting, consumers may assume that cars are getting cheaper, but at the same time this increases the risk of the user benefits being removed while the owner owns the car. This may increase the loss and the owner misses out on the available user benefits. A new trend is in the direction of a future market for 'premium' (more luxurious) small cars. The BMW i3 Electric car is as an attempt to explore this market niche.

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Table 26: Review of means/incentives for promotion of Electric vehicles.

Incentive	Introduced	Importance	Evaluation
VAT exemption	2001	++	EV's are more expensive to produce than traditional vehicles causing VAT to be higher. A 12 500 € price increase of the vehicle results in a 3125 € increase in VAT making the vehicle 15 625 € more expensive to the consumer. This would actually increase government income unless the VAT is exempted. The Exemption in Norway has evened out the price difference between EV's and conventional cars.
Access to bus lanes	2003/2005	++	Very efficient in regions with large rush-hour delays in the traffic. The disadvantage is that only a limited number of vehicles can use the bus lane before buses are delayed. There is a risk of increased vehicle ownership if people drive an EV in the bus lane rather than taking the bus. Minibuses were banned from the bus lanes in 2009, leaving EV's as the only vehicle type consumers can buy to get access to bus lanes.
Exemption from registration tax	1990/1996	+	The exemption from the registration tax was introduced temporarily in 1990, and permanently from 1996. It was based on the value of the car and the exemption was very important to initiate test programs in the 1990s. Today this tax is totally changed and most EV's with a weight below about 1540 kg would anyway get a zero tax, given the way the tax system works. Examples of tax on gasoline vehicles: VW Up: 2 600 -3 600 €. VW Golf typical taxes: 5 600-9 400 €. The tax on these competing vehicles makes the EV's more competitive.
Free parking	1999	+	Effective where parking space is limited. A limited number of places are available and many have a time limit. Little influence on the total number of EV's unless parking spaces are converted to EV parking on a larger scale.
Free toll roads	1997	++	This measure has a large impact when the toll roads are expensive. This is the case many places in Norway. In the Oslo-area the costs are 600-1 000 €/year for commuters. Some places in Norway there are tolls exceeding 2 500 €/year, resulting in EV sales in unexpected areas such as small Islands with underwater tunnels to the mainland.
Reduced annual vehicle license fee	1996/2004	+	Three rates apply for private cars. EV's and hydrogen vehicles have the lowest rate of 52 € (2013-figures). Conventional vehicle rates: 360-420 €.
Reduced rates on ferries	2009	0	Not important up to now, few use it and the value of the incentive is limited.
Reduced imposed taxable benefit on company cars	2000	0	This incentive had little impact up to 2012 but might be more important from 2013 for the sales of Tesla Model S. This should be an attractive company car, given its long range and the free of charge supercharger network put in place by Tesla in Norway.
Financial support for charging stations	2009	+	Reduce the economic risk for investors establishing charging stations, and the range issue for EV owners is alleviated as they can charge the vehicles during a longer trip. Contributes to expansion of the EV market, and aids in get more EV miles out of every EV. The EV alternative becomes more visible to the population.
Fast charge stations	2011	+	Fast charging increases the EV miles driven and the total EV market. It becomes easier for fleets to use EV's and is a premise for using EV's as Taxis.
Reserved EL number plates	1999	+	Increases visibility and makes other incentives easier to control, i.e. free parking, exemption from toll road charges.

The Tesla Model S is a large Electric vehicle that in many ways fits into the luxury market, and thus represents a return to the traditional pattern of technology introduction in the automotive industry. Tesla started with an electric sports car, the Tesla Roadster, which received much attention, continues with the luxury model Model S, ahead of the planned 2017 launch of a midsized car with a more 'reasonable' price to be manufactured in large volumes.

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The question may be asked as to how it was possible for a technology to be subject to so many incentives over the years. In the first years it was argued that unreasonable disincentives had to be removed. The most important of these was the vehicle registration tax, then based on the sale value of the car. This made Electric vehicles unreasonably expensive, because they were more expensive than petrol powered cars in the first place, and were given higher fees and on top of that, VAT was calculated on the total of the sales value and the registration tax. Total cost of the vehicle thus became prohibitive and in practice, the system made it impossible to import and sell Electric cars in Norway. There were similar problems with safety. For example, a deduction on the registration tax for airbags and ABS equipment, was introduced so it would be possible to bring these technologies into use in Norway. The system became unmanageable and was replaced by a weighted tax on engine capacity, engine power and vehicle weight from 1996. From 2007 engine volume was replaced by CO_2-emissions.

In 2009 the Resource Group for the electrification of road transport (Ressursgruppe 2009) stated that further incentives were necessary to get Electric vehicles on the road in sufficient numbers. Electric vehicle sales at the end of 2012, proves that it was not necessary a matter of too few incentives behind the low sales until 2009, it was most likely due to the lack of attractive cars in sufficient volumes. When attractive cars finally came, thanks to the incentives available, the market in Norway has taken off in a way that other countries have not come close to. There are still some actors wanting even more new incentives for Electric cars in Norway, but it is hardly the political will as long as sales continue to go as well as today. Politicians have protected the financial incentives for the parliamentary period ending in 2017 (in practice until the central government budget for 2018 is launched in October 2017). Nevertheless, user incentives can be changed before then, but only in consultation with local authorities. The area in which it is likely that there will be increased efforts, is within supporting development of infrastructure for recharging.

In practice, hydrogen vehicles have the same incentives as Electric vehicles. Plug-in Hybrid cars have no special incentives but fares relatively well in the registration tax system. They have low CO_2 emissions providing large deductions from the calculated weight tax and engine power tax. The weight deduction prior to calculation of the weight tax on Plug in hybrid vehicles, was increased to 15% from 31.06.2013, before it was 10%. The electric engine power is not considered in the calculation of the engine power tax, only the power of the combustion engine. The rules for charging stations have changed, so that Plug-in Hybrid cars are now allowed to use charging stations.

The free of charge charging stations in the Oslo municipality make it difficult to establish commercial activity. However, Oslo is a special case. Most counties, municipalities and Transnova, that provide support for the establishment of charging stations, assumes no responsibility for operations as Oslo does.

Many places charging stations are established to entice customers. The offer is then either free or included in the cost of parking. The investment cost for the charging stations is often partially or fully covered by grants from the municipality, county or Transnova. Some also cover the costs themselves.

A challenge for commercial operations, is that the value of the electricity that is used when recharging the car is low. If it is charged with a power of 3 kW, it is in the range of 0.25-0.37 € per hour in terms of the value of electricity sold, a maximum of about 9 € per day if vehicles are recharged all the time. There are also legal limitations

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on who is authorized to distribute and sell electricity in Norway. However, taking payment for parking, with electricity costs included in the price is entirely possible. The solution chosen by Oslo, where the municipality stands for the operation of free of charge charging stations, can be unfavourable as it in practice closes out private operators. A better solution is when the authorities support is limited to covering part of the investment cost of recharging stations, not its operation. For fast charging, a grant will be given to cover part of the costs of establishment, but no grants are given for its operation. Many quick recharging stations have been available for free in the early stages when the technology has been tested, but most now have established payment solutions. It is expected that fast charging will become a commercial business in the long term.

10.8 Cost of incentives – overall assessment

There has not been made an overall economic cost-benefit analysis for the various incentives for increasing the use of Electric vehicles. Table 27 shows a compilation of the available information regarding estimated costs of the various incentives in Norway.

Table 27: Estimate of cost/value of government economic incentives for increased use of Electric vehicles in Norway.

Incentive	Per car	Number of cars	Estimated cost in NOK/year	Comments
Annual licence fee	Electric cars 51 € Petrol 360 €	Approx. 15,000	Approx. 4.6 million €/year	Can be covered by increasing the rates for petrol and diesel cars.
VAT exemption	Average purchase price approx.27,500 €, VAT would have been 6,875 €	Approx. 6,000	Approx. 41.3 million €/year	Electric vehicles are more expensive than other cars, and VAT would thus have been considerably higher for an Electric vehicle than a comparable petrol vehicle.
Vehicle registration tax exemption	Today's typical Electric cars would have cost of 0 €. Similarly, small petrol cars have a registration tax of 2,500-3,100 € (VW Up), for a compact car this could be 5,600-9,400 € (VW Golf)	Approx. 6,000	No cost. Alternatively, it can be roughly estimated that the Government loses 5,600-9,400 €€ per Electric vehicle purchased instead of a petrol car (assuming a compact EV is the average EV, and the tax on average is as for the VW Golf). The cost then becomes approx. 34-56- million €/year.	Tesla Sedan S would have been given a positive fee of about 6,500-13,000 € due to heavy weight. For other Electric vehicles the deduction for the CO_2 proportion will compensate for the weight tax. Engine power tax only applies to internal combustion engines.
Reduced imposed benefit tax on Electric vehicle	Half of ordinary vehicles, may be around 2,000 € per year depending on car and income	600? (The Electric Vehicle Associations owner survey suggest that 4% of EVs are company cars)	Approx. 1.2 million €/year	Probably applicable to very few cars.
Lost fees on energy use for Electric vehicles (Assumpotions: EVs 0,2 kWh/km, petrol vehicles 0,6 litre/km, 13000 km/year	544 €-98 € = 457 €Year	Approx. 15,000	Approx. 6.9 million € per year	Electricity cost; with fees 0.13 €/kWh, without fees 0.09 €/kWh Petrol fees: 0.6 €/litre CO_2-charge on petrol 0,11€/litre

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As previously mentioned, the government will be able to compensate for the reduced income from taxes, by increasing rates for those who pay, or by increasing taxes and other charges in general. Assuming that this is what happens in practice, the estimated cost will rather be a measure of how large the distributional impact on the economy will be as a result of the Electric vehicle policy, not an estimate of reduced revenues.

Table 28 provides an overview of different local incentives aimed at users of Electric vehicles. There is no basis on which to calculate the total national cost, as it is not known to what extent the various incentives are used on average nationwide. There are also local differences between the municipalities in terms of the value of the incentives. When it comes to the exemption from parking fees, this only applies to public parking spaces. It has been estimated what owners of parking spaces would lose if such a scheme was applied also to private parking spaces, (Eriksen and Hansen 2010). In Oslo the losses would be significant, while they would be of little significance in a small town like Sarpsborg.

Table 28: Overview of costs/value of user-related local incentives.

Incentive	Per car	Number of cars	Estimated cost NOK/year	Comments
Free national highway ferries	Electric cars are free, drivers pay varying fees, so this is essentially a rebate.	Unknown	Probably low, but could be of local importance.	Probably applies to few vehicles. Ferry fares are determined by the government. May be set at a higher rate for those who pays in order to keep the revenues constant.
Access to bus lanes	No direct cost as available capacity is utilised.	Unknown, the numbers found are from 2009, but must be considered obsolete due to sales growth.	Can be said to be a subsidy that could be given to other road users such as goods transportation.	No cost as long as there is available capacity, but benefits to society may be higher for alternative use of the spare capacity.
No road toll charge	Oslo: approx. 1,000 €/per year, 3.4 € per vehicle entering the Oslo congestion toll charge area, 1.7 € per vehicle passing through Bærum toll charge area with rebate by subscription.	In June 2013, around 2,900 Electric vehicles per day passed through the Oslo toll charge area, and on average around1,600 through the Bærum congestion toll charge area, total volume in Norway is unknown.	Probably significant subsidies given the large number of toll stations in Norway. In Oslo and Bærum in 2013: approx. 4-5 million €.	Paid by other road users, because the tolls will remain for longer, or rates will increase, or there will be road construction delays, given that a total amount of money is to be collected to finance the projects.
Free parking in public parking places	Varies.	Unknown	In municipalities with limited parking areas this can be a significant incentive.	Municipalities are losing revenue. The benefit depends on whether there is parking with recharging where vehicles can stand all day, and be used as workplace parking, or if there is a 2-3 hour time limit.

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11 Summary and conclusions

11.1 Situation in Norway

Norwegian Electric vehicle policy has made the purchase of Electric cars economically feasible, and their use attractive. Norway is best placed on a global scale in terms of the number of Electric vehicles relative to population. The Electric car has received a positive reputation amongst Norwegian citizens. There has been sustained political interest and lobby organizations have always had a presence in the debate, and have pushed for better incentives for Electric cars, which has been successful. Over time there have been various organizations and different politicians who have been active. In the beginning it was the energy companies and environmental organizations like Bellona, and the municipality of Oslo. Later it became the Electric vehicle industry and their owners, while it is now the car importers, environmental organization Zero, and consumer organizations that are most active.

In the beginning of the 1990s it was local air quality, energy efficiency and increased use of Norwegian electricity that, were highlighted as the benefits of the Electric vehicle. During the period in the 2000s where it seemed it might be possible to build a Norwegian Electric vehicle industry, ensuring that this had a strong home market was a weighty argument put forward in the fight for better incentives. From the late 2000s onwards, it went on to be argued that the use of Electric vehicles is an effective mitigating measure for climate action. It is still the main driving force in Norwegian politics regarding Electric car engagement, but local air quality has also received renewed interest with the present difficulty of compliance with EU requirements on local air quality in Norwegian cities.

Most Norwegians probably perceive electricity as a clean and environmentally friendly option, as virtually all Norwegian electricity is produced from hydropower. It has also been many years since large hydropower plants were built. These power plants were accompanied by the development of major infrastructure such as dams, power lines as well damage to natural habitats (rivers were drained, areas were flooded), causing conflicts locally. Norwegians are probably not so aware of this side of hydroelectric power now a days.

The Electric Vehicle Association has established itself as an active operator with four employees, which benefits from all car dealers including a one year membership to the Association for those who purchase Electric vehicles. They are both lobbyist and assists its members in getting the most out of their Electric vehicles. They are also active in recruiting new members and Electric vehicle drivers, arranging ride and drive activities for testing Electric vehicles. They collate statistics and provide an overview of all available recharging stations in a format that can be used by modern GPS devices. They also facilitate the exchange of experiences between Electric vehicle owners, and from Electric vehicle owners to prospective buyers, via websites and Electric vehicle forums where the advantages, disadvantages and challenges of Electric vehicles are the subject of lively discussion.

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Through the establishment of Transnova it has been possible to fund charging station development, and various test and demonstration projects in many local municipalities and businesses. The energy industry has become financially involved in the business of charging infrastructure for Electric vehicles, through grants from Transnova for establishing fast charging stations. Transnova finance operations for the Grønn Bil organization, which aims to promote Electric vehicle use in municipalities and enterprises fleets of cars. The company has two full-time employees and informs through website, meetings and conferences etc.

Access to bus lanes has clearly had a decisive effect in the initial phases of the Electric vehicle market development. It explains for example, the high proportion of Electric vehicles in Asker municipality. Some places, the exemption from road tolls has been an important driving force. This especially applies to road toll stations where the annual cost has been over 2,500 €, for example, the undersea tunnels to the islands/fjords in the west of the country. Sales started from 2012 to spread to areas where these incentives cannot be the main factors explaining increased Electric vehicle sales.

11.2 Strong competition and Electric vehicles for most people

It is possible that the long and sustained interest in Electric cars is contributing to the positive development of Electric vehicle sales in Norway compared to other countries. Norway has had a small group of Electric vehicle pioneers who were enthusiastic in terms of the technology, and have been at the forefront among the customers of the new Electric vehicles coming onto the market. A study of the Electric vehicle phenomenon indicates that those who purchase Electric vehicles identify with the technology and the concept, and to a large extent will remain an Electric vehicle owner. It can be assumed that these people also act as ambassadors for the technology, both in their circles of family and friends, as well as in the community. This contributes to diffusion of the technology. This might be a contributory and explanatory factor as to why Mitsubishi sold so many Electric cars right after the market introduction, to people who had not previously owned an Electric vehicle.

Today Electric vehicles are a common sight in Oslo. Electric vehicles are sighted regularly on travels. This is also very influential. In parts of the Oslo press and local newspapers in the surrounding municipalities of Asker and Bærum, the car dealers have regularly run full-page ads for the sale of Electric vehicles over the past two years. There has also been advertising on commercial television channels.

The Electric vehicle market in Norway today is in many ways a highly competitive market, in which vehicles are sold mainly to private individuals. In 2013 it may also appear that both the private car fleets and the public car fleets are becoming more aware of Electric vehicles, with a large tender from Oslo for up to 1 000 Electric vehicles over three years, amongst others. There is a high level of creativity in marketing and various business models are being tested. Vehicle importers and dealers are now viewing the Electric vehicle market as attractive and want to get a share of it.

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There is also development and positioning in the market for fast charging stations. There is little money to be made so far, but the operators seem to assume that well positioned fast chargers can provide income in the long term.

11.3 Norway will encounter challenges in the phasing out of incentives

Norway will encounter challenges in the phasing out of Electric vehicle incentives in a controlled manner. The incentives are so extensive that to remove all of them would destroy the market completely. The most difficult incentive to remove is the exemption from the value-added tax (VAT), which will add 6,250 € to the price tag if a vehicle without VAT costs NOK 25,000 €. The most attractive usage incentive is access to bus lanes which will phase itself out. When the lanes are full, Electric vehicles will need to be taken out, otherwise the buses won't be able to move. The point at which Electric vehicles are selling well throughout the country, will gradually enable the removal of local user incentives in towns, without it involving too great a risk of destroying the market for Electric vehicles.

This is a difficult balancing act. Electric vehicles are desirable in cities because of the greatest additional benefits of less air pollution and noise and each fast charging station can service a large population. On the other hand, Electric cars should replace petrol and diesel cars and not public transport, walking or cycling. Access to bus lanes, may to some extent make it more attractive to purchase an Electric vehicle than to use public transport. The combination of reduced time consumed for transport, ability to drive all the way from home to work, and the possibility of running everyday errands on the way, have most likely made the Electric vehicle more attractive for everyday use. It is also true that the bigger the Electric vehicles become, the more emphasis must be placed on the fact that Electric vehicles also uses the same physical space as conventional vehicles.

It is unlikely that Electric vehicles would be given as extensive subsidies, if the policy was developed today. On the other hand, the Norwegian example proves that Electric vehicle is attractive as long as the incentives are powerful enough,. The feedback from the users, indicate that they can get their everyday travel done using them. The question is more about whether the policy contributes to EVs becoming fully competitive in the market of the future, or whether it will become a market that requires permanent incentives.

An interesting question is also whether it is necessary for a small country to be so far ahead of other countries, in terms of the introduction of Electric vehicles. It involves greater costs over a longer time, given that it is the volumes in the large car markets in Europe, Britain, France, Italy and Germany which primarily will determine the future price and cost of EVs. So far it is only France and Norway in Europe, where large numbers of Electric vehicles have been sold.

11.4 Untapped potential in car fleets

An obvious focus for both Norway and other countries will be on getting more vehicle fleets to adopt Electric vehicles. Especially those that operate in the major cities. Vehicles used in fleets are used for specific tasks that cannot be addressed by

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public transport. They are often driven locally throughout the day, and are thus an optimal area of use for Electric vehicle technology. Paradoxically fleets are lagging behind private consumers in the use of Electric cars in Norway. Most Electric cars (76%) are sold to private individuals.

11.5 Sales of Electric vehicles will remain high in coming years

There is reason to believe that Electric vehicle sales will remain high in Norway. The potential is particularly high in multiple vehicle households in urban areas. The Nissan Leaf has established itself as one of the best sellers in Norway, and Electric vehicles have become a common sight in cities. This will have an effect on how potential car buyers will consider Electric vehicles in the future. In addition, there are several Electric cars that are to be introduced for sale, that should be attractive to the Norwegian market. This is especially applicable to Electric vehicles from Volkswagen, Ford and BMW that are strong brands in Norway, and the Tesla Sedan S may be a hit in the market for company cars. In September 2013 Tesla made it to the top of the bestseller list in the Norwegian market. Although this was partly due to deliveries of a substantial number of pre-ordered cars, it nevertheless marks a major milestone in the Electric vehicle history.

Under the Climate Policy Settlement from 2012, politicians have decided that the economic incentives for Electric vehicles should be fixed until the end of 2017. It can is also a fact that prices for Electric vehicles have fallen the last years, and it is likely that they will continue to fall further over the years. The Norwegian economic incentives were introduced at a time when the Electric car prices were much higher and the products much less developed. Thus, it seems that the incentives become more powerful over time. Earlier they did not quite compensate for the extra cost of the vehicle, but because prices have gone down EVs are now becoming cheaper than other cars. At the same time the available range of Electric vehicles will expand, and the quality and life of batteries will improve. These factors will facilitate the continued increase in sales in Norway.

Things do not look promising for the Plug-in Hybrid cars, as the market has been slow. There is evidence that increased competition will lead to a reduction in the prices of these cars in the future years. In July 2013, GM announced a reduction in the price of its Volt model by USD 5 000, when the 2014 model was introduced for sale in the US.

In autumn of 2103, Opel will run a promotional price of NOK 349 900 on the Ampera model in Norway, for a model variant that used to cost NOK 409 000.

11.6 Sales of Electric vehicles is important for reaching national environmental goals

The target that new cars should not emit more than 85 g per kilometer of CO_2 by 2020 (Figenbaum et al 2013), established in the Climate Policy White Paper from 2012, can be reached if either Electric vehicles or Plug-in Hybrid vehicles gain a significant market share. A share of up to 20% for Electric vehicles may be required, if Plug-in Hybrid cars are not gaining market share, whereas a market share of 30%

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for Plug-in Hybrid vehicles may be necessary, if Electric vehicles are unable to achieve a good share of the market. The alternative where both technologies succeeds in the market will result in lower required market shares of both types of vehicles. It is unlikely that the target can be reached without these types of vehicles being a success.

The primary means of achieving the goal will be to increase the vehicle registration tax on CO_2-emissions, making cars with high emissions more expensive. At the same time, this will also make Electric vehicles and Plug-in Hybrid vehicle more cost effective, compared to petrol and diesel cars. Over time, car buyers will have an increased choice amongst vehicles with low emissions. The proposal implies that the tax increases roughly in line with increased options, so that car buyers can choose vehicles with low emissions, and thereby avoid paying more tax.

11.7 The diffusion process has gone by the book

In Norway, many of the prerequisites for successful diffusion of Electric vehicle technology, have been met:

- There is a social system that was ready for new approaches to the climate and environmental fields, and the need is anchored in a multiparty compromise at parliamentary level. In other words, there was an adaptable system that was willing to try out new technology.
- The public scheme has not been costly for the government, and has not demanded establishment of new sources of funding. The system has therefore been able to be entirely positive towards Electric vehicle technology. Users have been given more and more reasons to purchase and use Electric vehicles, and to continue to do so.
- Authorities and organizations have been successful in capturing objections, to develop solutions to problems identified in different phases, and to communicate this to potential users.
- There have been enough early users with financial resources to take risks, and with enough social capital to influence others. This resulted in a customer base in the private market that was ready to adopt the Electric cars as they came onto the market.
- The interest of a wide range of groups has been captured, from the environment to the motorist organizations and car importers. This has provided a good and broad communication process, and many good arguments for sticking to the Electric vehicle policy.
- The sum of the incentives has made Electric vehicles interesting for several groups of buyers, not only the traditional early users ('Innovators/Early adopters).

Overall, the diffusion process meant that the innovation, i.e., the Electric vehicle, was conceived to meet the requirements that one of the classics in the field of studying innovation diffusion processes, Rogers (1962, 1995), lists as prerequisites for a successful process, c.f. Figure 1 in Chapter 1:

- *Relative advantage (Advantage):* Electric cars have many clear practical and economic benefits for users, created through economic incentives and assigned user benefits. Electric vehicles meet many everyday travel needs, but

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not all. The relative advantages are also in place on the climate and environmental side, with better energy efficiency, reduced greenhouse gas emission, no local pollution, low noise, etc.

- *Compatibility (Compatibility):* Compatibility with the norms of the social system, can be found in that electrification was communicated and perceived as an important response, and part of the solution, to a major problem locally, nationally and globally - namely greenhouse gas emissions and local air pollution. The need to boost Electric vehicle usage is firmly anchored in both the transport and environment sectors, and Government through a Climate Policy settlement across all Norwegian parties (with one exception). Electric vehicles are also, based on the relative merits, compatible with the needs of multiple user groups.
- *Complexity (Complexity):* Electric vehicle technology is not so difficult to understand, but a new style of driving and the establishment of recharging bays at home can be a challenge for some. At the same time as being a challenge, this may also be the 'trigger' for early users (*early adopters*). Complexity in the sense that Electric vehicles can cover many different purposes, can mean that several different operators may be involved in driving the project and supporting it. The story of the Norwegian Electric vehicle market, is largely based on the fact that many operators at different levels, and with different roles, run the same thing from their own sides, sustained over time. Public authorities, businesses, new and old organizations, have all been involved.
- *Opportunity to try out the new (Trialbility):* Government incentives have accurately caught this dimension. The financial arrangements made it less risky to try out the new technology.
- *Opportunities to observe innovation (Observability):* The conducting of experiments, the visibility of Electric vehicles equipped with the special number plates with EL followed by a number, are advertisements in themselves that contribute to development and progression. That the early operators are important opinion makers is illustrated by the fact that they have managed to secure increasing media interest. The tendency for certain neighborhoods to have higher proportions of Electric vehicles can also be seen. Nesøya in the Municipality of Asker, is an example of this.

11.8 Future knowledge and research needs

Electric vehicles are not a new technology; the first electrically-powered cars were already around in the early 1900s. But the new needs and problems in the environmental field formed the basis for renewed interest and innovation . It can be seen that Electric cars are now constantly evolving at an increasing pace. Furthermore, it can be seen that the increased use of Electric vehicles can also cause environmental problems. Thus, there are a number of issues not covered by the present report.

To widen distribution and use of Electric vehicles in other countries and to reach new targets, it is important to establish more knowledge about:

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- Electric vehicle owners: why they choose Electric cars, what kind or form of transport/means of transportation they used before, how the vehicles are used, how behavior changes, how many cars are at the disposal of the household etc.
- Which factors have made Electric vehicles more popular in Norway than in other countries?
- Use of Electric vehicles in car fleets, private and public.
- Small utility vehicles such as electric bicycles, transport trolleys and cart.
- How is the charging infrastructure being used, especially fast charging and how is it progressing over time?
- Recharging patterns for normal charging throughout the day.
- Is there a risk of over-establishment of fast charging stations?
- What percentage of cars have a usage pattern that can be replaced by Electric vehicles?
- What will be the impact of removing the different incentives? Here, Norway could be a good laboratory for systematic evaluation.
- Which incentives are most suitable in different countries and different social systems? It is important to try and develop incentives in other countries and evaluate these.
- Which incentives may contribute to the increased use of Electric vehicles in private and public service or commercial fleets?
- What is needed to make the Plug-in Hybrid cars more attractive?
- What are the differences between the countries where the Plug-in Hybrid vehicles are leading the electrification race, and those who are backing the usual Electric vehicles?
- How can incentives for increased electrification be adapted so as to not spur increased car usage? Can it be developed better incentives for car sharing schemes as part of the electromobility solution? Examples are Electric car sharing and car pooling with larger Electric vehicles.
- Can the current incentives be twisted in order to stimulate a change in behavior, towards more car sharing, with a view to addressing congestion and capacity problems?
- How can use of Electric vehicles be spread from the cities to more rural areas, where Electric vehicles are equally suited to local transportation needs as in the cities?

In addition to market-related Electric vehicle topics mentioned above, technological research is needed for the development of batteries, for better operation in winter, and for clarification of the consequences of the material uses for Electric cars and batteries. Electric vehicle development must be seen in the context of de-carbonizing the electricity production in Europe. Another essential area of research, if the goal of reducing traffic growth in the cities is to be achieved, is how to ensure that Electric vehicles will replace petrol and diesel cars and not public transport, walking or cycling, or cars powered by other non fossil-based fuels. Capacity and congestion problems caused by urban growth, and lack of incentives for increased car occupancy, are urban transport challenges not being addressed by a transition to Electric vehicles alone.

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12 References

Anegawa, T. undated.
Development of Quick recharging system for Electric vehicle. Tokyo Electric power company.

ASEA 2013
Overview of Purchase and tax incentives for Electric vehicles in the EU. European Automobile Manufacturers Association (ASEA). 4.4.2013. www.asea.be.

Assum, T. et al. 2012
Competitive Electric Town Transport, COMPETT. Proposal to the EU, ERA-Net + Electromobility. Transportøkonomisk institutt, Austrian Energy Agency, Vejdirektoratet Denmark.

Axsen, J., Kurani, K. S. 2012
Inter-personal influence within car buyer's social networks: applying five perspectives to plug-in hybrid vehicle drivers. Environment and Planning A, 44,5, 1047-1065.

CARB 2013 (Undated, read on CARBS website, June 2013)
Facts about California Clean Vehicles Incentives. California, California Air Resources Board. http://www.arb.ca.gov/msprog/zevprog/factsheets/clean_vehicle_incentives.pdf.

CNCDA 2013
California Auto outlook, Volume 9, Number 3, August 2013, California New Car Dealers Association.

COMPETT 2013
State of the Art of Electric Propulsion: Vehicles and Energy Supply. COMPETT, Work Package 1 Report. Transportøkonomisk institutt, Austrian Energy Agency, Vejdirektoratet Denmark.

dsb og Statens vegvesen 2013
Til deg som eier elbil. Lastet ned september 2013 fra: http://www.vegvesen.no/Kjoretoy/Eie+og+vedlikeholde/Elbil

Econ Analyse 2006
Elbileiernes reisevaner (Travel behaviour of EV owners). Rapport 2006-040. Oslo, Econ.

Econ Pöyry 2009
Virkemidler for introduksjon av el- og hybridbiler. Rapport ISBN 978-82-8232-092-4. Oslo, Econ.

Econ Pöyry og Sunlab 2012
Strategi og kriteriesett for utplassering av hurtigladere (Del 1) Econ rapport R-2012-007. Oslo, Econ.

Eimstad, M 2013
Facilitating An On-Demand Market For Mobility. Foredrag på WEVS 2013, mai 14th 2013. Oslo, Move About.

Copyright © Institute of Transport Economics 2013

Ellis, I.O., Nesse, L.S. og Norheim, B. 2012
RVU dybdeanalyser - Sammenheng mellom transportmiddelvalg, transportkvalitet og geografiske kjennetegn. UA rapport 30/2012. Urbanet Analyse.

Engebretsen, Ø. 2006
Arbeids- og tjenestereiser. Den nasjonale reisevaneundersøkelsen 2005. TØI rapport 868/2006. Oslo: Transportøkonomisk institutt.

EV project 2013
Q1 2013 report, The EV Project. http://www.theevproject.com/cms-assets/documents/113177-646795.q1-2013-rpt.pdf.

FHWA 2011
US Federal Highway Administration, http://www.fhwa.dot.gov/policyinformation/statistics/2011/vm1.cfm.

Figenbaum, E 1994
Elbiler i Norge - Brukererfaringer. Testprogram for elbiler notat 03.02.1994. Oslo, Teknologisk institutt.

Figenbaum, E. 2010
Effektivisering og elektrifisering av kjøretøyer og anvendelse av hydrogen som energibærer. Arbeidsnotat, Vedlegg til sektortrapport om transport, 17 feb. 2010. Kimakur. Oslo, Statens vegvesen.

Figenbaum, E. Et al. 2010
Klimakur. Sektoranalyse transport. Tiltak og virkemidler for redusert utslipp av klimagasser fra transport. Oslo, Statens Vegvesen og KLIF (Klima-og forurensningsdirektoratet).

Figenbaum, E. 2013
Elbiler i Norge. TØI arbeidsdokument 50347. Oslo, Transportøkonomisk institutt. (Ikke offentlig).

Figenbaum, E. og Amundsen, A. 2013
Ladestasjoner. Tiltak i www.tiltakskatalog.no. Oslo, Transportøkonomisk institutt

Figenbaum E. og Kolbenstvedt, M. 2013
Elektromobilitet i Norge – erfaringer og muligheter med elkjøretøy. TØI rapport 1276/2013. Oslo, Transportøkonomisk institutt.

Figenbaum, E., Eskeland, G. S., Leonardsen, J. og Hagman, R. 2013.
85g pr kilometer i 2010. Er det mulig? TØI rapport 1264/2013. Oslo, Transportøkonomisk institutt.

Finansdepartementet 2012
Skatter, avgifter og toll 2013. Statsbudsjettet 2013, Prop. 1 LS (2012-2013. Godkjent I statsråd 28. September 2012.

Ford Media 2013
Ford Finds 60 Percent of Plug-in Vehicle Trips Are Gas-Free; Ford App Continues to Evolve EV Owner Driving Habits. Pressemelding fra Ford USA 29. juli 2013.

Fridstrøm, L. 2012
Green House Gas Abatement in the Norwegian Transport Sector. TØI arbeidsdokument 50277. Oslo, Transportøkonomisk institutt.

Fyhri, A. m fl 2012
Søknad Innosykl -prosjektet. Oslo, Transportøkonomisk institutt.

Fyhri, A. 2013
Elsykling. Tiltak i www.tiltakskatalog.no. Oslo, Transportøkonomisk institutt.

Copyright © Institute of Transport Economics, 2013

Gallup 2013
Klimakompass 2013. Oslo, TNS Gallup. Pressemelding.

Hagman, R. 2013a
Rekkevidde. TØI Rapport for Nordiske ministerråd. (Under arbeid).

Hagman, R. 2013b
Preliminære resultater fra prosjektet RekkEVidde. Presentasjon Ciens dagene 2013. Oslo, Transportøkonomisk institutt.

Hagman, R 2013c
Miljønytte og kostnader - ladbare hybridbiler. TØI arbeidsdokument 50391. Oslo, Transportøkonmisk institutt.

Hagman, R. Assum, T., Amundsen, A. H. 2011
Strøm til biler (Electricity for cars). Oslo, TØI rapport 1160/2011. Oslo, Transportøkonomisk institutt.

Hagman. R. og Assum, T. 2012
Plug-in Hybrid vehicles. Exhaust emissions and user barriers for a Plug-in Toyota Prius. TØI Report 1226/2012. Oslo, Transportøkonomisk institutt.

Hagman R. og A. Amundsen 2013
Utslipp fra kjøretøy med Euro 6/VI teknologi. TØI rapport 1259/2013. Oslo, Transportøkonomisk institutt.

Hagman, R. og Kolbenstvedt, M .2013
Elektrifisering av bilparken. Tiltak i www.tiltakskatalog.no. Oslo, Transportøkonomisk institutt .

Haugneland, P. 2012
Medlemsundersøkelse elbilforeningen august 2012. Foredrag på WEVS 2013, 14 - 15th May. Oslo, Norsk elbilforening (www.elbil.no, 4. sept. 2012).

Halsør, T.S. Myklebust, B. og Andreassen, G.L. 2010
Norges satsing på Elbiler, hydrogenbiler og ladbare hybrider. Oslo, Zero, Tekna.

HBEFA 2010
Handbuch für emissionfaktoren des strassenverkhrs (hbefa) (handbook of emission factors for road traffic). Utslippsdatabase. Versjon 3.1. Publisert som programvare på CD-ROM. Infras AG, Bern, Available from: www.hbefa.net.

Hjorthol, R. 2012
Endring i befolkningens reisevaner i en 25-årsperiode - trender og drivkrefter. TØI Rapport 1190/2012. Oslo, Transportøkonomisk institutt.

Hjorthol, R. 2013
Attitudes, ownership and use of Electric Vehicles - a review of literature. TØI Report 1261/2013. COMPETT, Work Package 2 Report. Transportøkonomisk institutt, Austrian Energy Agency, Vejdirektoratet Denmark.

Hoen, F., S. 2012
Elbil og transportbehov. Spørreundersøkelse for Profero AS. Rapport 09.01.2012. Trondheim, Sentio Research AS.

Holtsmark, B. 2012
Elbilpolitikken - virker den etter hensikten? Oslo, Samfunnsøkonomen 5, 2012.

Klimaforliket 2012
Innst. 390 S (2011-2012), Innstilling til Stortinget fra energi- og miljøkomiteen.

Copyright © Institute of Transport Economics 2013

Klimakur 2010
KLIF, NVE, SVV, Oljedirektoratet, SSB, Tiltak og virkemidler for å nå norske klimamål mot 2020, KLIF-rapport, TA2590/2010.

Klimameldingen 2012
Meld. St. Nr. 21 (2011-2012), Norsk Klimapolitikk .

Kløckner, C.A., Nayum, A. og Mehmetoglu, M. 2013
Positive and negative spillover effects from Electric car purchase to car use. I: Transportation Research Part D 21(2013) 32-38. Trondheim, NTNU.

Lataire, P. et al. 2003
Electrically assisted bicycles: demonstration, characteristics, health benefit Review E:Tijdschrift E, 119 (3) 32-39.

Mathiesen, T.A., Solvoll, G. og Smith, K.H. 2010
Bruk av elbiler. Forventninger og tilfredshet. SIB rapport 6/2010. Bodø, Høyskolen i Bodø, Senter for Innovation og Økonomi

Michelin 2013 a
Intervjuundersøkelse om dekk og bilbruk. Datautskrifter fra PFM Research. Michelin Nordic, Oslo.

Michelin 2013 b
Penga rår når nordmenn kjøper elbil. Michelin Nordic. Pressemelding Oslo 10.6.2013.

Miljøverndepartementet 2012
Norsk klimapolitikk. Meld. St. 26 (2012-2013) Oslo.

Mitsubishi 2012
i - MiEV. Standardrapport. Kjøperunderøkelse 2012. Internt notat. Oslo.

NAF 2012
NAFs medlemsundersøkelse. Spørsmål om elbilkjøp. Internt notat. Oslo.

Nivi analyse og Urbanett analyse 2010
Transnova - Virkemiddelbruk og organisering. Rapport november 2010. Oslo, Nivi analyse as og Urbanet Analyse.

Norbakke, S. og Hansson, L. 2009
Mobil med bil. Bilens rolle for bevegelseshemmedes mobilitet, velferd og livskvalitet. TØI rapport 1041/2009. Oslo: Transportøkonomisk institutt.

Oslopakke 3 2013
Politisk referansegruppe, presentasjon 7. feb 2013, Oslopakke 3 sekretariatet.

OVF 2013
Salgsoversikter. Oslo, Opplysningsrådet for veitrafikken.

Pearre, N. S. et al. 2011
Electric vehicles: How much battery life range is required for a day´s driving?, Transportation Research Part C 19 (2011) 1171-1184.

Ramjerdi, F. Rand, L, Sætermo, I.A. og Ingebrigtsen, S. 1996
Car ownership, car use and demand for alternative fuel vehicles. TØI-rapport 342/1996. Oslo, Transportøkonomisk institutt.

Rasmussen, I. 2011
Virkninger av endringer i insentiver for kjøp og bruk av ladbare biler. Vista Analyse AS rapport 2011/30. Oslo, Vista Analyse.

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Ressursgruppe 2009
Handlingsplan for elektrifisering av veitransport. Rapport fra ressursgruppe nedsatt av Samferdselsdepartementet.. Notat, Oslo.

Rogers, E. M. 1962
Diffusion of Innovations. ISBN 0-612-62843-4. Glencoe Free Press.

Rogers, E. M. 1995
Diffusion of Innovations. ISBN 0-7432-2209-1. New York, Free Press.

Rødseth, J. 2009
Spørreundersøkelse om bruk av og holdninger til elbiler i norske storbyer. Notat 2009-11-07. Trondheim, Asplan Viak AS.

Samferdselsdepartementet 2013
Nasjonal transportplan 2014-2013. Meld. St. 21 (2011-2012), Oslo.

Sandberg Eriksen, K. 2010
Gratis parkering for elektrisk drevne motorvogner. Beregning av inntekststap for eiere av parkeringsplasser. TØI rapport 1093/2010. Oslo: Transportøkonomisk institutt.

Sandèn, B. red. 2013
System Perspectives on Electromobility 2013. Chalmers University of Technology. ISBN 978-91-980973-1-3, Gøteborg.

Schelling, T. 1971
Dynamic Models of Segregation. Journal of Mathematical Sociology 1, 143-186.

Schelling, T. 1978
Micromotives and Macrobehaviour. New York & London, Norton & Company.

SFT 2007
Tiltak for reduksjon av klimagassutslipp i Norge. Delnotat om virkning av mulige tiltak for reduserte utslipp fra kjøretøy. Statens forurensningstilsyn (SFT).

Simons, M. Van Es, E. og Hendriksen, I. 2009
Electrically assisted cycling: a new mode for meeting physical activity guidelines? Med Sci Sports Exerc. 2009 Nov;41(11)

Skavhaug, G. K. 2013
Elbil og dekning av transportbehov. Spørreundersøkelse for Transnova. Rpport 05.09.2013. Trondheim, Sentio Research AS.

SSB Statistisk Sentralbyrå 2010
Statistikkbanken, http://statbank.ssb.no/statistikkbanken/ Default_FR.asp?PXSid=0&nvl=true&PLanguage=0&tisside=selectvarval/define.asp&Tableid=03153 (sett januar 2011).

SSB Statistisk Sentralbyrå 2012
Statistikkbanken. Statistikkbanken kildeTable 07305. Oslo, Statistisk Sentralbyrå.

SSB Statistisk Sentralbyrå 2013
Folke og boligtellingen 2011. Oslo, Statistisk Sentralbyrå.

Statens vegvesen 2010
Klimakur. Sektoranalyse transport. Tiltak og virkemidler for redusert utslipp av klimagasser fra transport. Arbeidsnotat. Oslo.

Statoil Fuel and Retail 2012
Undersøkelse om transportvalg framover. Datautskrift fra Respons Analyses forbrukerpanel. Stavanger.

Copyright © Institute of Transport Economics 2013

Think Nordic 2004
Why Think Nordic believes that BEVs are part of the future? v/Christian Bech. Presented at the 2004 European El-Drive Transportation Conference & Exhibition on Urban Sustainable Mobility is possible now.

Transnova 2012
Transnova for bærekraftig mobilitet. Prosjektrapport etter 3 år. Trondheim 2012.

Transportøkonomisk institutt 2010/2013
Tiltakskatalog.no Transport, miljø og klima. Nettbasert håndbok. www.toi.no.

Vågane, L. 2012
Fra A til B (via c). Reiselementer, enkeltreiser og reisekjeder. TØI rapport 1199/2012. TØI. Oslo: Transportøkonomisk institutt .

Vågane, L., Brechan, I. og Hjorthol, R. 2011
Den nasjonale reisevaneundersøkelse 2009 - nøkkelrapport, TØI rapport 1130/2011. Oslo, Transportøkonomisk institutt.

Vågane, L., Hjorthol, R., Brechan, I., Denstadli, J.M. og Fyhri, A. 2012
Reisevaneundersøkelsen 2009 - Faktaark. Oslo, Transportøkonomisk institutt.

Vågane, L. 2013
Den nasjonale reisevaneundersøkelse 2009 - Egne kjøringer for reiselengder flerbileiere 2013. Oslo, Transportøkonomisk institutt.

Holstmark, B. 2012
Virker elbilinsentivene etter hensikten? Samfunnsøkonomen nr. 5 2012.

Zelenkova, Nina 2013
What are the motives for Owning an Electrical Car for an Individual in Oslo? SUM Dissertations Theses. Oslo, Center for Utvikling og Miljø, Universitetet i Oslo.

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APPENDIX I: The SEVS Way - June 2013

Project owner: Anne Nilsson-Ehle
Project manager: Else-Marie Malmek

Understanding what shapes the future transport industry

The question is not which solutions that *can* be realised, the question is which solutions that most likely *will* be realised - and why. Yes, there are many ways that we can solve the current problems of electrical vehicles and relieve some of the CO_2-burden of the transport system - but does that mean that electro-mobility will happen on a large scale? And if it does happen, will climate change or customer demand be the main driving force or is it rather city planning that will pave the way?

In order for the transport industry to prepare for future challenges, technical analysis or customer focus groups are not enough. The transport of people and goods in urban areas are part of the society as a whole. To understand such complex systems we need tools that look at the whole system, tools that at the same time help us identify and focus on the most important factors and interconnections in this system. And we need people with different competence and background working together.

By using such tools and groups, one can reach conclusions like “Micro cars will not score if it’s up to the customers”, or “The patrons of private cars will be children, summer houses and recycling centrals”, or why not “Electro-mobility - who cares?” But more important than the conclusions themselves, is what lies behind these early examples of conclusions.

SEVS 2 (Safe, Efficient Vehicle Solutions) is a two-year project (2012-2013) with some 20 participators from the industry, academia and public sector and with funding from the FFI-program (Vehicle strategic research and innovation). The purpose is to “strengthen the Swedish automotive industries ability to analyse and address complex global societal and technological challenges related to the transition to a sustainable mobility and transport system by 2030+”.

With SEVS we try to avoid some of the problems that more or less monolithic methods will encounter:

- That transport systems cannot be analysed separated from the rest of society, since it is interconnected with all other parts, i.e. a so called wicked problem
- That single experts or organisations have difficulties keeping a wide enough perspective
- That we as people are having a problem to free our minds from ourselves and the present, as well as including more than one objective in an analysis.

SEVS is based on the need for tools that help us in thinking new, thinking structured and combining different expertise. The SEVS tools include:

- A **Driving force model** that structures complex interactions and enable the discussion of mechanisms
- **Use cases** with selection criteria of key actors that allow structured discussion of demands and if, and how, they may change (e.g. the Anderson family living in a Gothenburg suburb and Kurt’s bakery close to the city centre), as well as possible transport solutions.

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- **Scenarios** that help us think more freely, to take a step out of ourselves and out of today and to combine pieces of results. The four scenarios from SEVS 1 have been further developed in SEVS 2.
- A model for analysing relative **sustainability** in all three dimension for the solutions that plays out in the different scenarios

Note that these tools are not simulation programs. They are models and methods to be used by groups of people in order to reach insights in driving forces of change, development mechanisms (Lock-in, tipping point etc.), vehicles and how they are used, life style and values, business models and, not least, a holistic picture of transport in a societal context. Also note that different groups will reach different kinds of results depending on the organisations and people involved and the questions asked.

The SEVS 2 has used the "electro-mobility journey", based on the "difficult questions" put by the industry, to develop and test the tools. We have built use cases for personal mobility and transport of goods to analyse how different solutions plays out in different scenarios. This means that the models include content (i.e. possible transport solutions, selections criteria, prerequisites etc.) that can be utilised in other analysis - if applicable, of course. When the project ends in late 2013, we will also have performed the sustainability analysis and identified how the variables in the model differ between a city like Gothenburg and a city like Shanghai.

We will also have defined which actors can, and need, to do what on the journey to sustainable transport systems in the cities. What can be put in production today, **what need more research,** what need to be addressed by policy makers etc.

SEVS will thus deliver answers and identify actions, as well as - and most importantly - tools for others to use. We will therefore perform presentations workshops within our partner organisations as well as for external actors. We are also looking for ways to make the documentation of the tools interactive. The more they are used, the better. Every project, group or organisation that use the SEVS tools (and can disclose the results) will contribute to the collective data bank of experiences and analysis that this project has laid the foundation of.

The large and multidisciplinary SEVS project team has an advantage, being the first to use (as developers) the tools. Development of competence among project members was also one of the goals of the project - an important payback for the many hours invested by the partners. And talking about competence, one of the meta-knowledge that the project has produced is competence about competences, i.e. which competences that are needed to address certain "difficult questions".

But what about the conclusion that no one cares about electro-mobility? Firstly, one needs to challenge widespread truths, which is something the SEVS tools are made for. Secondly, one has to look at which actors do the key decisions. In this case it is the vehicle buyers, and they really don't ask for electro-mobility for its own sake. But there may be indirect reasons that may change the playground such as higher standards for city air quality or energy supply security.

If we look at the electro-mobility question using a driving force analysis, we see that climate change has slow, indirect effects on transport and that higher fuel cost will increase fuel efficiency, rather than change people's mode of transport. More pedestrian friendly cities, on the other hand, have direct effects. With car existing on pedestrians conditions, parking located further away from shops and

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with lower average speed on streets, cars will be less practical for people living in urban areas.

Using the SEVS tools, it is also possible to draw general conclusions. For example: Since transport and society has developed in a symbiosis, one will not change without the other, something the both prevent change but also imply that a new leading transport solution can shape the society. Maybe the most important conclusion - or advise - for those who need to prepare for future challenges is: You may not change, perhaps very few will - *but changes will occur anyway*…

Learn more by visiting www.sevs.se

About SEVS 2

The SEVS phase 1 project run during 2009 and 2010 responded to many important questions concerning future society, different scenarios and corresponding vehicle solutions. With the time horizon 2030+ and the four scenarios identified (eco political, radicalism in harmony, incremental development and eco individual) it became evident to the project team and participants that SEVS needed to continue.

SEVS phase 2 project runs during 2012-2013 and focuses on future transport system for goods and people challenges; in two different reference city environments (Gothenburg and Shanghai) where transportation is one part of the sustainable city solution. This involves many different actors, also outside the automotive industry, since a transition of the road transport system requires the knowledge and active involvement of many different stakeholders.

The large number of involved experts and stakeholders also leads to a need for a structured method for how to effectively perform the analysis in multidisciplinary teams. The demand for sustainable transportation solutions will reshape not only the vehicles, but also business models, development & production processes, services, technologies, education, management, partnerships, supply chain.

The main results of SEV phase 2 are:

- The SEVS tool box of models and methods for handling complexity in a structured and systematic way
- Addressing questions and issues to where (whom) they belong
- Higher/broader competence among project members
- Analysis, conclusions and answers to difficult questions

The SEVS project is run by SAFER and SHC, both national Centres of Excellence together with a wide set of partners, ranging from vehicle OEMs, academia, institutes and other business: Autoliv, Bisek, Chalmers, Göteborgs stad Trafikkontoret, Göteborgs Universitet, IBM, Innovationskontor Väst, Innovatum, Johanneberg Science Park, KTH, Malmeken, Mistra Urban Futures, Scania, SP, Volvo Car Corporation, Volvo Group, VTI. The project is funded by Vinnova through FFI (Fordonsstrategisk forskning och innovation).

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"The model of four scenarios from SEVS phase 1 has been further developed and are together with the driving force model, use cases with selection criteria of actors and sustainability analysis some of the tools delivered by the SEVS 2 project"

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The SEVS project: www.sevs.se

SAFER, a platform for open innovation: www.chalmers.se/safer

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APPENDIX II: Overview of purchase and tax incentives for Electric vehicles in the EU

This table provides an overview of the incentives that are granted in the Member States of the European Union for the purchase and use of electric and hybrid Electric vehicles including plug-in hybrid and conventional hybrid vehicles. Unless specified otherwise, the term “Electric vehicles” refers to vehicles that are powered exclusively by an electric motor.

The incentives that are listed here relate only to the vehicle itself. Additional incentives may exist in certain counties for the installation of the necessary recharging infrastructure.

More details regarding motor vehicle taxation in the European Union and other major markets can be found in the ACEA Tax Guide (available on www.acea.be).

COUNTRY	INCENTIVES
AUSTRIA	Electric vehicles are exempt from the fuel consumption tax and from the monthly vehicle tax. Hybrid vehicles and other alternative fuel vehicles benefit from an additional bonus under the fuel consumption tax. This fuel consumption tax (Normverbrauchsabsage or NoVA) is levied upon the first registration of a passenger car. Under a bonus-malus system, cars emitting less than 120g/km receive a maximum bonus of €300. Alternative fuel vehicles including hybrid vehicles attract an additional bonus of maximum €500. This bonus regime is valid until 31 December 2014. The Austrian automobile club ÖAMTC publishes the incentives granted by local authorities on its website (www.oeamtc.at/elektrofahrzeuge).
BELGIUM	Electric vehicles are exempt from registration tax in Flanders. They benefit from the Eco-bonus (up to €2,500) in Wallonia. They pay the lowest rate of tax under the annual circulation tax in all three regions. The deductibility rate for expenses related to the purchase and use of company cars is 120% for zero-emissions vehicles and 100% for vehicles emitting between 1 and 60g/km of CO_2. Above 60g/km, the deductibility rate decreases gradually from 90% to 50%.
CZECH REPUBLIC	Electric, hybrid and other alternative fuel vehicles are exempt from the road tax (this tax applies to cars used for business purposes only).
DENMARK	Electric vehicles weighing less than 2,000kg are exempt from the registration tax. This exemption does not apply to hybrid vehicles.
FINLAND	Electric vehicles pay the minimum rate (5%) of the CO_2 based registration tax.

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COUNTRY	INCENTIVES
FRANCE	Vehicles emitting 20g/km or less of CO_2 benefit from a premium of €7,000 under a bonus-malus scheme. For vehicles emitting between 20 and 50g/km, the premium is €5,000 and for vehicles emitting between 50 and 60g/km it is €4,500. For such vehicles, the amount of the incentive cannot exceed 20% of the vehicle purchase price including VAT, increased with the cost of the battery if this is rented. For vehicles emitting less than 20g/km, this is 30% of the purchase price. Hybrid vehicles emitting 110g/km or less of CO_2 benefit from a premium of €4,000. Electric vehicles are exempt from the company car tax. Hybrid vehicles emitting less than 110g/km are exempt during the first two years after registration.
GERMANY	Electric vehicles are exempt from the annual circulation tax for a period of ten years from the date of their first registration.
GREECE	Electric and hybrid vehicles are exempt from the registration tax.
IRELAND	Electric vehicles are exempt from the registration tax VRT up to a maximum of €5,000. Plug-in hybrids benefit from VRT relief of maximum €2,500. Conventional hybrid vehicles and other flexible fuel vehicles benefit from VRT relief of maximum €1,500.
ITALY	Electric vehicles are exempt from the annual circulation tax (ownership tax) for a period of five years from the date of their first registration. After this five-year period, they benefit from a 75% reduction of the tax rate applied to equivalent petrol vehicles in many regions.
LATVIA	Electric vehicles are exempt from the registration tax.
LUXEM BOURG	Purchasers of Electric vehicles (or other vehicles emitting 60g/km or less of CO_2) receive a premium of €5,000. The purchaser must have concluded an agreement to buy electricity from renewable energy sources in order to obtain the premium.
THE NETHER LANDS	Electric vehicles are exempt from the registration tax BPM and from the annual circulation tax. Other vehicles including hybrid vehicles are also exempt from the registration tax if they emit maximum 88g/km (diesel) or 95g/km (petrol) respectively and from the annual circulation tax if they emit maximum 95g/km (diesel) or 110g/km (petrol) respectively.
PORTUGAL	Electric vehicles are exempt from the registration tax ISV and from the annual circulation tax. Hybrid vehicles benefit from a 50% reduction of the registration tax.
ROMANIA	Electric and hybrid vehicles are exempt from the registration tax.

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COUNTRY	INCENTIVES
SPAIN	Various regional governments (Aragon, Asturias, Baleares, Madrid, Navarra, Valencia, Castilla la Mancha, Murcia, Castilla y Léon, Cantabria, Catalunya, Galicia, Pais Vasco, Extremadura) grant incentives of €2,000 to €7,000 for the purchase of electric, hybrid, fuel cell, CNG and LPG vehicles. In Andalucia, the incentive is maximum 70% of the investment.
SWEDEN	Electric vehicles with an energy consumption of 37kWh per 100km or less are exempt from the annual circulation tax for a period of five years from the first registration. The same five year exemption applies to electric hybrid and plug-in hybrid vehicles that fulfill the new green car definition applied for new registrations from 1 January 2013. The new green car definition from 2013 is related to the EU Directive 2009/443, but is more stringent than the Directive. The definition is dependent on the CO_2 emission in relation to the curb weight of the car. The formula for petrol, diesel, electric hybrid cars and plug-in cars is as follows: Maximum CO_2 emission allowed=95g/km CO_2 emission + 0,0457 x (the curb weight of the car - 1372kg curb weight). Example: a plug-in hybrid car has a CO_2 emission of 70g/km and a curb weight of 1 500kg: 95 + 0.0457 x (1500-1372) = 100.8. The actual CO_2 value 70g/km is less than the calculated value 100.8 which means that the car is classified as a green car with a five year exemption from paying annual circulation tax. Moreover for both Electric cars and plug-in hybrids the electrical energy consumption per 100km must not exceed 37kwh to be regarded as a green car. For electric and plug-in hybrid vehicles, the taxable value of the car for the purposes of calculating the benefit in kind of a company car under personal income tax is reduced by 40% compared with the corresponding or comparable petrol or diesel car. The maximum reduction of the taxable value is SEK16,000 per year. From 2014 the 40% reduction will be abolished, unless there will be a change of the law. However the permanent reduction of the benefit value for electric and plug-in hybrid vehicles down to the benefit value of a comparable petrol/diesel car will be valid also from 2014. From 1 January 2012 a so called “Super green car premium” (Supermiljöbilspremie) of SEK40,000 has been introduced for the purchase of new cars with CO_2 emissions of maximum 50g/km. The premium is applied both for the purchase by private persons and companies. For companies purchasing a super green car, the premium is calculated as 35% of the price difference between the super green car and a corresponding petrol/diesel car, with a maximum of SEK40,000. The premium is paid during the period 2012-2014 and will be paid to a total of maximum 5,000 cars.
UNITED KINGDOM	Purchasers of Electric vehicles and plug-in hybrid vehicles with CO_2 emissions below 75g/km receive a premium of £5,000 (maximum) or 25% of the value of a new car or £8,000 (maximum) or 20% of the value of a new LCV meeting eligibility criteria (for example, minimum battery life range 70 miles for Electric vehicles, 10 miles electric battery life range for plug-in hybrid vehicles). Electric vehicles are exempt from the annual circulation tax. This tax is based on CO_2 emissions and all vehicles with emissions below 100g/km are exempt from it. Electric cars are exempt from company car tax until April 2015 and electric vans are exempt from the van benefit charge until that date too.

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APPENDIX III: Price history for Electric vehicles 1999 - 2013

Prices in NOK, 1 € = 8 NOK, Not adjusted for inflation

Date	Think	Kewet Buddy	Mitsubishi i-MiEV	Peugeot Ion	Citröen C-zero	Nissan Leaf	Renault Kangoo truck
Nov 1999	199 000						
Jul 2001	162 000						
2008-2010	199 000 + battery rental 975+VAT						
	285 000 with Zebra battery included.						
May 2010	244 000with Li-Ion						
1. half-year 2010		199 900 Ni-MH 144 900 Lead					
Sept 2010		169 900 Ni-MH	239900				
Oct 2010	244 000 for 2+2 seater 224 000 for 2-seater Zebra or Li-Ion						
July 2011 delivered from Nov.						255 000	
Nov 2011			219900	218 300 better battery warranty			
Jan 2012			193 000	193 000	193 000		
Sept 2012				170 000 Campaign[3]			213000+ battery rental
March 2013	Not for sale	169 900	192 800	193 300	199 000	239900[4] Better battery warranty	190000+ battery rental
June 2013			182 800	193 300	182 000	219 700 Visia 242500 Acenta 265000 Tekna	

Price without shipping/preparation (normally NOK 8000-10000 for small and compact cars).

[3] Price NOK 189 900 road-ready with shipping/preparation (approx. NOK 8 000) and winter tyres (approx. NOK 12 000).

[4] Road-ready with shipping, preparation, registration costs and winter tyres

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APPENDIX IV: Overview of Norwegian interview surveys on electromobility

Institution&publisher	Author	Report number	Client	Methode	Year	Nr of respondents	Answers	Type of sample
Gallup	Gallup	Kompass		Telephone int	1993	1000		Cross No population
TØI	Ramerdi, F m fl	TØI report 342/1996	Research Council No	Telephone int	1993	2060	68 %	Cross carowners
				SP, Panel	1994	1627	79 %	Cross carowners
TI, Techn. institute	Figenbaum, E	03.02.1994	bl Road adm, Min Trsp	Postal interveiws	1994	36	55 %	EV owners
ECON Analyse		2006-040	Min Transport	Interviews	2006	703	71,30 %	EV owners
				Interviews	2006	103	60,40 %	EV in business
Asplan Viak	Rødseth J	nov.11	Publ Road Adm	Telephone int	2009	600	25 %	EV owners
				Telef int, labtest	2009	600		Driver licence in O,B,T
HHB/SIB As	Mathiesen m fl	SIB report 6/2010		Int, GPS, Dialog	2009	29		EV in business
Zero	Halsør, T S m fl	nov.12	TEKNA	Interviews	2010	1 400		Cross members of TEKNA
TØI	Hagman, R & Assum, T	1226/2012	Toyota, Transnova	Int tlf/ pers Lab	2010	53		PHEV testcars in business
SUM/UiO	Zelenkova, N	Master thesis	Univ. of Oslo	Interviews	2010	121	61 %	EV owners
Sentio Research	Hoen, F S	jan.12		Telephone int	2011	1 000		Cross No population
TØI	Hagman, Assum, Amur	TØI report 1116/2011	Research Council No	Interviews	2011	991		Hybrid owners
NAF	NAF/Gallup	Internal material	(No Automob Society)	Net Interviews	2012	1640		Cross NAF members
NTNU	Kløckner, C A	Internatio. article		Postal interveiws	2012	372	27,30 %	EV owners
				Postal interveiws	2012	1608	13,40 %	ICE car buyers
EVcar assosiation (EF)	Haugneland, P	Lecture			2012	459	22 %	EV owners, EF members
Move About	Eimstad, M	Lecture	DNV	Net Interviews	2012	470		EV in business
RESPONS	Statoil/Respons	Internal material	Statoil Retail	Int	2012	3 000		Cross No population
Mitsubishi	Mitsubishi	Int kjøperund		Net Interviews	2012	350	70 %	EV owner I Miev
Michelin Nordic	PFM Research	Internal material	Michelin	Net Interviews	2013	1 000		Cross No population
				2000 Net Int	2013			Cross Sw&Dk population
Sentio Research	Skavhaug, GK	sep.13	Transnova	Telephone int	2013	1 000		Cross No population
TNS Gallup	Gallup	Klima Kompass		Net Int. Panel	2013	?		Cross No population
SUM Total						**20 222**		
				Int= interviews				Cross = cross-section
				SP= Stated Preferences				No= Norwegian
								O, B. T= Oslo, Bergen, Trondheim

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APPENDIX V: Distances covered by vehicle type and vehicle age

Distance covered by vehicle type and vehicle age. Average distance per vehicle. Km

	Total	0-4 years	5-9 years	10-14 years	15-19 years	20-24 years	25 years or older
Total vehicles	13 844	17 764	15 943	12 265	9 836	7 200	3 639
Total passenger cars	12 969	16 174	14 880	12 136	9 788	7 286	3 624
Passenger cars	12 856	15 657	14 918	12 166	9 808	7 351	3 631
Taxis	58 552	64 079	43 369	21 847	13 395	5 324	9 958
Ambulances	33 140	47 919	31 653	6 511	4 018	1 644	2 484
Camping vehicles	7 143	9 018	8 512	7 465	5 805	4 470	3 287
Total buses	30 973	52 453	37 697	19 405	11 670	6 162	3 749
Mini buses	12 861	28 501	21 676	14 281	10 563	5 603	4 187
Buses	39 761	54 292	41 466	24 309	13 953	7 001	3 124
Total large trucks	36 890	58 752	41 729	19 007	11 836	6 862	3 267

Source: Statistisk sentralbyrå (Central Bureau of Statistics): Statistikkbanken kildeTable 07305

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APPENDIX VI: Press release regarding new and ambitious goal of reducing greenhouse gas emissions from new cars

SAMFERDSELSDEPARTEMENTET

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Du er her: regjeringen.no / Samferdselsdepartementet / Pressesenter / Pressemeldinger / Nye og ambisiøse mål om reduksjon av klimagassutslepp frå nye bilar

Pressemelding, 29.10.2007

Nye og ambisiøse mål om reduksjon av klimagassutslepp frå nye bilar

Regjeringa går inn for nye nasjonale mål om at gjennomsnittleg klimagassutslepp frå nye personbilar skal reduserast til maksimalt 120 gram CO2 per kilometer innan 2012. I dag er utsleppet frå nye bilar i gjennomsnitt 158 g/km.

- Noreg skal vere eit føregangsland i bruken av bilar med lågare utslepp, og dei offisielle måla om reduksjon av klimagassutslepp frå personbilar er eit viktig steg i den retning. Eg er svært glad for at både styresmaktene og bilimportørane står saman om desse ambisiøse måla, seier samferdselsminister Liv Signe Navarsete.

På ein pressekonferanse måndag presenterte samferdselsminister Liv Signe Navarsete og miljø- og utviklingsminister Erik Solheim det nye nasjonale målet, som skal liggje til grunn for det vidare arbeidet med å fremje ein meir miljøvennleg transportsektor. Saman med dei to ministrane var representantar frå Bilimportørenes Landsforening, som viste fram fleire bilmodellar som har utslepp under 120 g/km.

Regjeringa har frå 2007 erstatta slagvolumkomponenten i eingangsavgifta med ein CO2-komponent, som eitt av fleire tiltak for leggje om skatte- og avgiftspolitikken for å fremje ein meir miljøvennleg transportsektor. Det gjennomsnittlege CO2-utsleppet frå nyregistrerte bilar er redusert frå 177 g/km i 2006 til 158 g/km i perioden frå januar til august 2007.

EU-kommisjonen har gjort framlegg om å innføre eit krav til bilindustrien som tilsvarer målet som regjeringa no har gått inn for. Dette forslaget er i EU-systemet, og det kan ta fleire år før eit regelverk er på plass.

- Vi vil vere i forkant av denne utviklinga, og vil leggje til rette for ein marknad for meir miljøvennlege bilar, samstundes som vi ønskjer å vere ein pådrivar i Europa i dialogen mellom styresmakter og bilindustri for å få meir miljøvennlege køyretøy på marknaden, seier samferdselsminister Navarsete.

Innsatsen til den einskilde bilførar er viktig for å få reinare biltransport. Det handlar mellom anna om å velje bilar med ein god miljøeigenskapar og å effektivisere køyrestilen slik at utsleppa vert minst mogelege.

- For å oppnå reduksjonar i klimagassutslepp frå transportsektoren må vi ta i bruk eit breitt spekter av tiltak. I tillegg til å redusere utsleppet frå nye bilar, må vi mellom anna redusere transportbehovet, utvikle alternative drivstoff og reise meir kollektivt, seier samferdselsminister Liv Signe Navarsete.

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APPENDIX VII: Accidents featuring Electric vehicles

Head-on collision on Osterøy at Bergen

A Think Electric vehicle was involved in a head-on collision with a Mitsubishi Lancer in Osterøy at Bergen in 2001. The driver and passenger in the Think vehicle came out of the accident better than the occupants of the other car, see Figure 1.

Frontkolliderte med «plastbil»

Osterøy:

Tre personer ble skadet i front mot front kollisjonen på Osterøy klokken 12.45. Best gikk det med fører og passasjer i den knøttlille, elektriske «plastbilen» Think.

AV: Gard Steiro
Publisert: 13.okt. 2001 14:38 Oppdatert: 13.okt. 2001 14:38

- Det er ganske så overraskende. Den vanlige bensindrevne bilen er totalvrak, men denne elektriske saken har det gått overraskende bra med. Jeg hadde egentlig forventet det motsatte, sier lensmannsbetjent Asle Bratholmen ved Osterøy lensmannskontor.

El-bilen av merket Think hadde skader på fronten, men selve kupeen var uskadet. Bilens karosseri er laget av termoplast. Likevel kom både fører og passasjer fra ulykken uten alvorlige skader.

Forbikjøring
Det var klokken 12.45 lørdag at føreren av en Mitsubishi forsøkte å gjøre en forbikjøring på riksvei 567 ved Hosanger kirke. Mitsubishien var på vei sørover mot Lonevåg da den frontkolliderte med den knøttlille el-bilen.

- Føreren av Mitsubishien pådro seg alvorlige skader i bein og hode. Han ble fraktet til Haukeland sykehus med legehelikopter, sier Bratholmen.

Til operasjon
Ved Haukeland sykehus får bt.no opplyst at den 24 år gamle føreren er alvorlig skadet, men at tilstanden hans er stabil. Mannen skulle ved 14.30-tiden sendes til operasjon.

Fører og passasjer i el-bilen, begge i midten av 20-årene, pådro seg kun lettere skader i ulykken.

Biltilsynet gjorde i går en rekke undersøkelser på ulykkesstedet. Veien var stengt i en kort periode etter kollisjonen.

RELATERTE BILDER

LITEN MEN STERK: EL-bilen tålte sammenstøtet bedre enn bensinbilen som ble totalvrak. FOTO: FOTO: TOR HØVIK

Figure 1: Think vehicle head-on collision. Source: www.bt.no.

Head-on collision in Hamangtunnelen in Sandvika

Sandvika is located two miles southwest of Oslo and is Norway's most congested roads. The E16 is the main road to Bergen from Oslo on which there was a head-on collision between one of the first Mitsubishi i-MiEVs, which came to Norway with a Volkswagen Transporter in February 2011. It was very slick on the road where the accident occurred. The driver survived, see Figure 2

Figure 2: Head-on collision with Mitsubishi i-MiEV in Sandvika, south of Oslo. Source: www.budstikka.no

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Collision chain on E18 in Bærum

In November 2012, a Mitsubishi i-MiEV (or equivalent Peugeot/Citröen) was sandwiched between a car and a bus in Høvik, 10 km south of Oslo. No one was seriously injured in the accident which happened in the outbound direction where there are no bus lanes. See Figure 3.

Figure 3 Collision chain involving an Electric vehicle in Bærum, south of Oslo. Source: www.budstikka.no

Another accident in bus lane on Innherredsveien in Trondheim

The accident happened in October 2009 and involved a Buddy car and a passenger car. The passenger car was turning left across an oncoming traffic lane and a bus lane. The passenger car was driving forward when the cars stopped in the oncoming field, but the driver obviously did not see the Electric car in the bus lane. The owner of the Electric vehicle made an evasive manoeuvre and ran a sign down but was not seriously injured.

Accident in bus lane on Innherredsveien in Trondheim

The story of an Electric vehicle owner:

Buddy held up!

On Friday 29 July 2011, Buddy and I experienced a harsh encounter with a Golf on Innherredsveien in Trondheim. The Golf was attempting to cross two lanes of traffic that were waiting in a queue heading east when suddenly it was propelled into the bus lane in which I was driving at about 65 km/hour. I had about 2 metres within which to react when the Golf 'popped' out in front of me. I 'twisted' the steering wheel to the right and managed to angle the Buddy somewhat - but a collision was inevitable! The sharp and narrow seat belt held me tight and I received a blow to my right knee , which was depressed on the brake pedal. The Buddy windshield disappeared at speed for 5 – 6 metres in the direction of the curb and stopped there. Buddy took a powerful hit on the left-hand side, and then the Golf hit Buddy directly on its right front wheel. The wheel of the Golf was severely deformed and the front suspension was lying on the ground. The rest of the chassis on the Buddy was entire, the body was entire and both doors could be opened. I took a real hit to the chest from the belt that secured me from further damage and my right knee also took a big hit, but the Buddy held out!

Attached are images of our beloved Buddy after the collision.

Thanks for delivering a great and safe car!!

Figure 4: Description of an accident and pictures of Buddy taken by the driver of an Electric vehicle following a head-on collision. Source: http://www.facebook.com/puremobility.

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Head-on collision at Slependen outside Oslo, March 2013

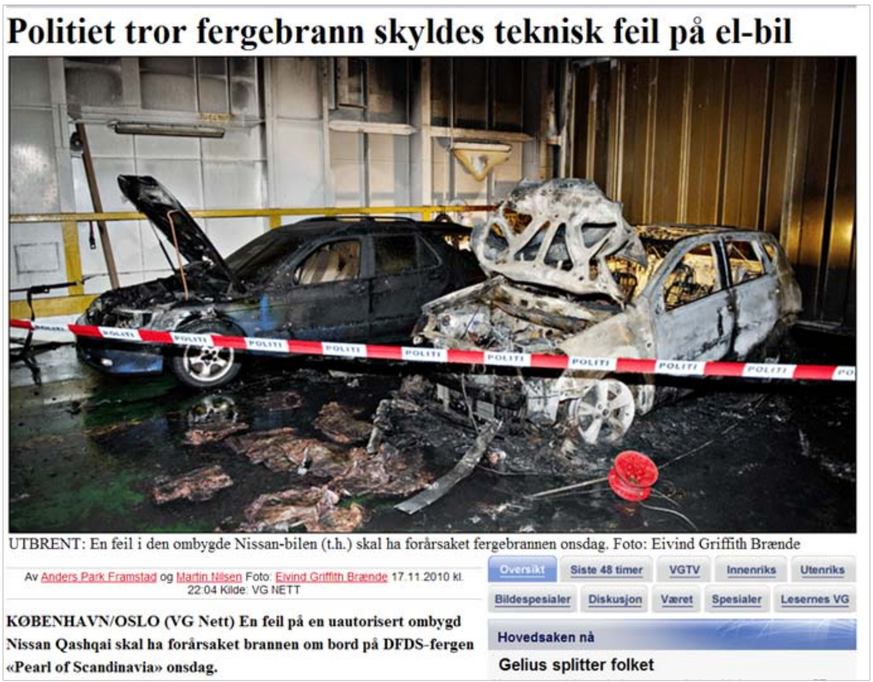
A Peugeot Ion was involved in a head-on collision with a passenger car on 16 March 2013. The owner of the Electric car walked away from the accident unharmed. The driver of the other car crossed into a wrong lane and hit the Electric vehicle. The driver of the other car was taken to hospital.

Fires

The following section briefly describes a selection of vehicle fires.

Fire on car ferry

There was a serious fire accident on the car ferry DFDS Pearl of Scandinavia in November 2010. It started in a converted Nissan Qashqai that was charged with a homemade connector adapter. The conversion of the car had not been approved by the public road authorities, see Figure 5.



Politiet tror fergebrann skyldes teknisk feil på el-bil

UTBRENT: En feil i den ombygde Nissan-bilen (t.h.) skal ha forårsaket fergebrannen onsdag. Foto: Eivind Griffith Brænde

Av Anders Park Framstad og Martin Nilsen Foto: Eivind Griffith Brænde 17.11.2010 kl. 22:04 Kilde: VG NETT

KØBENHAVN/OSLO (VG Nett) En feil på en uautorisert ombygd Nissan Qashqai skal ha forårsaket brannen om bord på DFDS-fergen «Pearl of Scandinavia» onsdag.

Oversikt | Siste 48 timer | VGTV | Innenriks | Utenriks
Bildespesialer | Diskusjon | Været | Spesialer | Lesernes VG

Hovedsaken nå

Gelius splitter folket

Figure 5: Fire with recharging of Electric cars on the DFDS ferry to Denmark. Source: www.vg.no.

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Electric car burns at Blommenholm in April 2012

Blommenholm is located 15 km south of Oslo. An Electric vehicle caught fire and there was a lot of smoke during peak morning traffic heading towards Oslo, see Figure 6.

Figure 6: Fire in an Electric vehicle at Blommenholm south of Oslo. Source: www.budstikka.no.

Electric vehicle burns at Høvik during morning rush hour in June 2012

The car, a Renault van caught fire and there was a lot of smoke, see Figure 7.

Figure 7: Renault Electric vehicle on fire at Høvik south of Oslo. Source: www.budstikka.no, Mobile photo credit: Martine Madsen.

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Electric vehicle fire spreads at residential building

In December 2010, a fire that started in an Electric car spread into a carport and detached house. The fire started early in the morning and everyone managed to get out of the building, see Figure 8.

Put on the parking heater

At 07:30 on Wednesday the owner of an Electric vehicle put the heater on in the vehicle while it was parked in the carport. After about 10 minutes, the owner came out to see that the vehicle was on fire and for the next few minutes was panicked. The owner managed to alert everyone in the building and get them out to safety. In addition the owner emptied the powder device in the car but it didn't help and says it was probably the heater that caused the fire. Manager of Police on site, Ketil Lund says that the Police must investigate the fire before they are able to make any comment regarding the cause. www.rb.no, 02.12.2010

Figure 8: Electric vehicle fire spread to a carport and residential building in Lillestrøm north of Oslo. Source: www.rb.no, FOTO: Tina Aardahl.

Fire in garage in Røyken

In March 2010 a garage in the municipality of Røyken, several miles south of Oslo, caught fire. In all likelihood, the fire started in an older electric vehicle that was being recharged. See Figure 9.

Figure 9: Garage fire caused by Electric vehicle. Photo: Per D. Zaring.

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Norwegian Centre for Transport Research

Established in 1964, the Institute of Transport Economics is an interdisciplinary, applied research centre with approximately 70 professionals. Its mission is to develop and disseminate transportation knowledge that has scientific quality and practical application.

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