TØI report 1492/2016

Erik Figenbaum
Marika Kolbenstvedt

Institute of Transport Economics
Norwegian Centre for Transport Research

Learning from Norwegian Battery Electric and Plug-in Hybrid Vehicle users

Results from a survey of vehicle owners

TØI rapport
1492/2016

Learning from Norwegian Battery Electric and Plug-in Hybrid Vehicle users

Results from a survey of vehicle owners

Erik Figenbaum
Marika Kolbenstvedt

ISSN 0808-1190
ISBN 978-82-480-1718-9 Elektronisk versjon
Oslo, June 2016

Tittel	Lærdommer fra brukere av elbiler og ladbare hybridbiler – Resultater fra en spørreundersøkelse blant bileiere	**Title**	Learning from Norwegian Battery Electric and Plug-in Hybrid Vehicle users – Results from a survey of vehicle owners

Forfatter(e):	Erik Figenbaum Marika Kolbenstvedt	**Author(s)**	Erik Figenbaum Marika Kolbenstvedt
Dato:	06.2016	**Date:**	06.2016
TØI rapport	1492/2016	**TØI Report:**	1492/2016
Sider:	98	**Pages:**	98
ISBN elektronisk:	978-82-480-1718-9	**ISBN Electronic:**	978-82-480-1718-9
ISSN:	0808-1190	**ISSN:**	0808-1190
Finansieringskilde(r):	Statens vegvesen, Vegdirektoratet	**Financed by:**	Norwegian Public Roads Administration

Prosjekt:	4108 – Emiroad	**Project:**	4108 – Emiroad
Prosjektleder:	Christian Weber	**Project Manager:**	Christian Weber
Kvalitetsansvarlig:	Beate Elvebakk	**Quality Manager:**	Beate Elvebakk
Fagfelt:	Miljø og klima	**Research Area:**	Environment and climate
Emneord:	Elbil Ladbare hybridbiler Spørreundersøkelse Brukererfaringer	**Keyword(s)**	Battery Electric Vehicles Plug-in Hybrid Vehicles Survey User experience

Sammendrag:

En spørreundersøkelse ble gjennomført blant bileiere, for å finne ut hvem elbil- og ladbar hybridbileiere er, hvordan bilene brukes, hvorfor de kjøpes, hvordan teknologien vurderes, sammenlignet med bensin- og dieselbileiere. Elbileiere er yngre, har flere barn og biler, høyere yrkesdeltagelse og lengre jobbreisevei enn de andre nokså like gruppene. Ladbare hybridbiler og elbiler konkurrerer pga. insentivstrukturen ikke om samme kunder. Elbilene brukes mest totalt og hverdagsturer, minst på ferieturer. Bilene lades hjemme, til dels på arbeid og sjelden ellers. Elbileierne klarer hverdagen bra, 83% har aldri droppet en reise, kun 6% har avbrutt en reise. Droppede og avbrutte reiser kan halveres med bedre ladeinfrastruktur. Ladbare hybridbiler kjøres gjennomsnittlig 55% i «elmodus» og 63% på arbeidsreiser. Kjøperne motiveres i hovedsak av sparte kostnader og miljø. Elbileiere motiveres i tillegg av insentiver som gratis bomring.

Summary:

A survey of vehicle owners identified who the owners of Battery Electric vehicles (BEV) and Plug-in Hybrid (PHEV) vehicles are, how the vehicles are used, why they are bought and how the technology is rated, compared to owners of Internal Combustion Engine Vehicles. BEV owners are younger with more children and vehicles, a higher share of workers and longer work trips, than other groups. BEVs and PHEVs does not compete for the same customers due to the incentive structure. BEVs are in total and on weekdays used more, but less on vacation. The vehicles are charged at home, partly at work, rarely elsewhere. BEV owners manage everyday driving, 83% never dropped and only 6% aborted trips. Better infrastructure can halve these problems. PHEVs are driven 55% of total km in E-mode, 63% on work trips. Cost and environment motivate buyers, and incentives such as free toll roads available to BEV owners are important.

Language of report: English

Transportøkonomisk Institutt
Gaustadalleen 21, 0349 Oslo
Telefon 22 57 38 00 - www.toi.no

Institute of Transport Economics
Gaustadalleen 21, 0349 Oslo, Norway
Telefon 22 57 38 00 - www.toi.no

Preface

This report is part of the Emiroad (Emission from Road Transport vehicles) project financed by the Norwegian Public Roads Administration with a contribution from the BISEK (A research programme on the social and economic impact of vehicles) research programme. The objective of Emiroad is to bring forward new knowledge about emission from vehicles, under different driving conditions in Nordic climate, and the potential of cutting emissions in the coming years with new technologies and alternative energy carriers.

The objective of this report is to use a vehicle owner survey to find out how plug in hybrid (PHEVs) and battery electric vehicles (BEVs) can contribute to emission reductions when they offset usage of gasoline or diesel vehicles.

No information existed prior to this survey on the usage pattern of PHEVs in Norway. For BEVs a similar survey carried out in 2014 as part of the COMPETT (Competitive Electric Town Transport) project, make it possible to track progress over time.

The survey covers topics on how owners use these vehicles, how they are charged, why people buy them, the effects of incentives, and the attitudes to these vehicles in different vehicle owning groups.

We want to express our gratitude to Petter Haugneland at the Norwegian EV association and Christer Tonheim at the Norwegian Automobile Association (NAF) for their expedient support and distribution of the questionnaire to their members.

Erik Figenbaum has been responsible for the data-analysis and been the main author of the report with contributions from Marika Kolbenstvedt. Beate Elvebakk has been TØI's quality assurer.

Oslo, June 2016
Institute of Transport Economics

Gunnar Lindberg
Managing Director

Michael Wøhlk Jæger Sørensen
Research Director

Content

Acronyms

BEV:	Battery Electric Vehicle, a vehicle only powered with electricity from batteries
E-mode:	The operative mode of a PHEV or EREV vehicle when driven completely or almost completely by electric power recharged from the electricity grid and stored in the vehicles battery prior to the start of the journey
EV:	See PEV
EREV:	Extended Range Electric Vehicles, a vehicle operating mainly as a BEV but with an engine/generator set on board generating electricity charging the battery when empty
HEV:	Hybrid Electric Vehicle, a vehicle where the electric motor partly or part time powers the wheels, using electricity recharged into the batteries when running the electric motor in generator mode, thus reducing the fuel consumption of the ICE.
ICE:	Internal Combustion Engine, i.e. gasoline or diesel engine
ICEV:	Internal Combustion Engine Vehicle (Gasoline or diesel vehicle)
PEV:	Plug in Electric Vehicle, all vehicles with a plug to be able to recharge the battery from the grid, i.e. BEV, PHEV, EREV
PHEV:	Plug in Hybrid Electric Vehicle, a vehicle that can be powered by an electric motor with electricity stored in the vehicles battery, and power the wheels in combination with an ICE engine in other operation modes
YM:	Year Model

Acronyms sub samples

Single BEV, or BEV single	BEV household owning one vehicle
Multi BEV ICEV, or, BEV multi ICEV	BEV household owning a BEV and one or more ICEVs
Multi BEV, or, BEV multi	BEV households owning more than one BEV, and no other vehicles

PHEV and ICEV households follows the same pattern

Institute of Transport Economics
Norwegian Centre for Transport Research

Summary

Learning from Norwegian Battery Electric and Plug-in Hybrid Vehicle users – Results from a survey of vehicle owners

TØI Report 1492/2016
Authors: Erik Figenbaum and Marika Kolbenstvedt
Oslo 2016 98 pages English language

Battery electric vehicles are more energy efficient, pollute less and emit fewer greenhouse gases than vehicles powered by fossil fuels. Plug in hybrid vehicles are in a mid-position, capable of prolonged driving in electric mode with electricity charged from the grid or the use of fossil fuel in an internal combustion engine. A survey of over 8000 vehicle owners show that plug-in hybrids drive electrically with power from the grid 55% of the time but battery electric vehicles are driven more in total and in everyday traffic. Buyers are different but motivated by economy of use and environment, whereas battery electric vehicle owners also are motivated by the free toll road incentive. Battery electric vehicle owners are younger, have more children, longer distance to work and own more vehicles than other vehicle owners. Normally diesel and gasoline vehicles are replaced but a larger share of battery electric vehicles become extra vehicles in households. These owners could belong to an age group and family type where such behaviour is more common or indicate a rebound effect. The vehicles are mainly charged at home, partly at work and rarely elsewhere. Fast charging is used for irregular trips where users plan to use fast chargers to accomplish the trip or to solve a problem on the go. Most battery electric vehicle owners manage everyday life well and are satisfied with the vehicle which in combination with attractive local incentives not available to other vehicle users, may explain why these two vehicle types do not seem to compete for the same customer.

Survey sample

This report presents the results of a nationwide survey of Battery Electric Vehicle (BEV), Plug in Hybrid Electric Vehicle (PHEV) and Internal Combustion Engine Vehicle (ICEV) owners in Norway conducted in March 2016. The 3 111 BEV respondents were recruited using e-mails sent to members of the Norwegian EV Association. The 2 065 private PHEV owners were recruited using postcards sent to their home address. The 3 080 ICEV owners were recruited using e-mails sent to a representative national sample of the members of the Norwegian Automobile Federation (NAF). The total response rate was about 19%, slightly higher for PHEV owners (26%) and lower for ICEV owners (15%). The BEV owner sample is mostly representative of the total BEV fleet, apart from an overrepresentation of Tesla Model S, and minor regional deviations. The PHEV sample is relatively representative of private owners.

Owner's socio-demographic characteristics, housing and vehicle ownership

Vehicle purchase taxes are very high in Norway. The registration tax consists of taxes on vehicle weight, engine power, CO_2-emissions and NO_X-emissions. The tax is progressive, and registration tax for heavier vehicles with large engines and high emissions can be over 15 000 Euros. Tax for a typical compact vehicle could be 6 000 Euros, for a small vehicle around 2 000 Euros. BEVs' are exempted from this tax and the compact sized PHEVs typically have no registration tax as the low CO_2-emission value of these vehicles gives a tax deduction that can be deducted from the tax on the other elements. In addition, BEVs are exempted from the 25% VAT imposed on other vehicles. Several local incentives are also available, such as access to bus lane and free passing of toll roads.

The sociodemographic data show that PHEVs and BEV owner's are very different groups. BEV owners live in larger households with more children and are on the average seven years younger than PHEV owners are. They more often belong to multivehicle households than PHEV owners and have longer distances to work.

PHEV owners have many similarities with ICEV vehicle owners in general, such as about average share of multi vehicle households, but lie in some ways between ICEV and BEV owners' characteristics.

For working owners of vehicles from 2011 and newer, the household income proves to be more or less the same, with the exception that single vehicle PHEV owners are better off than BEV and ICEV owners.

About two thirds of people in these three groups live in detached houses, the remaining split in two between other small houses and flats. BEV owners in general live in more urban locations than PHEV owners do, whereas ICEV owners are the group that is most spread out. These housing conditions mean that BEV owners and PHEV owners in general have good access to parking and charging facilities on their own property.

Most BEV owners (71%) also own an ICEV, 4% a PHEV and 4% more than one BEV. The remaining 21% only have the one BEV. 46% of PHEV owners and 48% of ICEV owners belong to single vehicle household. The most multipurpose BEV, Tesla Model S, is twice as common in single BEV households as in households also owning ICEVs, and four times as common in households owning several BEVs.

Why did they buy the vehicle, where did they get information, and will they buy the same vehicle again?

The four reasons most frequently mentioned by the 89% of BEV owners who say they will buy a BEV again are economy of use, environmental performance, future proof technology, and the free usage of toll roads without paying. Less than 1% will not buy a BEV again. The reasons not to buy again are range and charging issues.

The three main reasons why 80% of PHEV owners say they will buy one again are economy of use, environmental performance and that the technology is future proof. Only 2% will not buy a PHEV again. The main reasons not to buy again are the short range in E-mode and inability to use E-mode when it is cold.

Peer-to-peer influences is particularly important to diffusion of BEVs, being the biggest source of information leading to the purchase. PHEV buyers received most information leading to the purchase from dealers and advertising material. The dealer also played a large

role for ICEV owners but they also got information from peers. BEVs require more adaption of travel patterns than ICEVs. When their friends say that range is manageable it is more likely that people will consider BEVs as an option. The average BEV owner have influenced about 1.2 persons to buy and 1.2 persons to consider buying BEVs. This peer-to-peer communication may thus be supporting a self-sustained sale of BEVs in Norway.

Trip types and total travel

BEV owners use their BEVs more for all types of trips in everyday traffic but less on non-routine trips and vacation, than PHEV and ICEV owners do. BEV owners have about 7 km longer distance to work than owners of a PHEV or owners of an ICEV. BEV owners drive their BEVs about 15 500 km per year which is slightly more than PHEVs that are driven 15 200 km. ICEVs are used the least, around 15 000 km. Part of the difference may be due to higher share of ICEVs being owned by retired people.

Recurring long distance travel over 300 km, for instance to holiday houses, friends and family, is undertaken by close to 50% in all three owner groups. The share not doing recurring trips above 100 km, and trips in the interval 100-150 km, is somewhat higher among BEV owners, 12% versus 7-9% in the other groups. About 64% of BEV owners use their BEVs on at least one of the recurring trip types. On these trips, 74% charge their vehicle along the way using fast chargers, and 60% at the destination. PHEV owners do not need to charge to be able to carry out these trips but over half of them do it at the destination. About 20% of both groups stop at friends or family and charge.

BEV owners have a particularly vehicle based travel pattern and seems to be a sub group of new vehicle buyers that use vehicles very actively in everyday life. Their reasons to do so, is probably related to their larger households with many children and long distances to work.

PHEV share of driving in the «all electric mode» and users range estimates

PHEVs are on average driven about 55% of yearly km in «E-mode», the «all electric drive mode». The share is higher for trips to work and in the summer and lower in the winter. Longer range in E-mode in general leads to higher E-mode share, but the spread is large for most vehicle types. Only the vehicle with the longest range, the Opel Ampera, has a positive correlation between increased annual vehicle mileage and increased E-mode share. All the other vehicles have a negative correlation, indicating that their e-mode range is not optimal from a user perspective.

User estimates for E-mode range is on average about 20% lower than the official range in E-mode in the summer and 30% lower in the winter.

Changes to travel pattern and vehicle ownership

BEVs have substantial incentives in Norway, such as access to bus lanes, reduced purchase taxes, access to toll roads and free public parking, on the assumption that they replace ICEVs. Most BEVs in use in Norway have a limited range and people may not be able to replace all their driving with a BEV when replacing an ICEV, further highlighting a need to verify if BEVs are an addition to the fleet or a replacement. There is also a possibility that

the total vehicle based travel increases, i.e. that people drive more with BEVs than they would have with ICEVs, since the variable cost per km is much lower for BEVs than ICEVs, and attractive user incentives are available. On the other hand, BEV owners may belong to an age group and in a family situation where it is common to buy an extra vehicle.

The vehicle was for 22% of BEV, 5% of PHEV and 12% of ICEV owners, an additional vehicle in the household. For the others, the vehicle usually replaced an ICEV, 6% of BEV owners, however, replaced a BEV and 2 % a Hybrid Electric Vehicle (HEV), whereas 4% of PHEV owners replaced a HEV, 1% a PHEV and 1% a BEV.

The driving pattern remained unchanged for 67% of BEV owners, 87% of PHEV owners and 89% of ICEV owners, after buying their vehicles. The majority of the rest of the owners tended to have negative modal shifts for the environment and the target to limit vehicle based travel in cities, regardless if they bought an electric, plug-in hybrid, diesel or gasoline vehicle. Driving increases in general in all groups. Few say they drive less. The same is true of cycling, walking and using public transport, which many more people say they have reduced than increased. It is unknown how much more or less they travel. BEV owners have the largest mode changes. Their long distances to work, and that they have more children than the other groups, could be the reasons for these larger mode changes.

In another question, 72% of BEV owners, 90% of PHEV owners and 81% of ICEV owners stated that the total km in the household's vehicle insurances had not changed after buying a 2011 or newer model vehicle as a replacement for an ICEV. 8% of BEV owners said it had been reduced, 20% that it had increased. The corresponding figures for PHEVs were 4% and 6% and for ICEVs 11% and 8%, indicating that there is a potential rebound effect related to vehicle kilometres driven for BEVs, although there could be other reasons for the differences.

Changes to the household, such as the household or workplace having moved, an addition to the family or an increased need to escort children in general, were for about half of the BEV owners the main reason to buy an extra vehicle. If these people would have bought an extra vehicle anyhow, had it not been for the BEV incentives, or continued using another transport mode, is not possible to find out from the survey. Such issues could potentially also lead to an increase in the mileage when a BEV replaces an ICEV. The other half of buyers of extra vehicles seemed mainly motivated by "insufficient public transport" and wanting to "use the other household vehicle less". The latter could indicate that they want to reduce the environmental impacts of their driving and/or motoring cost. PHEV and ICEV owners had many of the same reasons for buying an extra vehicle apart from "use other vehicle less", which was not motivating ICEV owners.

Charging is mostly done at home

94-95% of BEV and PHEV owners, charge their vehicles at home in their garage, carport or parking space. Few report challenges with planning or establishing charging facilities at their home location.

The peak period for starting charging is in the period 16-18 but many also start before 16. The peak charging period drags out into the evening as more people start to charge, and those that have already started continue. The result will be that the peak time for charging with maximum charging power will coincide with the peak power drain from the grid, when people come home from work, turn up living room heaters, start cooking, watching

TV etc. The peak will be higher and longer in the winter since more people will need to recharge their vehicle every day, as the range in winter is shorter.

About 50% of BEV owners and 75% of PHEV owners never charge their vehicles at work. 28% of BEV owners, but only 16% of PHEV owners, do it mostly daily.

Standard public chargers are less regularly used, but 60% of BEV owners use them at least monthly or yearly. Only about 10% use them on a weekly basis. Over two thirds of PHEV owners never use public chargers. Less than 10% do it more than a few times per year.

Fast chargers are used a bit more in the 2016 survey than in the 2014 survey, but 30% of BEV owners and 90% of PHEV owners never use them (Mitsubishi Outlander is the only PHEV that can use fast chargers). 8-9 % of BEV owners use fast chargers weekly and 28% monthly with almost no difference between summer and winter. About 70% of users plan to use fast chargers before going on a trip. In addition, running out of range occasionally during a trip is sorted out using fast chargers, and more so in the winter. BEV owners use fast chargers more often for irregular long distance trips, than recurring long distance trips or daily trips.

Charging problems have, by 29% of BEV owners and 10% of PHEV owners, been experienced. The most frequent problem is "no power". At home, the second most important problem is damaged vehicle cable and for public chargers damaged charge sockets. About 2% of those that had problems, had experienced "burned charge socket" at the home location or a public, work place or destination charge socket, indicating that about 1 600 owners in the total EV fleet had experienced this problem. A burned charge socket could potentially escalate to a fire and EV owners should use home chargers (wall boxes) having robust plugs and sockets. Public charging stations should use Mode 3, Type 2 sockets, to avoid future problems. Some modern BEVs with temperature sensors in the connector on the cable supplied with the vehicle, stop charging when detecting an over-temperature.

PHEV owners rate public chargers much more negatively than BEV owners but also know less about them. A third of BEV owners rate them as good, a third poor and the rest neither nor. Only about a tenth of PHEV owners rate them as good.

Challenges using the vehicles are manageable

The average BEV owner has avoided travelling due to range being too short or the charging infrastructure being insufficient, on five days per year, but the majority (83%) never had to avoid a trip. Those who have cancelled trips on average did it 18 days per year. Tesla owners had much fewer problems, on average less than half a day per year, indicating that the Model S has enough range and that the Tesla supercharger network provides a stable service.

The average BEV driver have aborted trips less than one day per year, and only 6% of BEV drivers have aborted trips. Those who have aborted trips experience it 12 days per year on average.

Half of avoided and aborted travel relate to the availability and quality of the charging infrastructure. These issues should be addressed by authorities that provide support for charging station establishment, and those with operational responsibility for the infrastructure.

The other half of cancelled or aborted travel is mostly due to miscalculated range or unexpectedly high consumption of energy. Technical faults on vehicles are very rare.

Overall, these problems seems relatively small, which could be a result of self-selection, i.e. that consumers buy BEVs when their driving pattern is compatible.

When range is too short, the typical behavioural adaptation will be to fast charge, and drive more efficiently while turning down auxiliary loads. Before embarking on trips, people plan for instance where to charge, or get hold of an alternative vehicle or switch their mode of transport. Multi vehicle households will predominantly swap vehicles within the household.

Female drivers seem to be less aware that the low noise of BEVs could be a problem in traffic. Three times higher shares of women driving BEVs than those driving ICEVs, have perceived situations were pedestrians, cyclists or children did not hear the vehicle as dangerous. Male BEV drivers experience the same but to a much lower degree. The gender differences could be due to, exposure, experience, different perception of situations or that women take more notice of such situations. Female ICEV owners, strangely enough, experience this problem least often of all groups, but the survey cannot give further insight into this issue.

Value and use of incentives

BEV owners enjoy local incentives such as access to bus lanes, free public parking exemption from toll roads, and reduced rates on coastal main road ferries. PHEV owners do not have any of these incentives.

BEV owners pass toll road gates on the way to work twice as often as owners of ICEVs and owners of PHEVs. Their estimated savings on toll roads is twice of what the other groups' reported toll road cost. The average reported saving on ferries is rather small on a national scale. Since ferries still cost about half price for BEVs, BEV owners actually spend about the same as other groups, but should have spent twice as much. BEV owners also say the save more on parking than the other groups say the pay for parking. BEV owners can also charge at no cost on many public charging stations, but not on fast chargers. The bus lane time saving is an important part of local incentives, accounting for 32% of the average yearly value per BEV owner, which was estimated to be 14 000 NOK/year.

Perceived advantages and disadvantages of BEVs and development since 2014

All three groups consider environmental effects, operating cost and home charging as big advantages of BEVs. BEV owners are the most positive followed by PHEV owners. Range and charging time are significant disadvantages of BEVs, particularly for ICEV owners. ICEV owners are rather indifferent to comfort, safety and design and image of BEVs, whereas BEV and PHEV owners rate these items more positively, especially comfort. ICEV owners are somewhat negative to the size of BEVs, whereas BEV owners and PHEV owners are rather neutral. BEV and PHEV owners seem to think that handling cables is not a big deal, whereas ICEV owners are more negative. BEV and PHEV owners rate second hand value of BEVs relatively neutral whereas ICEV owners think it is a disadvantage.

Both BEV and ICEV owners rate second hand value much more positively in 2016 than in 2014. BEV owners also see less problems compared to ICEV owners when evaluating charging time, heating system, and handling cables, but slightly more challenges with range and vehicle size. The latter items could indicate that they want to use their BEV for more trips than their BEVs range and size currently allow for. For issues such as charging time, comfort and size, ICEV owners have reduced both positive and negative assessments between 2014 and 2016, thus moving towards a more neutral position.

Opinions on measures to expand the PHEV and BEV market

For PHEVs, "competitive price" is the most important factor for increasing sales according to the respondents, followed by increased range in E-mode. BEVs already have a competitive price so the most important measure to expand the BEV market is increased range.

The median *winter range* that people say is required for more people to become interested in PHEVs ranges from 75 km among PHEV owners, 85 km among BEV owners to 175 km for ICEV owners. Up to 2016, no PHEV had the ability to drive 175 km in E-mode. The closest is the BMW i3 REX that, according to BEV variant users with the same battery, can be driven over 100 km in the winter. It is unlikely that many PHEVs will match these desired ranges in the near future, even the range desired by PHEV owners. Such winter ranges are only achievable with purpose designed EREVs, i.e. vehicles that were designed primarily to be used in electric drive mode, with the ICEV assisting long distance trips, whereas the strategy of most vehicle manufacturers is to make PHEV variants of standard vehicles. There is not enough space in most standard vehicles for a large battery. BMW i3 REX, an example of a purpose designed EREV, will come with a larger battery in the fall of 2016 having a range compatible with ICEV owner's needs.

The median *winter range* the respondents say will make more people interested in buying BEVs, range from about 230-250 km stated by BEV and PHEV owners, to 300 km by ICEV owners. Tesla Model S is already capable of such ranges and the second generation BEVs arriving on the market in 2017-18 are likely to be capable of such ranges.

For BEV owners increased availability of fast chargers and retaining the exemption from purchase taxes are also very important measures for increased appeal to consumers according to the respondents. Reduced ferry rates and bus lane access are the least important local incentives, whereas toll road exemption is highly valued by BEV owners. PHEV owners would like to have free toll roads and free parking to spur more PHEV sales, and the other groups agree. The possibility to drive in cities when other vehicles are banned, increased taxes on polluting vehicles, as well as better public and workplace charging, are factors that are even more important in all groups apart from ICEV owners, who do not want higher taxes on polluting vehicles. Better availability of makes and models is not as important as the other measures and incentives.

Competition or complementarity between BEVs and PHEVs

Nothing in the survey results indicates that BEVs and PHEVs currently compete for the same customers. Owning a HEV, BEV or PHEV does not seem to lead to substantial recruitment to the other two technologies, a somewhat surprising result. One could have imagined that PHEVs would be attractive to disillusioned BEV owners tired of congestion at public chargers or with the short winter range. In fact, only one percent of PHEVs replaced a BEV, and, as stated earlier, most BEV manage their transportation needs

effortlessly and that should make it less interesting to replace the BEV with a more expensive PHEV with no local incentives.

BEVs and PHEVs are also partly in different size segments. Apart from the large Tesla Model S, BEVs are mostly compact, small and mini vehicles. PHEVs are mainly in segments compact, medium, large and SUVs. Buyers of PHEVs actively choose to forego BEV incentives and pay a premium over BEVs. In the survey one sees that they also have different socio-demographic characteristics; BEV owners being younger, having families with children and longer distances to work. Recurring long distance driving on the other hand differs very little between the groups, BEV owners on average only having slightly fewer of these trips. Tesla owners have an extreme long distance driving pattern, which could not only be related to the vehicles long range, but also to the free access to the supercharger network giving owners zero energy cost on long distance trips.

Transportøkonomisk institutt
Stiftelsen Norsk senter for samferdselsforskning

Sammendrag

Lærdommer fra brukere av elbiler og ladbare hybridbiler – Resultater fra en spørreundersøkelse blant bileiere

TØI rapport 1492/2016
Forfattere: Erik Figenbaum og Marika Kolbenstvedt
Oslo 2016 98 sider

Elbiler er energieffektive, forurenser mindre lokalt og slipper ut mindre klimagasser enn biler som bruker fossilt drivstoff. Ladbare hybridbiler er i en mellomstilling der de kan kjøres elektrisk over lengre strekninger med strøm fra kraftnettet, men også kun med fossilt drivstoff eller en blanding av disse kjøremodusene. En spørreundersøkelse blant over 8000 bileiere i mars 2016 viser at de ladbare hybridbilene kjøres rundt 55% av tiden med strøm ladet fra kraftnettet, mens elbiler kjøres totalt sett mest per år og mest i daglig trafikk. Kjøperne er ulike grupper men motiveres av økonomisk bilhold, fremtidsrettet teknologi og miljø. Elbilkjøpere motiveres også av insentiver, spesielt tilgang til gratis bomveier. Elbilkjøpere er yngre, har flere barn, lengere reisevei til arbeid, flere biler og er mer yrkesaktive enn andre bileiere. Som regel erstatter både elbiler og ladbare hybridbiler en diesel- eller en bensinbil, men flere elbiler blir ekstrabiler i husholdningen, noe som kan skyldes at disse bileierne er i en fase i livet der dette er vanlig å gjøre. Det kan imidlertid også indikere økt bileierskap pga. lave kostnader ved elbilhold. Bilene lades i hovedsak hjemme, til dels på jobb og sjelden ellers. Hurtiglading brukes mest på planlagte irregulære lengre turer og for å løse en knipe underveis. I det store og det hele klarer elbileierne seg bra i hverdagen og er fornøyde noe som sammen med forskjellen i insentiver forklarer hvorfor de to biltypene i liten grad ser ut til å konkurrere med hverandre.

Om spørreundersøkelsen

Denne rapporten presenterer resultater fra en nettbasert spørreundersøkelse av norske eiere av elbiler, ladbare hybridbiler og bensin- og dieselbiler utført i mars 2016. 3 111 elbileiere ble rekruttert til undersøkelse fra medlemsregisteret til elbilforeningen. 2 065 private eiere av ladbare hybridbiler ble rekruttert med postkort sendt til eierne, og 3 080 eiere av bensin- og dieselbiler ble rekruttert fra medlemsregisteret til Norges Automobil-Forbund (NAF). Total svarprosent var ca. 19%, hvorav svarprosenten var ca. 26% for eiere av ladbare hybridbiler, 19% for elbileiere og 15% for eiere av bensin- og dieselbiler.

Elbileierne er forholdsvis representative for den totale bilflåten bortsett fra en overrepresentasjon av Tesla Model S og enkelte regionale forskjeller. Ladbar hybridbileiere er forholdsvis representative for private eiere.

Eiernes sosio-demografiske karakteristikk, bolig og bileierskap

Skattene på bilkjøp er svært høye i Norge. Engangsavgiften består av progressive delskatter basert på bilens vekt, motoreffekt, CO_2-utslipp og NO_X-utslipp. Større biler kan få avgifter fra 100 000 kr. og oppover. En vanlig kompakt bensinbil kan ha en avgift på rundt 50 000 kr., en minibil rundt 15 000 kr. Elbiler er fritatt for denne avgiften. De mindre ladbare

hybridbilene har typisk null engangsavgift fordi lave CO_2-utslipp gir fradrag i engangsavgiftsberegningen. Elbiler har i tillegg fritak for mva., og tilgang til lokale insentiver som gratis bruk av bomveier og kjøring i bussfil.

Eiere av elbiler og ladbare hybridbiler er svært ulike grupper. Elbileiere bor i større husholdninger med flere barn og er syv år eldre i gjennomsnitt enn eiere av ladbare hybridbiler. De er også i langt større grad flerbilseiere og har lengre reisevei til jobb.

Eiere av ladbare hybridbiler har mange likheter med vanlige bileiere. Andel flerbilseiere er omtrent lik. De skiller seg fra vanlige bileiere på noen områder, for eksempel hvor viktig brukskostnader er for bilkjøp, der de ligger mellom elbileierne og eiere av vanlige biler.

Husholdningsinntekter for arbeidende eiere av biler nyere enn 2011 modeller er nokså lik for de tre gruppene bileiere i flerbilshusholdninger. I enbilshusholdningene har eiere av ladbare hybridbiler høyere inntekt enn de andre, noe som kan skyldes at biltypen er dyrere enn de to andre biltypene.

To tredjedeler av eiergruppene bor i enebolig, de resterende er fordelt mellom andre småhus og leiligheter. Elbileiere bor i større grad i urbane strøk enn det eiere av ladbare hybridbiler gjør, mens eiere av vanlige biler bor mest spredtbygd. Mulighetene for å etablere ladefasiliteter på egen parkeringsplass eller garasje er dermed gode. 71% av elbileiere eier også en bensin- eller dieselbil, 4% en hybridbil, mens 4% eier mer enn en elbil. 21% eier kun elbilen. Til sammenligning eier 46% av eierne av ladbare hybridbiler og 48% av vanlige bileiere en bil.

Hvorfor ble bilen kjøpt, hvor kom informasjon fra, vil biltypen kjøpes igjen?

At bilen er økonomisk i bruk, miljøvennlig, fremtidsrettet og gir tilgang til gratis bomveier, er hovedgrunnene til at 89% av elbileierne sier de vil kjøpe elbil igjen. De første tre grunnene er også de viktigste for eiere av ladbare hybridbiler. Mindre enn 1% av elbileierne vil ikke kjøpe igjen, hovedsakelig pga. rekkevidde eller ladeutfordringer, mens 2% av eierne av ladbare hybridbiler ikke vil kjøpe igjen pga. kort rekkevidde i el-modus, eller at denne kjøremodusen ikke er tilgjengelig i kulde.

Informasjonsdeling mellom venner, familie og kolleger er viktigste element i spredningen av elbiler i befolkningen, mens ladbar hybridbilkjøpere i første rekke fikk informasjon fra forhandlere og reklamemateriell. I og med at elbiler kan medføre behov for å endre bilvaner er pålitelige informasjon fra likemenn spesielt viktig. Gjennomsnittlig har elbileiere inspirert 1,2 andre til å kjøpe og 1,2 til å vurdere å kjøpe elbil, og er dermed teknologiambassadører som bidrar til at elbilsalget er mer eller mindre selvbærende i Norge, gitt dagens elbilpolitikk.

Reisemiddelfordeling og total årlig reiselengde

Elbileiere bruker elbilen mer for alle typer reiser i daglig trafikk, men mindre til ferier og andre tilfeldige turer, men kjører samtidig mest av bileiergruppene i året, ca. 15 500 km kjørelengde noe som er 2-4% mer enn i de andre gruppene.

Elbileierne har et spesielt bilbasert reisemønster og ser ut til å være en undergruppe av nybilkjøpere som bruker bil svært aktivt for å få hverdagen med barn og lang vei til arbeid til å gå opp.

Omtrent 50% i alle de tre gruppene foretar gjentatte årlige reiser, for eksempel til feriehus, venner eller familie, mens andelen elbileiere som aldri har slike reiser over 100 km ligger på 12% mot 7-9% for de andre gruppene. 64% av elbileierne tar elbilen på minst en av disse reisetypene. 74% lader underveis og 60% på destinasjonen. Eiere av ladbare hybridbilere kommer seg frem på langturer med bensin/diesel-motoren og trenger ikke lade, men 50% lader imidlertid på destinasjonen.

Ladbar hybridbileieres andel kjøring i E-modus og rekkeviddeestimater

Gjennomsnittlig kjøres ladbare hybridbiler 55% av årlige km i elmodus, det vil si det kjøremoduset der bilen helt eller i hovedsak kjøres på strøm fra batteriet ladet fra kraftnettet. Andelen er høyere for arbeidsreiser og om sommeren og mindre om vinteren. Bilen med lengst rekkevidde i elmodus har en positiv korrelasjon mellom økt årlig kjørelengde og økt andel i elmodus. For alle de andre bilene er sammenhengen negativ, noe som indikerer at rekkevidden er knapp for mange. Brukernes estimerte rekkevidde er 20% lavere enn det offisielle tallet for sommerkjøring og 30% om vinteren.

Endringer i reisemønster og bileierskap, mer utslag for elbiler

Elbiler har fått betydelige insentiver i Norge, bl.a. tilgang til bussfil, reduserte kjøpsavgifter, gratis bomring og parkering, forutsatt at de erstatter en bensin- eller dieselbil og dermed bidrar til reduserte klimagassutslipp og mindre lokal luftforurensning. Begrenset rekkevidde gjør at de fleste elbiler som var i bilflåten på tidspunktet spørreundersøkelsen ble gjennomført, egner seg best til lokal og regional transport. Det er dermed en mulighet for at enkelte kjøper elbiler som tilleggsbiler, og dermed bidrar til økt bilhold, eller at elbiler kjøres mer siden den variable kostnaden per km er lav og det finnes attraktive brukerinsentiver. På den den annen side kan det skyldes at eierne er i en aldersgruppe og familiesituasjon der dette er mer vanlig. 22% av elbiler, 5% av ladbare hybridbiler og 12% av bensin- og dieselbilene var ekstrabiler. Av bilene som ble erstattet var de aller fleste bensin- og dieselbiler, men 6% elbileiere erstattet en elbil og 2% en hybridbil, tilsvarende for eiere av ladbare hybridbiler var henholdsvis 1% og 4% samt 1% som fornyet en PHEV.

Reisemønsteret var uforandret etter bilkjøpet for 67% av elbileierne, og henholdsvis 87% og 89% av eiere av ladbare hybridbiler og bensin og dieselbiler. De fleste som endret reisemønster hadde negative modale skift i forhold til miljøet og mål for å begrense biltrafikkveksten i byene, dvs. at de kjørte mer og tok mindre kollektivtransport og syklet og gikk mindre. Noen hadde også positive skift. Undersøkelsen sier ikke noe om hvor stor endringen var. Elbileier hadde størst endring men har også størst husholdning og lengst reisevei til jobb. En overgang til elbiler er også langt mindre problematisk for miljøet enn en overgang til bensin- og dieselbiler.

72% av elbileiere, 90% av eiere av ladbare hybridbiler og 81% av bensin- og dieselbileiere, sa at de totale km i husholdningens samlede bilforsikringer var uendret. For elbileiere hadde de økt for 20% og blitt redusert for 8%. For eiere av ladbare hybridbiler var tallene 6% og 4% og for bensin- og dieselbileiere 11% og 8%. Ulikhetene indikerer at det kan være mulig at elbiler kjøres mer enn man ville gjort med andre biler, men det kan også være andre årsaker til disse forskjellene.

Endringer i husholdningen slik som at man har flyttet, en person har byttet jobb, barn må eskorteres mer enn tidligere m.m., er årsaker som oppgis å ha bidratt til beslutningen om å

kjøpe en ekstra bil. Andre årsaker er at brukerne sier de har et utilstrekkelig kollektivtransporttilbud, det er blitt flere personer i husholdningen mens endel elbileiere sier at man ønsker å bruke den andre bilen mindre.

Lading av bilen foregår stort sett hjemme

94-95% av elbil- og ladbar hybridbileiere lader hjemme i garasje, carport eller på parkingsplass. De fleste har greit fått etablert ladeløsning.

Lading hjemme startes normalt av flest i perioden fra kl. 16-18 men en del starter også før kl. 16. Utover kvelden kobler flere seg til mens andre fortsatt lader, noe som medfører at det blir en topp i ladingen som strekker seg mellom kl. 16-22, og dermed legger seg oppå toppbelastningen som allerede er i nettet i samme tidsrom. Det er størst og lengst topp om vinteren fordi flere lader hver dag, og energiforbruket per km er høyere.

Halvparten av elbileiere og tre fjerdedeler av eiere av ladbare hybridbiler, lader aldri bilene på arbeid mens henholdsvis 28% og 16% gjøre det stort sett daglig. Normal offentlig lading er brukt sjeldnere, men seks av ti elbileiere gjør det månedlig eller årlig, gjør bare 10% det ukentlig. To tredeler av ladbare hybrideiere lader aldri på offentlige ladestasjoner.

Hurtiglading brukes litt mer av elbileiere i 2016 enn i 2014, men 30% bruker aldri tilbudet. I underkant av 10% bruker hurtigladere ukentlig, 28% månedlig. 70% planlegger på forhånd å bruke hurtigladere for å gjennomføre turer, og de brukes mest på irregulære turer. Ellers brukes hurtigladere for å redde situasjonen når bilen er i ferd med å gå tom for strøm.

29% av elbileiere og 10% av eiere av ladbare hybridbiler har opplevd ladeproblemer, hvorav «strømløs» er viktigste problem, fulgt av skadet kabel ved hjemmelading og skadet støpsel på offentlige ladestasjoner. 2% har opplevd «svidde» kontakter, et problem som indikerer en potensiell brannfare, men som enkelt kan løses ved å ta i bruk hjemmeladere og mer robuste mode 3 type 2 offentlige ladepunkter.

Eiere av ladbare hybridbiler mener at offentlige ladestasjoner er dårligere enn det elbileiere gjør, men det er også slik at en betydelig høyere andel av eierne av ladbare hybridbiler vet lite om offentlig ladeinfrastruktur sammenlignet med elbileierne. Bare 10% av ladbar hybridbileiere gir infrastrukturen en godkjent karakter. Elbileierne er tredelte, en tredjedel er fornøyd, en tredjedel er misfornøyd og en tredjedel verken eller.

Utfordringer med bruk av bilene er håndterbare

87% av elbileiere har aldri måttet stå over en reise fordi rekkevidden er for kort eller ladetiden for lang, men de 13% som har gjort det gjør det ca. 18 ganger per år, eller fem dager per år gjennomsnittlig for alle elbileiere. Bare 6% prosent av elbileierne har avbrutt reiser med bilen fordi de går tom for strøm. I gjennomsnitt skjer det 12 dager per år for de som har problemet, men bare en gang per år i gjennomsnitt for alle elbileiere. Halvparten av problemene kan fjernes ved å bedre infrastrukturen. Feil på bilene er sjeldne men det hender bileiere feilkalkulerer rekkevidden. Totalt sett er problemene relativt små, men det kan være et utslag av selv-seleksjon, det vil si at man kjøper elbil hvis bruksmønsteret er kompatibelt.

Tesla eiere har stort sett ikke problemer, en indikasjon på at en bil med om lag 300 km vinterrekkevidde kombinert med et godt nettverk av hurtigladere er et bra konsept for norske forhold.

Lite støy fra elbiler gjør at eierne oftere enn andre opplever situasjoner der fotgjengere, syklister eller barn ikke hører bilen komme, som risikable, og kvinner oftere enn menn. Det kan ha ulike årsaker, for eksempel at man oppfatter risiko ulikt.

Bruk og verdi av insentiver

Elbileiere har lokale insentiver som tilgang til bussfil, gratis parkering, gratis bomveier og billigere riksveiferger. Ladbare hybridbileiere har ingen av disse fordelene.

Elbileierne passerer bomstasjoner på vei til arbeid dobbelt så ofte som de andre brukergruppene og sier de sparer dobbelt så mye per uke som det de andre gruppene sier de bruker. Ferge insentivet utgjør lite nasjonalt men er viktig nok lokalt. Den totald verdien av insentivene er estimert av brukerne til 14 000 kr/år, hvorav ca. en tredjedel er sparte tidskostnader ved bruk av kollektivfeltet.

Meninger om elbilers fordeler og ulemper og utvikling siden 2014

Alle gruppene anser miljøegenskaper, brukskostnader og hjemmelading som store fordeler ved elbiler. Elbileierne er mest positive til teknologien, bensin- og dieselbileiere minst positive. Rekkevidde og ladetid er de største ulempene, spesielt slik eierne av bensin- og dieselbiler ser det. Komfort, sikkerhet, design og image evalueres middels av bensin- og dieselbileierne men mer positivt av elbileiere og ladbar hybridbileiere, spesielt komfort. Håndtering av ladekabler går greiere for elbileiere enn i 2014, og greit for ladbar hybridbileiere. Også bensin- og dieselbileiere er mindre negative enn i 2014. Den samme positive utviklingen gjelder for forventet bruktverdi for elbiler der det er betydelig lavere usikkerhet enn i 2014. Også ladetid og varmesystem i elbiler evalueres mer positivt av elbileiere enn i 2014, mens rekkevidde og bilstørrelse evalueres marginalt dårligere enn i 2014, kanskje fordi man gjerne skulle brukt bilen til flere turer.

Meninger om tiltak for å øke markedet for ladbare hybridbiler og elbiler

Konkurransedyktig pris er viktigste faktor for å øke salget av ladbare hybridbiler i henhold til respondentene, fulgt av mer rekkevidde i E-modus. Elbiler har allerede konkurransedyktig pris, så for den biltypen er mer rekkevidde viktigst for å kunne ekspandere markedet.

Median vinterrekkevidde i el-modus som skal til for å øke ladbare hybridbilers markedsappell, er ifølge eierne selv 75 km mens elbileierne sier 85 km og bensin- og dieselbileiere 175 km. Sistnevnte er det ingen bil som klarte opp til 2016, men den oppgraderte BMW i3 som får over 300 km sommerrekkevidde, vil klare dette med installasjon av et ladeaggregat som rekkeviddeforlenger. For øvrig er det små muligheter for at disse rekkeviddeforventningene vil bli oppfylt av særlig mange ladbare hybridbiler de kommende årene. Det vil kreve spesialdesignede biltyper for å få plass til et stort nok batteri, mens bilindustrien hittil har satset på å lage ladbar hybridvarianter av vanlige biler med begrenset batteriplass. For elbiler er tilsvarende rekkevidde ønske ca. 230-300 km. Flere modeller som lanseres de neste årene vil kunne få så lang rekkevidde.

For elbiler er økt tilgang på hurtiglading og å beholde avgiftsfordelene ved kjøp og fritak for bomstasjoner, vesentlig for å beholde og øke appellen. Gratis parkering og billig ferge

er mindre viktige insentiver. For ladbare hybridbiler er det viktig at man vil få lov til å kjøre dersom det blir kjøreforbud i byer ved luftforurensningsepisoder. For øvrig sier elbileiere og ladbar hybridbileiere at økte avgifter på forurensende biler også er en vei å gå, men det var ikke eiere av bensin- og dieselbiler så enige i.

Elbiler og ladbare hybridbiler er foreløpig komplementære teknologier

Ingenting i spørreundersøkelsen indikerer at elbiler og ladbare hybridbiler foreløpig konkurrerer om de samme kundene. Å eie en hybridbil, en elbil eller en ladbar hybridbil ser ikke ut til å bidra til at man vurderer å kjøpe en bil med en av de andre to teknologiene. Potensielt burde for eksempel elbileiere som er lei av rekkevidde utfordringer vært interessert i en ladbar hybridbil, men bare 1% av eierne av de ladbare hybridbilene byttet inn en elbil. Det at elbileierne stort sett får hverdagen til å gå rundt gjør det jo mindre interessant å bytte til en dyrere biltype uten lok ale fordeler, for å få ubegrenset rekkevidde.

Biltypene er delvis i ulike størrelsessegmenter. Elbiler er stort sett mini-, små- og kompaktbiler med unntak av storbilen Tesla Model S, mens ladbare hybridbiler er kompakte og store biler og terrengbiler. Dette vil endre seg i fremtiden, men elbiler får neppe konkurranse av ladbare hybridbiler i mini- og småbilsegmentene.

1 Introduction

Battery Electric Vehicles (BEVs) and Plug-in Hybrid Vehicles (PHEVs) can contribute to reduction of greenhouse gas emissions and local pollution when replacing transport otherwise carried out using diesel or gasoline fuelled vehicles. 98% of Norwegian electricity production is based on Hydro-electric power plants (Figenbaum and Kolbenstvedt 2015). The total annual electricity production is on average sufficient to power Norway's annual electricity consumption. As electric power production is part of EUs Emission Trading System (EU ETS), the emission from foreign produced imported electricity will also be emission free when BEVs or PHEVs replace diesel or gasoline vehicles, since the EU ETS has an emission ceiling. The increased electricity consumption from BEVs will not increase this ceiling, and will therefore lead to additional renewable electricity production being established somewhere in Europe, or the emission from fossil fuel based electricity being offset by emission reductions somewhere within EU ETS.

Norway has introduced numerous incentives for BEVs leading to market shares in the area of 15-20 % in 2015 and Q1-2016 and a share of over 3% of the total passenger vehicle fleet. PHEVs have gained momentum through 2015 and in Q1 2016 reached a market share of 12%, and a share of the fleet of 0.6%.

The development of the total new vehicle market shares for BEVs and PHEVs, is presented in figure 1.1.

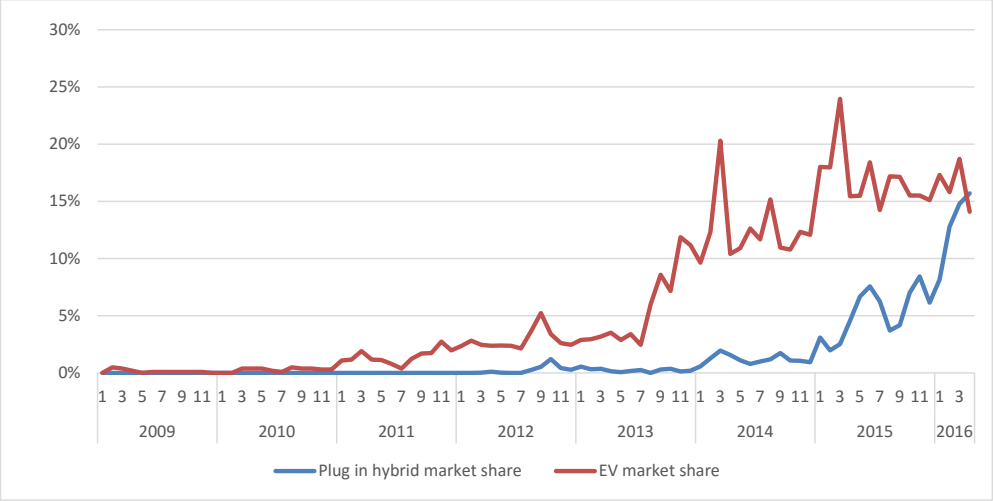


Figure 1.1 New vehicle market share BEVs and PHEVs, Norway 2009-2016. Source: OFVAS 2016. Norwegian PEV consumer survey, TØI 2016.

Norway consists of 19 provinces, as seen in figure 1.2. Some results will be analysed for individual provinces to explore regional differences. Oslo, the capital, is a province of its own. The other main cities are marked in the map.

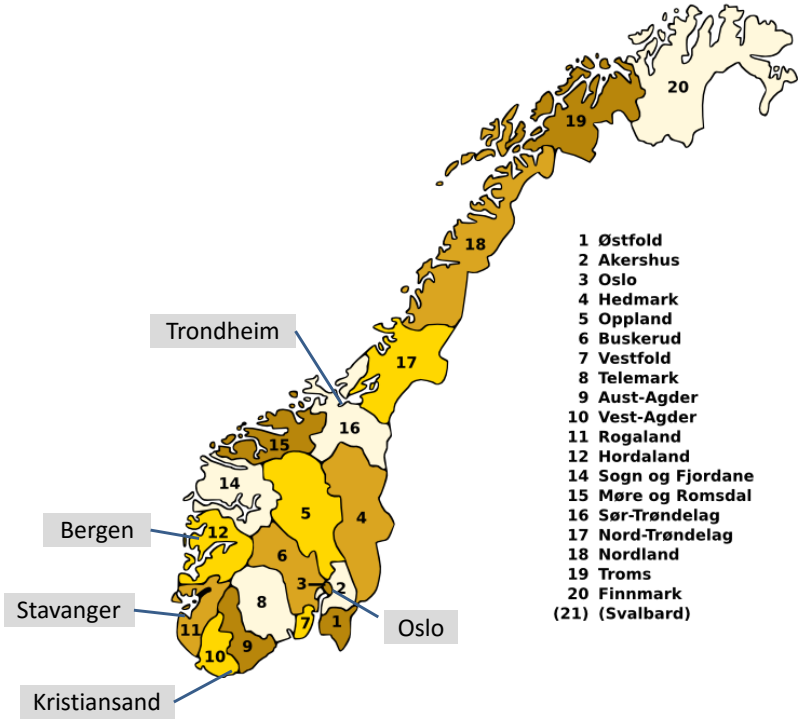


Figure 1.2 Norway's provinces and cities. Map source: Wikipedia

The geographical spread of the approximate 70 000 BEV and 12 000 PHEV owners per 31.12.2015, is shown in figure 1.3.

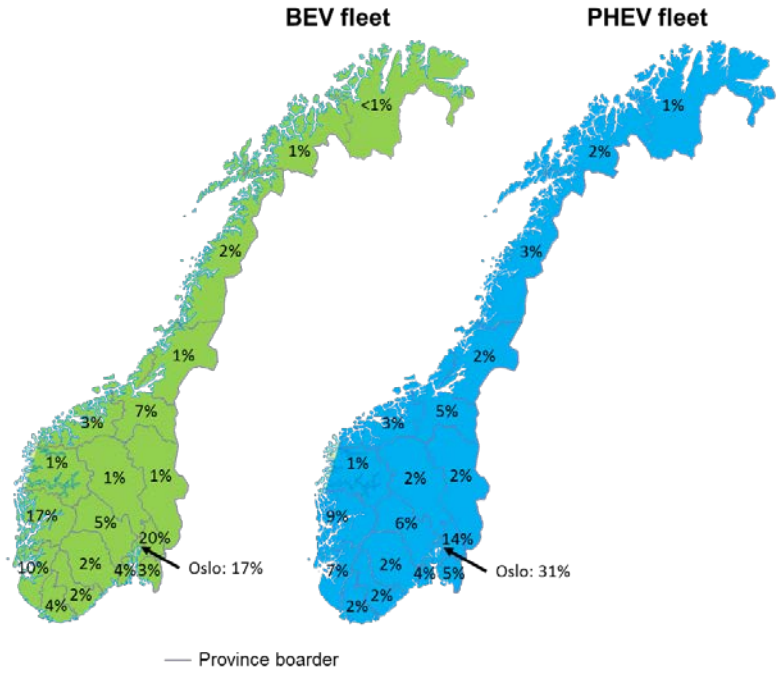


Figure 1.3 Geographical distribution of national fleet of BEVs (left) and PHEVs (right), percentage. Norwegian PEV consumer survey, TØI 2016.

Norwegian owners of PHEVs, were surveyed to obtain information on how these vehicles are used, and why people buy them. Owners of BEVs and Internal Combustion Engine

Vehicle (ICEVs), were surveyed to provide a basis for comparison, and to be able to see if BEVs and PHEVs attract the same or different customers.

The survey is part of the project Emissions from Road Transport Vehicles (Emiroad), which focuses on improving the understanding of emissions from vehicles. Emissions from vehicles are in laboratories measured using a standard driving cycle that ideally should represent "average driving" in real traffic. Whereas there is substantial knowledge on how owners use ICEVs in real life, no information existed on the usage of PHEVs, so there was no way to relate the laboratory emission to real traffic emissions. The problem is particularly important for PHEVs since they can partly operate in a fully or almost fully electric drive mode using grid electricity with zero tailpipe emissions.

There is also a need to update the knowledge on BEVs, to be able to estimate how much they are used and if they replace ICEVs fully or if there could be unwanted side effects. The objective of the survey is to fill these knowledge gaps. A similar survey will be done in Sweden in the SELF-I project, but limited to owners of BEVs and PHEVs. The two projects have cooperated on the questionnaire so that some questions are identical to allow for comparisons across the border.

PHEVs have an electric propulsion system that gets its power from batteries recharged from the grid. In addition, an internal combustion engine (ICE) power either the wheels directly, or is coupled to a generator producing electricity used to recharge the battery and feed electricity to the electric motor. Numerous configurations are possible and these vehicles can run in full electric (or almost full electric) drive mode (E-mode) for 25-83 km, depending on the model, according to the official European test procedure. When the battery is empty, the ICE starts up. In practice, the E-mode range is less in real traffic and there are temperature limitations: Some systems do not operate in E-mode in low temperatures, or in some cases starts the ICE to provide cabin heat even when driving in E-mode.

The pattern of use thus becomes very important for PHEVs. When running in E-mode, kilometres that would otherwise be done with ICEVs is replaced with electricity powered driving, resulting in reduced greenhouse gases and less local pollution. The share of electric powered driving is thus a measurement of the environmental effect of PHEVs. When not driving in E-mode, the fuel consumption of PHEVs may be slightly higher than for non-rechargeable hybrids since they are heavier (due to a larger battery and more electronics). For BEVs the equation is simpler. All BEV driving replaces ICEV driving with electric powered driving, given that the BEV replaces an ICEV. If the BEV is an additional vehicle, then the result on emissions depends on whether the owner would have bought an ICEV instead if BEVs had been unavailable.

In the proposal for the next National Transportation Plan covering the period 2019 to 2027 (NTP 2018-2029), the Transport Authorities presented the target that all new passenger vehicles sold in 2025 shall be zero emission, i.e. pure electric or hydrogen powered. Until 2025, fossil fuelled vehicles sold shall be plug in hybrids. The same document also has a target that all future traffic growth in cities shall be based on public transport, walking or cycling. The report therefore presents data that can shed light on how these targets can become achievable, i.e. how to expand the market for BEVs and PHEVs through a better understanding of how these vehicles are used, why they are bought, and what will make more people buy them. The effects on modal shares will also be analysed.

The report provides an overview of the total survey results.

2 Methodology and survey design

The survey's primary objective was to provide information about how PHEVs why people buy them, how they are used, and the users' opinions about them. In addition, BEV owners and ICEV owners surveyed, provide a reference for the results. A previous survey of BEV and ICEV owners conducted in 2014 as part of the COMPETT project (Figenbaum et al 2014), makes it possible to track changes over time.

A list of the survey's questions is presented in appendix one, and the questionnaire in appendix two. The questions and the questionnaire were developed from the 2014 survey, adding relevant questions for PHEV owners covering important aspects identified in the literature. Readers interested in the further background on the strategy and theoretical background for the survey design of the 2014-survey, is referred to Figenbaum et al (2014).

The main categories of questions were:

- Socio-demographics and other information on respondents
    - Age, gender, income, education
    - Membership in environmental NGO, interest in vehicles
- Household characteristics and vehicle ownership
    - Type of house and area of living
    - Number of vehicles by fuel type
    - Household size, i.e. total number of persons, children, driving licences
    - Postal area code (translated into municipality)
- Process of buying the vehicle
    - Where, from whom
    - Information sources
- Vehicle usage pattern
    - Trips with the vehicle
    - Total driving length
    - Range and electrical km travelled
    - Challenges using the vehicle
- Charging the vehicle
    - Where, how, how often, type of chargers and grid connection
    - Public charging, perception of offering, where, usage frequency
    - Challenges with charging
- Travel pattern influences
    - Reasons for buying the vehicle
    - Modal changes
    - Work trips
    - Long distance travel
- Incentives
    - Importance and usage
- Technology diffusion related topics

- Information sources
- Influence on friends and family
- Willingness to buy vehicle with the same propulsion technology again

The survey was, as seen in table 2.1, sent out to three different vehicle owner groups. EV owners were primary reached through the membership registry of the EV association. Private PHEV owners were reqruited by sending out postcards to the private owner registered address in the national vehicle register of the Norwegian Public Roads Administration. Vehicle owners in general were recruited by sending e-mails to a representative national selection of 20 000 members of the Norwegian Automobile Federation (NAF). These different reqruitment methods could potentially result in some persons receiving more than one invitation to participate.

Respondents selected the type of vehicle they answered about, a battery electric vehicle, a PHEV or a vehicle with an ICE (including hybrids without a plug).

Table 2.1 Overview of sample. Norwegian PEV consumer survey, TØI 2016.

Sample	Survey recipients	Respondents	Response rate	Share of national fleet	Date
PHEV owners	7.870 mail letters with address to the online survey, only private owners 47 letters returned with unknown address	2065 PHEV owners	26.4%	17%	
EV association members	16.321 members with e-mail address	3111 EV owners	19%	4%	
Norwegian Automobile Federation (NAF) members	20.000 members with e-mail addresses selected randomly to represent national average	3080 ICEV owners	15%	0.12%	
Total	44.191	8.256 (+ 46 non-owners)	18.7%	0.3%	

It is difficult to calculate the exact response rates for each group of owners. One can however assume that PHEV owners answered questions about PHEVs, EV association members answered about BEVs and NAF members mainly answered questions about an ICEV. On average, one would expect that only about 3% of NAF members own a BEV or a PHEV based on the share of these models in the Norwegian vehicle fleet so the assumption seems reasonable.

3 Sample characteristics

3.1 BEV and PHEV Models represented in the survey

The sample is relatively representative of the BEV fleet average. The most important deviations are an overrepresentation of Tesla Models S as seen in table 3.1 and an underrepresentation of Nissan Leaf (balanced by an overrepresentation of similarly capable vehicles). The sample was un-weighted, with the exception of a few calculations noted specifically.

Table 3.1 BEV models in the sample. n_{BEV} = 3111. Source fleet data: NPRA (2016). Norwegian PEV consumer survey, TØI 2016

BEV models	Respondents	Share of respondents	Total BEV fleet (31.12.2015)	Fleet share
BMW i3	215	7 %	4476	6 %
Citroën C-Zero	73	2 %	2008	3 %
Peugeot Ion	64	2 %	1970	3 %
Mitsubishi I-Miev	97	3 %	3099	4 %
Kia Soul	272	9 %	3348	5 %
Mercedes B class	81	3 %	1473	2 %
Nissan Leaf	697	22 %	21386	30 %
Renault Zoe	97	3 %	2076	3 %
Tesla Model S	608	20 %	9911	14 %
Volkswagen E-Up	194	6 %	5472	8 %
Volkswagen E-Golf	562	18 %	11405	16 %
Nissan E-NV200	14	0 %	732	1 %
Ford Focus	9	0 %	65	0 %
Renault Fluence	3	0 %	52	0 %
Smart fortwo	4	0 %		0 %
Tesla Roadster	5	0 %	83	0 %
Renault Kangoo ZE	5	0 %	450	1 %
Think City	22	1 %	858	1 %
Kewet Buddy	13	0 %		0 %
Others	35	1 %	1941	3 %
Unknown	41	1 %		
Total	3111		70805	

The PHEV sample has a good representation of the fleet, as seen in table 3.2, but, due to the method of data collection, it is only representative of private owners.

Table 3.2 PHEV models in the sample. n_{PHEV} = 2065. Source fleet data: NPRA (2016). Norwegian PEV consumer survey, TØI 2016

PHEV models	Respondents	Share of respondents	Total fleet 31.12.2015	Share of fleet
Audi A3 E-tron	255	12 %	1825	15 %
BMW i3 REX	4	0 %	35	0 %
BMW i8	1	0 %	57	1 %
BMW 225xe	1	0 %	3	0 %
BMW X5	5	0.2%	64	1 %
Chevrolet Volt	4	0.2%	11	0 %
Mercedes C350e	16	0.8 %	117	1.0 %
Mitsubishi Outlander	1087	53 %	5902	49 %
Opel Ampera	61	3 %	248	2 %
Porsche Cayenne	7	0 %	88	1 %
Porsche Panamera	1	0 %	7	0 %
Toyota Prius PHEV	85	4 %	412	3.4 %
Volkswagen Golf GTE	368	18 %	2189	18 %
Volkswagen Passat GTE	8	0 %	94	1 %
Volvo V60	151	7 %	1027	8 %
Others/Unknown	11	0,5 %	151	1 %
Total respondents	2065		12136	

The average BEV owner owns a 2014 model (2 years old), the average PHEV owner a 2015 model (1 year old) and the average ICEV owner a 2009 model (7 years old) as seen in figure 3.1. The average vehicle in the fleet is 10.5 years old (OFV AS Kjøretøystatistikk 2015).

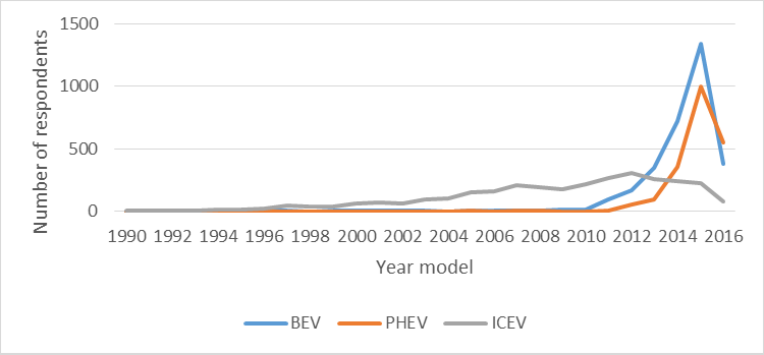


Figure 3.1 Vehicle age by type of vehicle in the sample. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

3.2 Geographical distribution of respondents

The geographical distribution of the respondents is as seen in table 3.3, relatively representative of the fleet's geographical distribution. The biggest exception is the number of PHEVs in Oslo. A large share of PHEVs are leasing company owned vehicles registered in Oslo. These vehicles could be in use anywhere in the country. The survey only covers privately owned PHEVs.

Table 3.3 Geographical distribution of survey respondents and the total fleet. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Source fleet data: NPRA (2016). Norwegian PEV consumer survey, TØI 2016.

	BEV		PHEV		ICEV	
	Respondents	Fleet 31.12.2015	Respondents	Fleet 31.12.2015 (Private)	Respondents	Fleet 31.12.2015
Østfold	5 %	3 %	6 %	5 % (6 %)	4 %	6 %
Akershus	19 %	20 %	16 %	14 % (16 %)	15 %	12 %
Oslo	14 %	17 %	13 %	31 % (12 %)	11 %	11 %
Hedmark	2 %	1 %	3 %	2 % (2 %)	5 %	4 %
Oppland	1 %	1 %	3 %	2 % (3 %)	4 %	4 %
Buskerud	6 %	5 %	7 %	6 % (7 %)	6 %	6 %
Vestfold	5 %	4 %	5 %	4 % (5%)	4 %	5 %
Telemark	2 %	2 %	3 %	2 % (3 %)	3 %	4 %
Aust-Agder	2 %	2 %	2 %	2 % (2 %)	2 %	2 %
Vest-Agder	3 %	4 %	2 %	2 % (2 %)	3 %	3 %
Rogaland	9 %	10 %	8 %	7 % (10 %)	7 %	9 %
Hordaland	15 %	17 %	13 %	9 % (13 %)	10 %	9 %
Sogn og Fjordane	1 %	1 %	2 %	1 % (2 %)	2 %	2 %
Møre og Romsdal	3 %	3 %	4 %	3 % (4 %)	5 %	5 %
Sør-Trøndelag	6 %	7 %	5 %	5 % (6 %)	6 %	6 %
Nord-Trøndelag	2 %	1 %	2 %	1 % (2 %)	3 %	3 %
Nordland	3 %	2 %	3 %	2 % (3 %)	5 %	5 %
Troms	1 %	1 %	2 %	1 % (2 %)	4 %	3 %
Finnmark	0 %	0 %	0 %	1 % (1 %)	1 %	1 %

3.3 Socio-demographics of owners

The socio-demographical data in table 3.4 demonstrates that there are differences between the samples. It will, however, be demonstrated that these differences become much smaller when the samples are limited to those who own newer vehicles (2011 and newer) and are working full time.

Table 3.4 Work status, education, gender, age among the different samples. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

		BEV	PHEV	ICEV
Work status	Employed or self-employed	91 %	77 %	67 %
	Retired/Benefit recipient	8 %	23 %	33 %
	Student	1 %	0 %	1 %
Education	Primary and lower secondary school (1-10th grade)	2 %	3 %	5 %
	Upper secondary/High school (11-13th grade)	20 %	22 %	28 %
	Higher education up to 4 years	38 %	38 %	37 %
	Higher education in excess of 4 years	40 %	37 %	29 %
Gender	Female	20 %	17 %	22 %
	Male	80 %	83 %	78 %
Average age		47 years	55 years	56 years

The respondents' (in most cases also the owner) age profile shows that BEV owners are young, typically 35-54, with the average owner being 47 years old as seen in figure 3.2, which is identical to the BEV owners age in the 2014 survey (Figenbaum et al 2014). PHEV owners have a flatter profile, the majority being in the interval 45-66. The average PHEV owner is 55 years old. ICEV ownership peaks in the 55-66 cohort, but also strongly represented in the 45-54 age group, the average being 56 years old. The share of BEV owners in the cohorts 25-34 and 35-44 is about double of the other groups whereas there are BEV owners in the 67-74 cohort.

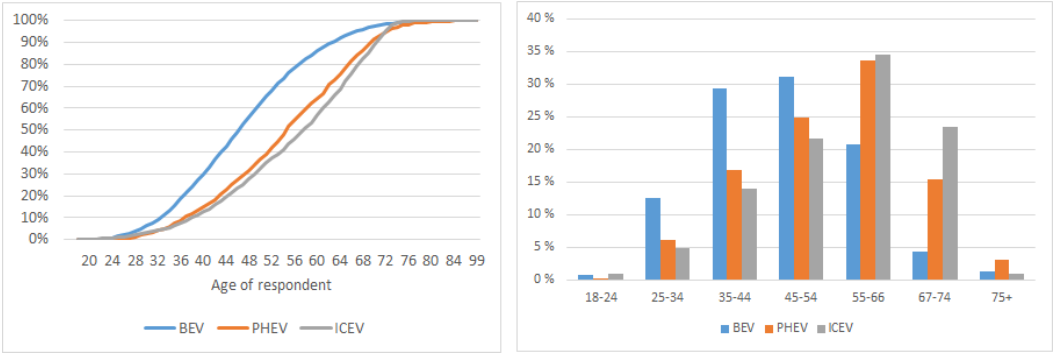


Figure 3.2 Age profile of respondents, accumulated (left), cohorts (right). n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

3.4 Household size and income

BEV households are large, 56% having children, twice as many as ICEV owning households. PHEV owners have slightly more children than ICEV owners, as seen in table 3.5. The gross income is higher among BEV owners when we look at BEV owners at large. In a later chapter, the picture will prove to be different when looking at owners of newer vehicles in all three groups.

Table 3.5 Household size and gross income in the different samples. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

		BEV	PHEV	ICEV
Household size	Average number of persons in household	3,2	2,6	2,5
	Share of households with children	56%	32%	27%
	Share of households with more than 1 child	38%	20%	16%
	Average number of Children below 18y	1,1	0,6	0,5
	Number of persons with driving licence	2,03	1,96	1,87
Household gross income	<200 000	0 %	0 %	1 %
	200-400 000	3 %	3 %	8 %
	400-600 000	9 %	13 %	21 %
	600-800 000	14 %	19 %	22 %
	800-1000 000	23 %	22 %	22 %
	>1 000 000	51 %	44 %	26 %
	Average	920 171	884 289	774 025

3.5 Housing conditions

In theory, one would expect that BEV and PHEV owners predominantly live in single-family houses, row houses or other smaller building types to have access to parking and charging facilities on their own land. There are numerous reports in the press about issues related to charging that people living in flats with shared parking facilities face. It turns out, however, that all groups mainly live in single-family houses as seen in figure 3.3. About 15-20% live in flats, mainly in cities, in all groups. Two times more BEV owners than ICEV owners live in detached houses in cities. The differences may partly be a result of the different methods of recruiting the participants for the survey. The NAF members, from where the ICEV respondents were recruited, were selected as a representative national sample of NAF members.

BEVs are more common in cities than in the countryside according to the national vehicle register. As a comparison, 49% of all households in Norway live in single family houses (+plus 5% living in farm houses), 25% live in flats and about 20% in row houses and other small houses (SSB 2015: Boforhold, levekårsundersøkelsen).

A possible explanation for the similar share of owners of flats could be a natural selection amongst BEV and PHEV owners. You «only» buy this type of vehicle if you can charge it at home. Those living in flats in the survey should, thus be those who have succeeded in establishishing charging facilities for their vehicles.

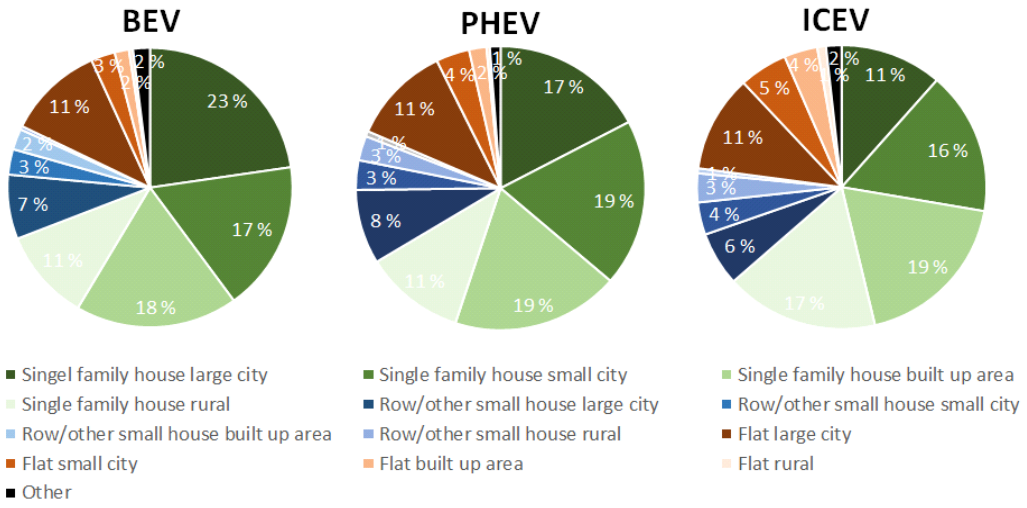


Figure 3.3 Housing conditions of the sample groups. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

3.6 Vehicle ownership

Vehicle ownership is rather similar amongst PHEV and ICEV owners, as seen in figure 3.4. Just under half of them belong to multivehicle households, whereas 79% of BEV owners have more than one vehicle at their disposal. Of BEV households, 21% only own one BEV, 4% own more than one BEV, about the same share as in the survey in 2014 (Figenbaum et al 2014). Another 4% have a BEV in combination with a PHEV. The rest owns BEVs in combination with ICEVs. In the national travel survey from 2014 (Hjorthol et al 2014) the share of vehicle owning households that have one vehicle in the household is 51%.

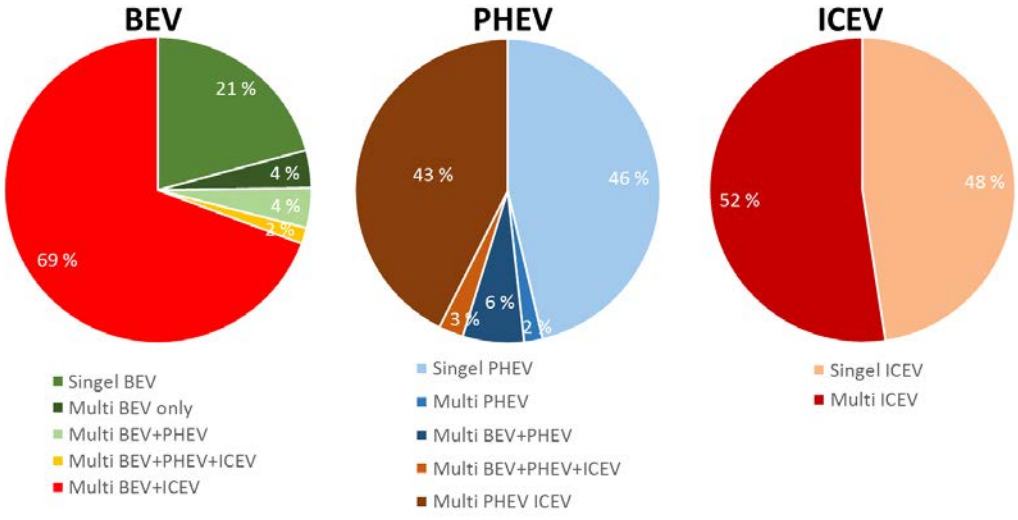


Figure 3.4 Vehicle ownership in BEV, PHEV and ICEV households. n_{BEV} = 3290 (3111+ some ICEV/PHEV owners also owning a BEV), n_{PHEV} = 2140 (2065+ some BEV/ICEV owners also owning PHEVs), n_{ICEV} =3022 (3080 -those ICEV owners that own also BEV or PHEV). Norwegian PEV consumer survey, TØI 2016.

The distribution of BEV only ownership between provinces is shown in figure 3.5. Oslo has the highest share of single vehicle owners, by far, but, in general, Oslo has a low share

of multivehicle ownership. The lowest share is found in Møre og Romsdal, whereas the adjacent province Sogn og Fjordane, also a region with Fjords and long distances, has the second highest, followed by provinces with larger cities.

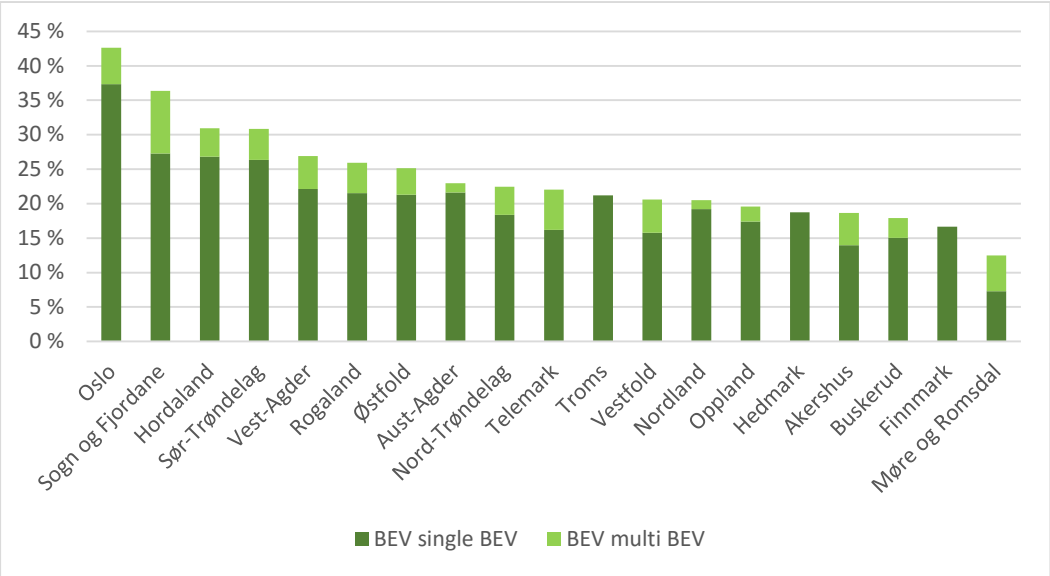


Figure 3.5 BEV only ownership by province. Norwegian PEV consumer survey, TØI 2016.

Vehicle ownership in households that only own a BEV is of particular interest, i.e. can they cope with a standard BEV given the range and charge time limitations? Figure 3.6 shows the share of BEVs in different BEV households. Of BEV single vehicle households, 30% own a Tesla Model S, versus the 15% of households that also own ICEVs. About 60% of households owning multiple BEVs, i.e. only BEVs, own a Tesla Model S. The latter indicates that some multi BEV ICEV household become a BEV only household when a Tesla is taken into use. A standard limited range BEV suffice for 15% of all BEV owners as their only household vehicle.

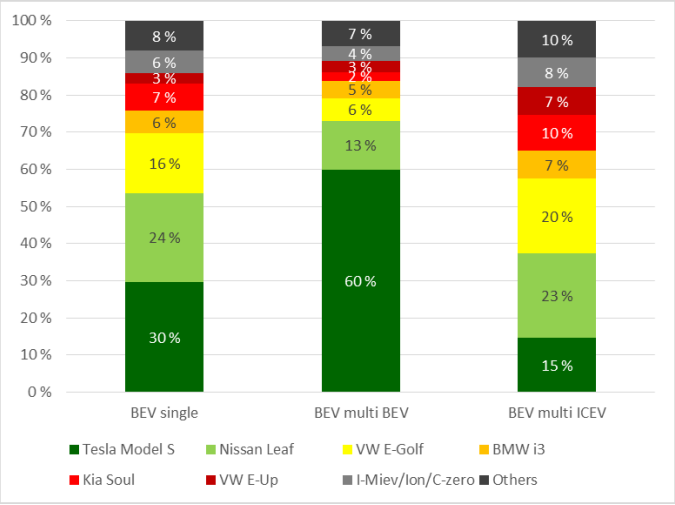


Figure 3.6 Vehicle ownership in different BEV households, $n_{BEV\,single}$*=680,* $n_{BEV\,MultiBEV}$*=130,* $n_{BEV\,MultiICEV}$*=2224. Norwegian PEV consumer survey, TØI 2016.*

3.7 Sub samples used in the report

Various sub samples are used, to be able to take socio-democraphic differences into account when analysing behaviour related to buying or using vehicles.

- Owners of year models 2011-2016 working full-, part-time or being self-employed
- Owners of year models 2011-2016
- Owners of year models 2010 and older
- Single vehicle households
- Multi vehicle households
- Specific models of BEVs and PHEVs

4 Buying the vehicle

The buying process within the sample groups is different. As seen in the sample characteristics, BEV and PHEV owners have newer vehicles than the average ICEV owner, and the sources of information and factors leading to the vehicle purchase differ.

4.1 Where and how

About 85% of BEVs and PHEVs where bought new at brand dealers, another 5% second hand. These brand dealers, thus, hold the key position in the diffusion of these new technologies. A small market of 4% peer to peer second hand BEV sales has also emerged. The main reason for this situation is, of course, that BEVs and PHEVs use new technologies, and relatively few have entered the second hand market so far. Over the next years a large expansion of the second hand market for BEVs is expected, as BEVs bought in 2011-2013 will enter the second hand market. For ICEVs, the picture is very different, 44% are bought new at brand dealers and 24% second hand at brand dealers. Peer to peer sales is four times higher and independent brand dealers play a larger role as seen in figure 4.1.

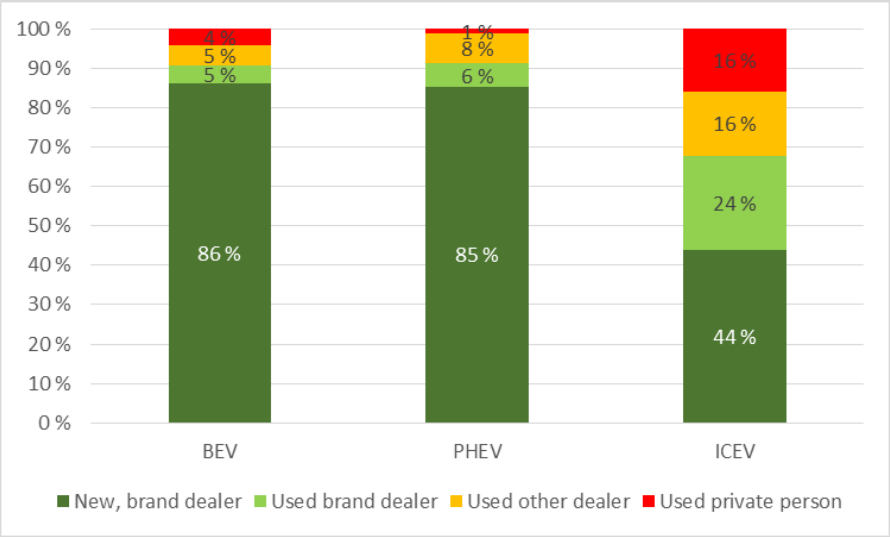


Figure 4.1 Source of purchased vehicles within the samples. n_{BEV} *= 3111,* n_{PHEV} *= 2065,* n_{ICEV} *=3080. Norwegian PEV consumer survey, TØI 2016.*

Most respondents had decided what vehicle type they wanted before going to a dealer. BEV owners more so than PHEV owners, whereas ICEV owners are the least determined, figure 4.2. This result indicate that dealers were not the most important link in the decision-making chain leading to the purchase of the vehicle.

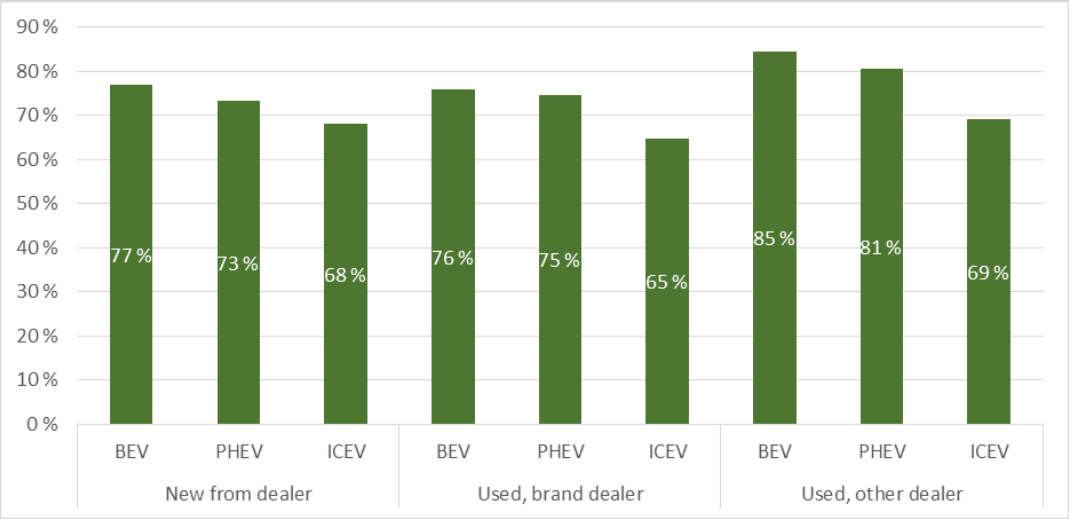


Figure 4.2 Share that decided to buy the type of vehicle before going to the dealer, by type of dealer. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

4.2 Information sources

The information sources that had a decisive impact on the purchase decision differ between the groups. BEV owners primarily got information from friends/family and secondarily from the dealer and advertising material, see figure 4.3. Dealer information was the most important for buyers of PHEVs and ICEVs, followed by advertising material for PHEV owners and friends/family for ICEV owners. These results are logical in the sense that ICEVs are mature products that you go to the dealer to buy influenced by the opinion of and experience with the brand and vehicle type amongst your peers.

BEVs have been on the marker longer than PHEVs and many more will therefore have friends that own BEVs that can provide them with reliable information. It is more important for BEV buyers to get information from peers than it is for ICEV owners. BEV has a limited range and longer refill times than the traditional ICEV vehicle, which lead to the potential need for usage pattern adaptations. It is difficult for buyers to foresee such needs before buying the vehicle. Getting information from existing owners is therefore useful. Advertising material is typically more important to bring the consumers' attention to technology that is not yet widely known amongst their peers, in this case PHEVs. These observations fit well with Rogers' theory of diffusion of innovations (Rogers 1995). The diffusion of innovations will according to Rogers be faster through peer-to-peer communication. In the early diffusion phase observability and testability of the innovation is very important. Further discussion of this theory as applied on the Norwegian BEV market, can be found in Figenbaum and Kolbenstvedt (2015).

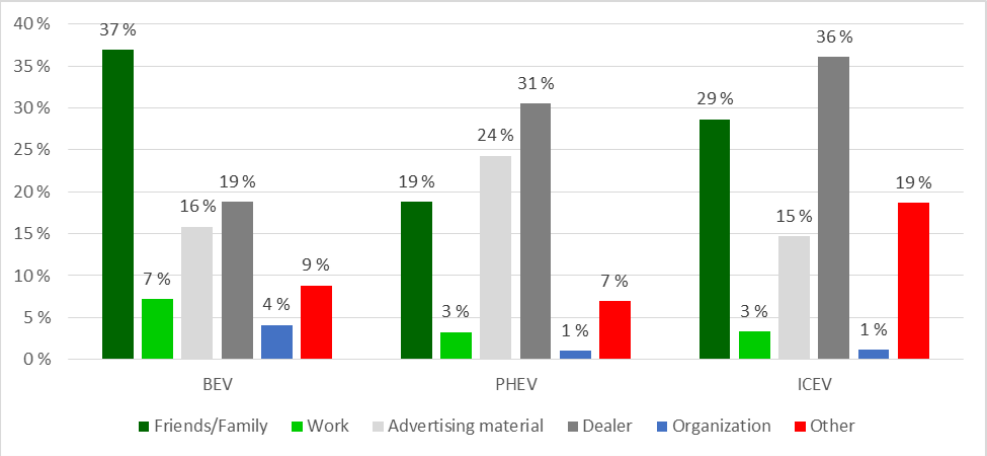


Figure 4.3 Decisive information sources leading to the vehicle purchase. Multiple answers were possible. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

4.3 Reasons for buying their vehicle

Most BEVs and all PHEVs in the Norwegian fleet are newer than 2010 models. The ICEV owner group was organised in two groups, one containing owners of 2011 and newer vehicles and the other with owners of older vehicles. In the analysis of reasons for buying a vehicle, this approach facilitated a better comparison with BEV and PHEV owners. Table 4.1 presents an overview of factors having a large impact on the decision to purchase the respondents vehicle, with detailed answers in figures 4.4-4.8.

Table 4.1 Factors that had a large impact on the decision to buy vehicles (stated by over 50% of buyers). $n_{BEV2011+}$ = 2936, $n_{PHEV2011+}$ = 1699, $n_{ICEV2011+}$ =1295. $n_{ICEV<2011}$ =1590. Selected from 19 factors. YM=Year Model. Norwegian PEV consumer survey, TØI 2016.

	BEV2011+YM	PHEV2011+YM	ICEV2011+YM	ICEV<2011YM
1 priority	Low energy cost	Short trips on electricity	Reliability	Reliability
2. priority	Best for my need	Best for my need	Best for my need	Best for my need
3. priority	Value for money	Reliability	Comfort	Value for money
4. priority	Reliability	Low energy cost	Safety	Comfort
5. priority	Low cost service/maintenance	Comfort	Value for money	Safety
6. priority	Environment	Value for money		
7. priority	Comfort	Environment		
8. priority	Exemption toll road charges	Safety		

"Best vehicle for my need" is equally important to all the groups. Comfort and reliability are more important to owners of newer ICEVs than to BEV owners, with PHEV owners being in the middle. Owners of older ICEVs are less demanding. Performance is not particularly important in any group.

Slightly more buyers of PHEVs, compared to BEV owners, say the environment was important. Few ICEV owners highlight the environment as a reason for buying their vehicle, owners of older ICEVs even less so. The latter group, of course, has fewer environmentally friendly options. Safety is most important to buyers of newer ICEVs followed by older ICEVs, with BEV owners being the least concerned. It is a bit surprising that BEV owners are less interested in safety considering the fact that they have more children than other groups. Older people have, on the other hand, a higher risk of being involved in accidents.

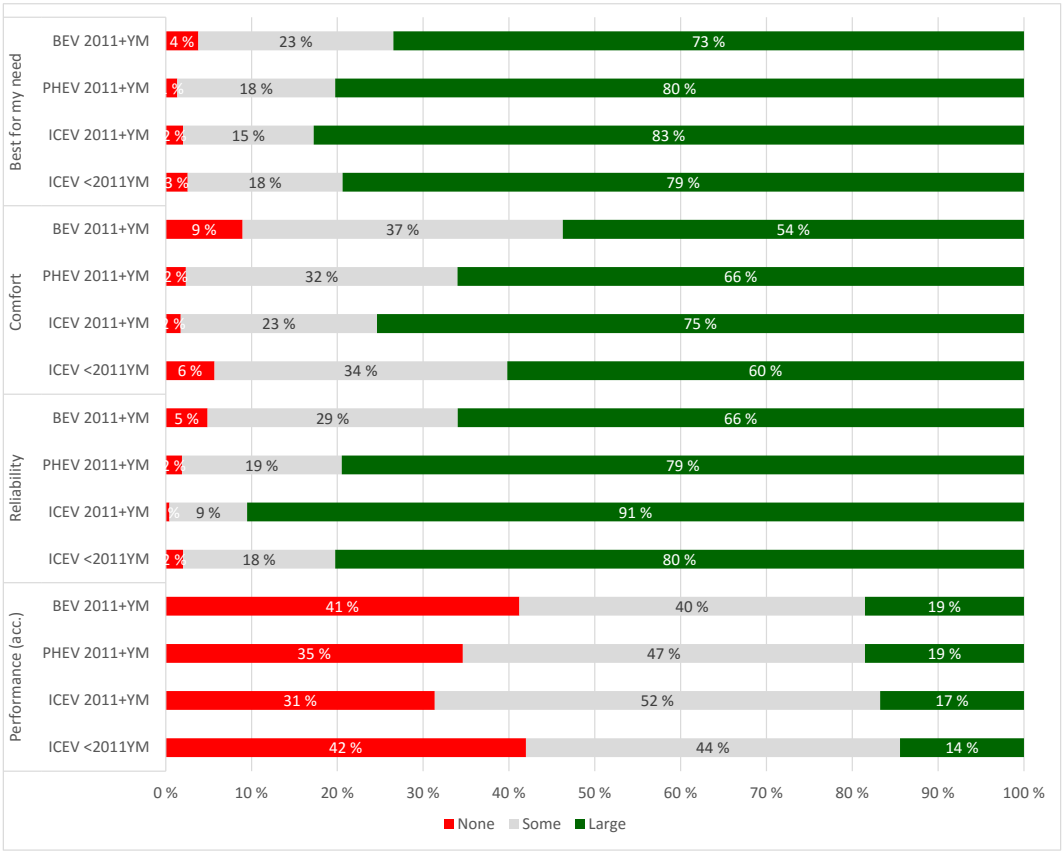


Figure 4.4 Importance of practical aspects when buying the vehicle. $n_{BEV2011+}$ = 2936, $n_{PHEV2011+}$ = 1699, $n_{ICEV2011+}$ =1295. $n_{ICEV<2011}$ =1590. YM=Year Model. Norwegian PEV consumer survey, TØI 2016.

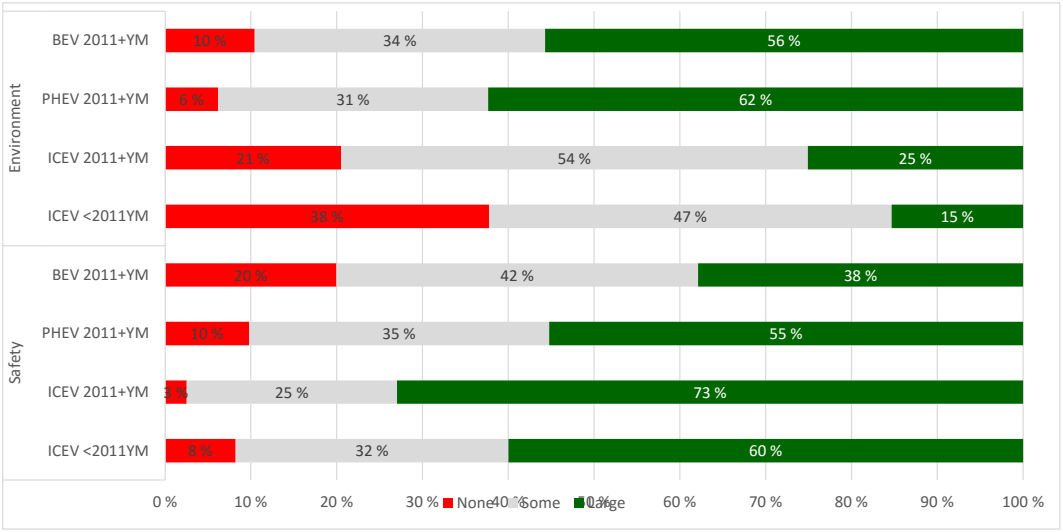


Figure 4.5 Importance of societal aspects when buying the vehicle. $n_{BEV2011+}$ = 2936, $n_{PHEV2011+}$ = 1699, $n_{ICEV2011+}$ =1295. $n_{ICEV<2011}$ =1590. YM=Year Model. Norwegian PEV consumer survey, TØI 2016.

"Value for money" is important to all groups. Purchase incentives to BEV and PHEV buyers are included in this variable. BEV owner's rate variable cost (energy and service) as extremely important compared to the others. PHEV owner's rate energy costs as important, having bought a very complex vehicle, rather than service cost.

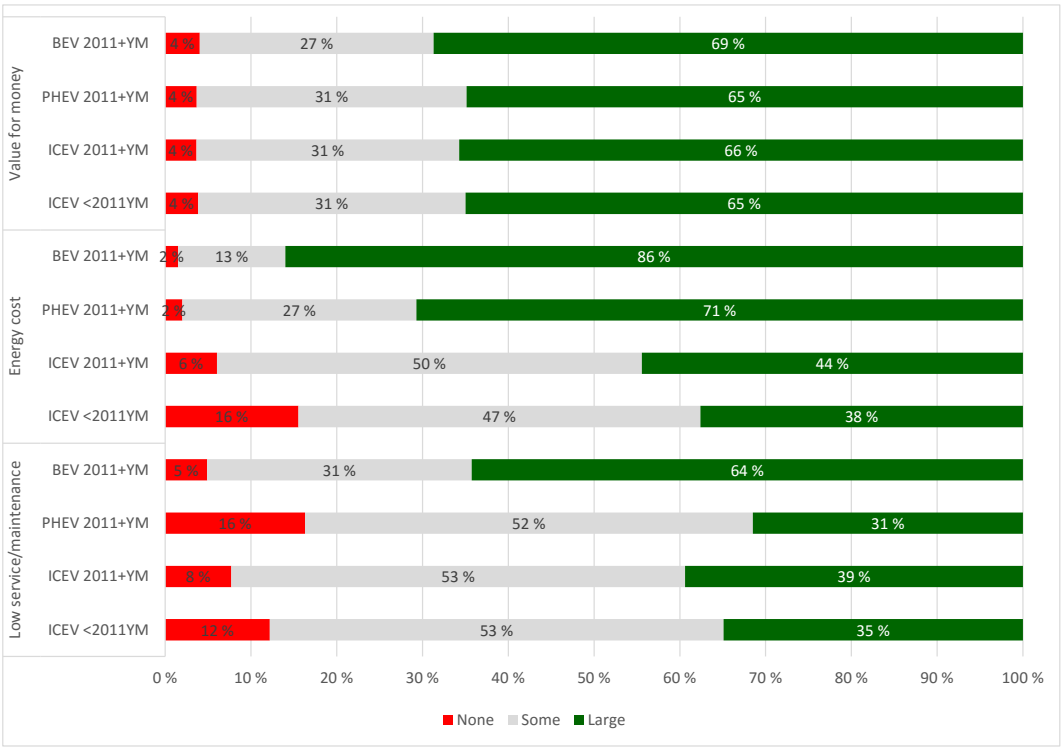


Figure 4.6 Importance of economic aspects when buying the vehicle. $n_{BEV2011+}$ = 2936, $n_{PHEV2011+}$ = 1699, $n_{ICEV2011+}$ =1295. $n_{ICEV<2011}$ =1590. YM=Year Model. Norwegian PEV consumer survey, TØI 2016.

Additional questions to BEV owners give insights into the importance of BEV specific incentives. The exemption from toll road fees and reduced annual tax are important reasons for buying BEVs. All buyers benefit from the lower annual tax, and the exemption from toll roads is also very important many places. Bus lane access and reduced ferry rates are incentives that fewer can utilize, and therefore not so important on a national scale.

These incentives can however be very important to those who can take advantage of them. Free parking and a reduced imposed benefit tax of owning a company vehicle, are incentives that users only rate somewhat important. BEV buyers, so far, are not preoccupied with brand preferences. Work place charging is also not an urgent issue for them.

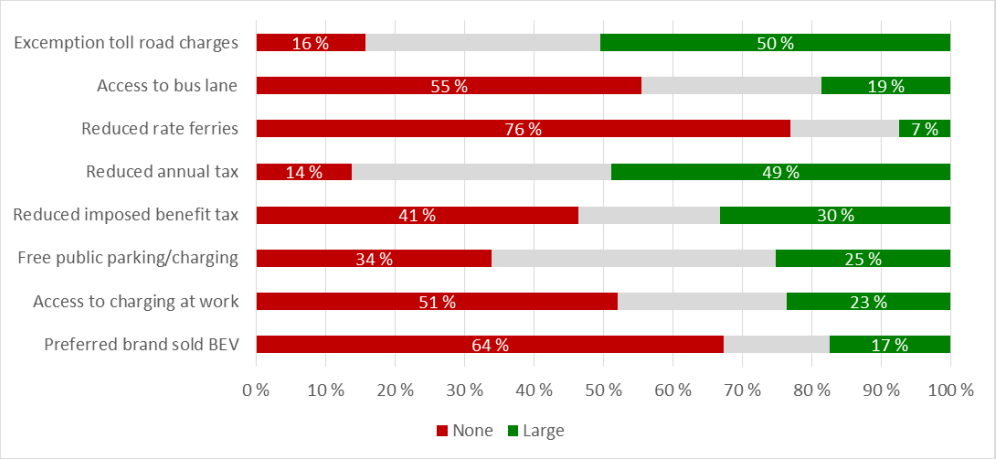


Figure 4.7 Importance of various factors when buying a BEV. n_{BEV} = 3111. Norwegian PEV consumer survey, TØI 2016.

PHEV owners value highly the ability to do short distance trips on electricity. This was most likely the principal reason why most owners bought a PHEV instead of a HEV or ICEV.

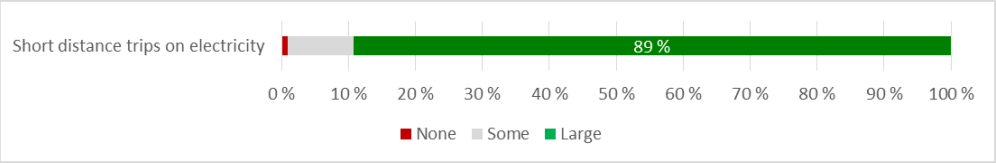


Figure 4.8 Importance of ability to drive electric on shorter distances when buying a PHEV. n_{PHEV} = 2065. Norwegian PEV consumer survey, TØI 2016.

Performance (acceleration) did not have a large impact on the purchase decision in any of the groups, which was a surprise, as high performance seems to be the sales pitch of many PHEVs. When looking at individual PHEV models one can see that performance oriented models such as the Golf GTE, Volvo V60 and Mercedes C350e attract more people interested in performance. Buyers of Prius and Outlander are not interested in performance at all, as seen in figure 4.9. Buyers of Tesla Model S, renowned for its performance, rated the importance of acceleration about the same as Golf GTE buyers. The factors presented earlier in figure 4.2-4.6 were much more important to buyers of PHEVs and Tesla.

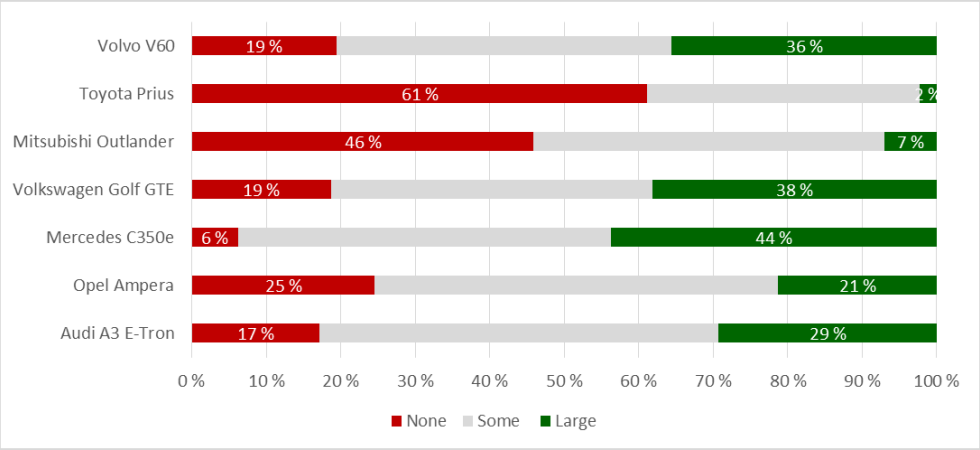


Figure 4.9 Importance of performance when buying PHEVs by model. Norwegian PEV consumer survey, TØI 2016.

4.4 Additional vehicles or replacements for ICEVs

BEVs' limited range has led to speculation as to what degree BEVs sold could be used as additional vehicles, i.e. not replacing ICEVs. If that was the case, then BEV policies might need to be reviser, to avoid increased vehicle ownership.

The majority, 78% of BEV owners, 95% of PHEV owners and 88% of ICEV owners, replaced another vehicle in the household when buying their vehicle. In the 2014 survey, BEV owners reported that 67% of BEVs replaced another household vehicle. The higher 2016 share indicate a «normalization» of BEVs in the population.

More BEV owners traded in a BEV (6%) and more PHEV owners (4%) traded in a Hybrid Electric Vehicle (HEV) than in the other groups, as seen in figure 4.10. The latter indicates that owning a HEV could be a steppingstone towards a PHEV. In 2014, 4% of BEV owners traded in a BEV (Figenbaum et al 2014). However, the vast majority (>90%) of replaced vehicles in all household types were ICEVs.

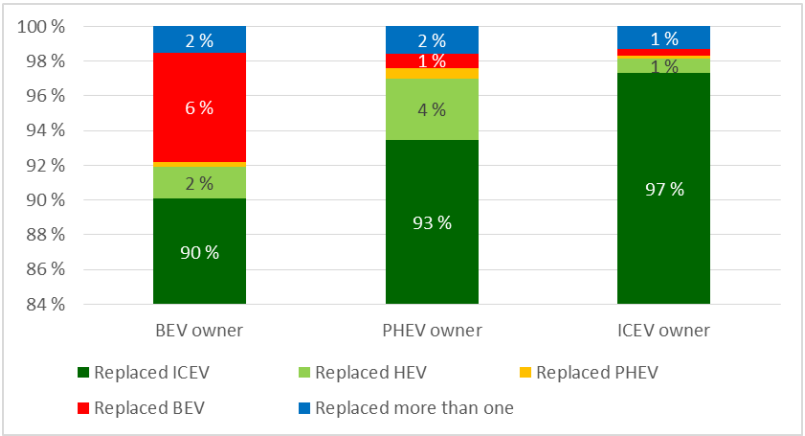


Figure 4.10 Type of replaced vehicle, percentage of total vehicles in the survey. n_{BEV} = 2433, n_{PHEV} = 1963, n_{ICEV} =2705. Note the deviating scale on the y-axis (84-100%). Norwegian PEV consumer survey, TØI 2016.

It turns out that for 22% of BEV owners, the vehicle became an additional vehicle in the household. The same situation was the case among 12% of ICEV owners, but only 5% of

PHEV owners. The latter could be related to the relatively high cost of PHEVs, a much higher share of single vehicle owners than is the case for BEVs, or that only privately owned PHEVs are included in the sample.

The difference between the share of BEV owners buying an extra vehicle and ICEV owners doing the same could be a rebound effect where BEV incentives make it attractive and possible to buy an extra vehicle. The share of BEV owners buying an additional vehicle is particularly high in and around Oslo (including Akershus) and Bergen (Hordaland) and in some rural provinces (Nord-Trøndelag, Nordland, Troms), as seen in figure 4.11. Other rural provinces such as Hedmark, Sogn og Fjordane and Finnmark have low shares extra vehicles.

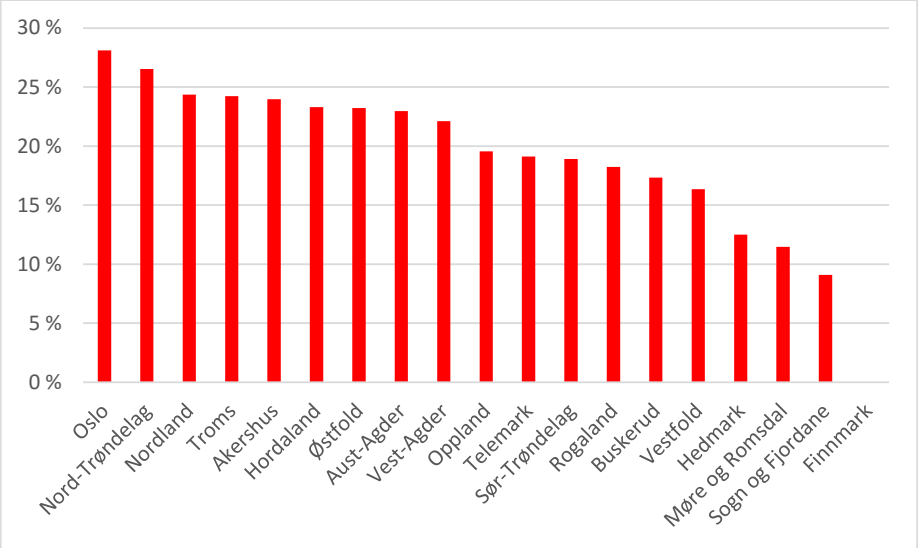


Figure 4.11 Share of BEVs bought as additional vehicles in households by province. Norwegian PEV consumer survey, TØI 2016.

A special question to buyers of additional vehicles covered aspects potentially influencing the decision to by an additional vehicle. The results shown in figure 4.12, point at households having moved, someone in the household switching jobs, more people with driving license, increases in household size, and the perception of public transport being inadequate for their needs, as factors leading to extra vehicles being purchased among all groups. BEV owners, and to some extent PHEV owners, also stated a wish to use the other vehicle(s) in the household less, i.e. that the new vehicle take care of daily transportation needs (instead of the other household vehicle). A higher share of PHEV owners and ICEV owners stated that an increased number of driving licence holders in the household affected the purchase of an additional vehicle.

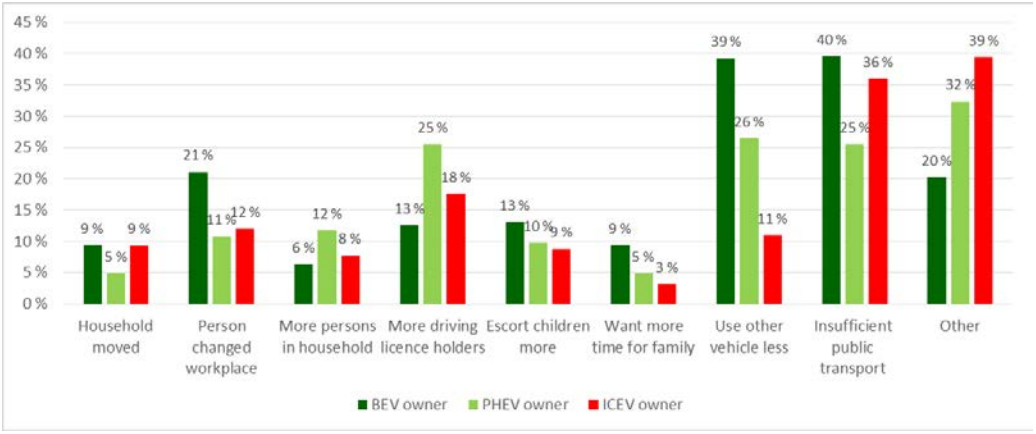


Figure 4.12 Factors that contributed to the decision to buy an additional household vehicle. Percentages of additional vehicles, several answers could alternatives could be answered. $n_{BEV} = 678$, $n_{PHEV} = 102$, $n_{ICEV} = 375$. *Norwegian PEV consumer survey, TØI 2016.*

Some of these factors are interrelated, "Escort children more" most likely covers "More persons in the household" and "Want more time for family". About 50% of extra vehicles are justified in changed transportation requirements due to factors such as, the household having moved or someone in the household having a new job leading to new routes to get to work, there being more persons in the household and or a larger need to escort children. The other half does not seem to see public transport as an alternative that could cover their needs. The "use other vehicle less" factor could be a result of people entrenched in vehicle based transportation patterns wanting to pollute less, contribute less to greenhouse gas emissions or wanting to reduce their cost of driving.

In figure 4.13, results from subgroups of single (buying their first vehicle), and multivehicle households is presented. «Use other household vehicles less» is an important purchase reason for buying a BEV or PHEV as an extra vehicle in households that own ICEVs. More people with driving licences is a more important reason for buying an extra PHEV or ICEV in ICEV households than a BEV. All groups list insufficient public transport as a reason to buy extra vehicles. Changed workplace is a more important reason to buy a BEV than PHEVs or ICEVs. The large «other» category for PHEV and ICEV single vehicle owner groups indicates that the survey did not quite capture their motives for purchasing.

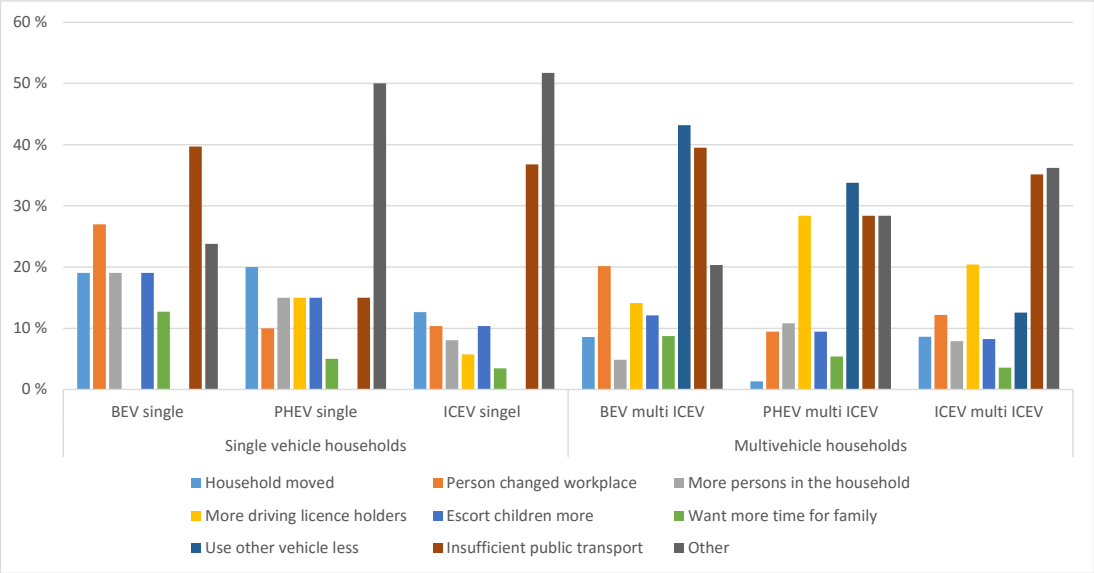


Figure 4.13 Factors that could have influenced the decision to buy an additional vehicle in single and multi-vehicle BEV, PHEV and ICEV households. $n_{BEV\,single}$ =63, $n_{BEV\,multiICEV}$ =595, $n_{PHEV\,single}$ =20, $n_{PHEV\,multiICEV}$ =74, $n_{ICEV\,singel}$ =87, $n_{ICEV\,multiICEV}$ =279. Norwegian PEV consumer survey, TØI 2016.

Municipalities where more than nine persons bought an additional BEV were also analysed to gain further insights. As seen in figure 4.14, the tendency is the same in all municipalities, but some places switching job was a very important factor. Poor public transport is more or less a unison factor across the different municipalities.

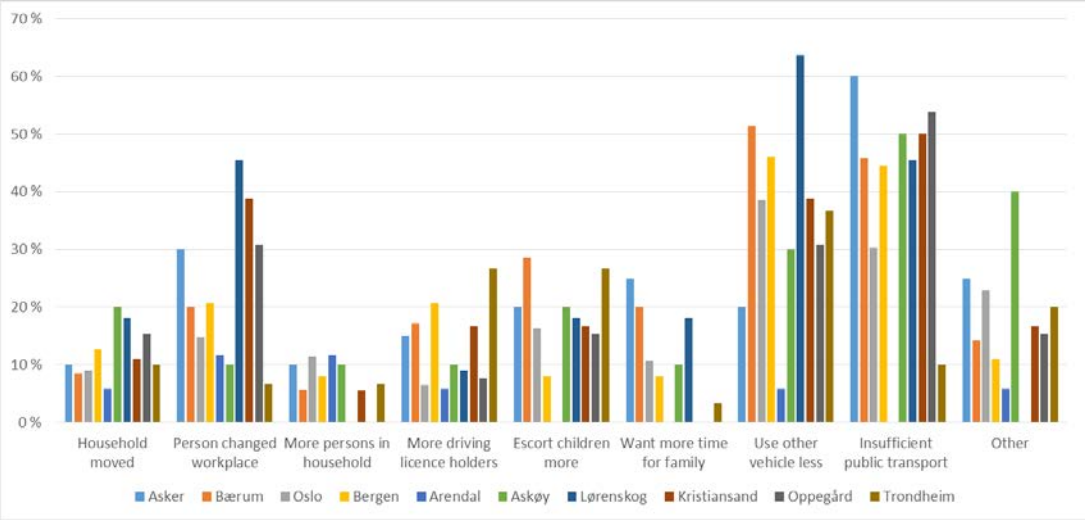


Figure 4.14 Factors that could have influenced the decision to buy an additional vehicle, by municipalities with more than nine respondents. Norwegian PEV consumer survey, TØI 2016.

Interestingly the «other» category is larger for ICEV and PHEV owners than BEV owners. A possible explanation for the high share of the «other» category for BEV owners in Asker Oslo and Trondheim could be a rebound effect where people that have to use expensive toll roads save enough money to pay for parts of the cost of an extra vehicle. Inhabitants in Asker can also use the bus lane into Oslo, potentially saving over 30 minutes on a commute into Oslo. For ICEVs and PHEVs potential motives for the «other» category are unknown.

The actual rebound effect, if any, is not possible to calculate based on the survey results. A similar group of people with a very vehicle based travel pattern could be part of the large group of ICEV owners in the total vehicle fleet. BEV owners may also belong to an age group and be in a family situation where it is common to buy an extra vehicle. If vehicle buyers behave rationally, then one would expect the first BEV buyers to come from this group, thus potentially explaining why they drive more and buy more vehicles than the PHEV and ICEV groups in the survey.

4.5 Employed or self-employed owners of 2011 and newer year model vehicles

There are large income and socio-demographic differences in the overall sample groups. When the samples are limited to workers owning a 2011 and newer year model vehicle, the income differences become minor as seen in table 4.2.

Table 4.2 Household income intervals and average income of households owning vehicles, 2011 year models and newer, where the respondent is employed or self-employed. Norwegian PEV consumer survey, TØI 2016.

	Under 200 000	200-400 000	400-600 000	600-800 000	800 000-1000 000	Over 1000 000	Average[1]
BEV Single	0 %	5 %	21 %	22 %	21 %	30 %	798 381
PHEV Single	0 %	2 %	13 %	17 %	24 %	43 %	885 084
ICEV Single	0 %	4 %	19 %	22 %	26 %	27 %	806 102
BEV Multi BEV	0 %	1 %	2 %	9 %	23 %	66 %	1 000 840
BEV Multi ICEV	0 %	1 %	3 %	11 %	24 %	61 %	983 386
PHEV Multi ICEV	0 %	1 %	6 %	16 %	23 %	53 %	945 727
ICEV Multi ICEV	0 %	0 %	5 %	13 %	28 %	54 %	961 009

BEV owners have the largest households with more children and they are the youngest vehicle owners of these subgroups as seen in table 4.3 and figure 4.16.

Table 4.3 Number of persons in the household and age of respondents. Norwegian PEV consumer survey, TØI *2016.*

	Persons in household	Persons younger than 18y in household	Average age
BEV Single	2.6	0.9	43 years
PHEV Single	2.4	0.6	50 years
ICEV Single	2.3	0.5	53 years
BEV Multi BEV	3.4	1.3	44 years
BEV Multi ICEV	3.5	1.2	47 years
PHEV Multi ICEV	3.1	0.8	51 years
ICEV Multi ICEV	3.0	0.8	53 years

[1] *Income above 1 million set at 1.1 million, income under 200' set at 200'.*

The age cohorts show that in the age group 45-54 there are few differences between the multi-vehicle ownership groups. A high share of BEV owners are in the 25-34 and 35-44 cohorts, and a low share in the 55-66 year group. The situation is the opposite for ICEVs and PHEVs.

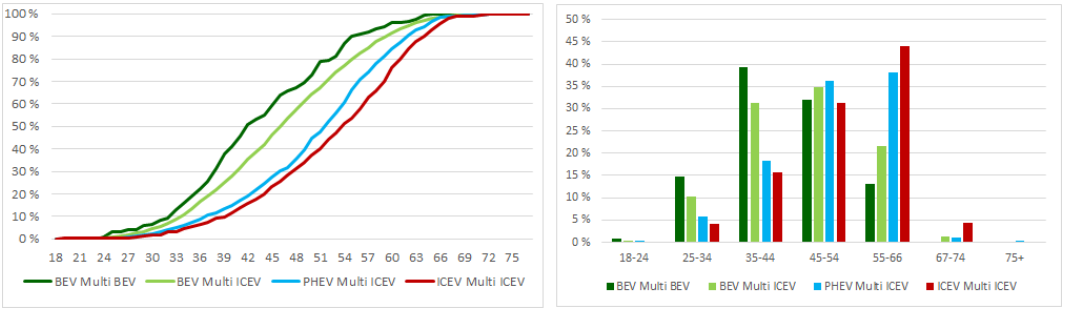


Figure 4.15 Age distribution and age cohorts of multi vehicle owners. $n_{BEVMultiBEV}$=122, $n_{BEVMultiICEV}$=2013, $n_{PHEVICEV}$=733, $n_{ICEVMultiICEV}$=472. Norwegian PEV consumer survey, TØI 2016.

The age and household differences are large enough to indicate that BEVs and PHEVs do not necessarily compete for the same customers at this stage of market development. BEVs have much larger incentives than PHEVs. Selecting a VW Golf GTE over a VW E-Golf, involves foregoing the attractive BEV incentives and paying about 9 000 Euro more for the vehicle, to be able to go on long trips without having to charge on the go. In effect, this separates the consumers into different buyer segments as clearly seen for the VW Golf in figure 4.16.

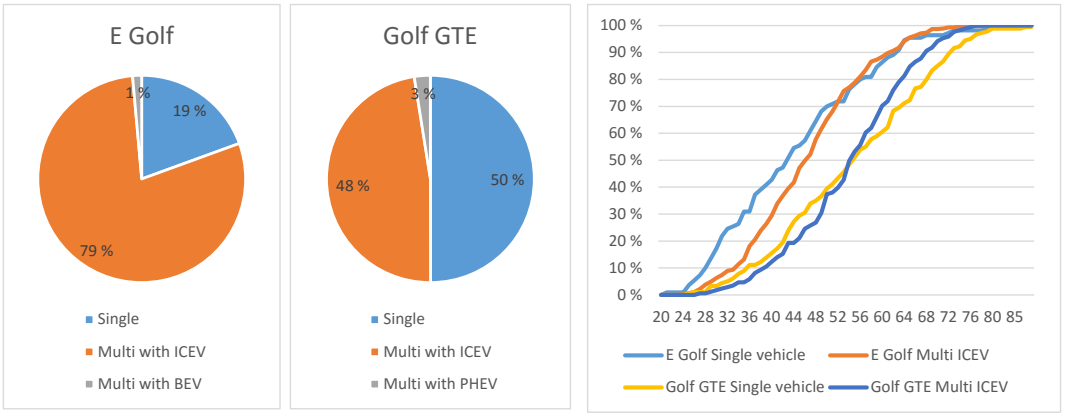


Figure 4.16 Distribution of VW Golf BEV and PHEV versions, household vehicle ownership and age of owner. Norwegian PEV consumer survey, TØI 2016.

For the Mitsubishi Outlander the situation is different. The PHEV version of the Outlander competes with the diesel version. The latest revision to vehicle taxes made the PHEV version the cheapest and it dominates the sales of that model.

In the longer run the BEV market could expand into the older groups of buyers, when today's BEV buyers become older, and the technology matures. In the even longer run it is evident that BEVs are much more widely distributed among households with children, than in the general public (56% of BEV households have children whereas 28% of all households in Norway have children, SSB 2016). These children will have grown up with BEVs, and will be accustomed to their particularities when they become vehicle buyers.

5 Trips

The expectation for the travel pattern of BEVs, is that they are used mainly for local transport, and apart from the Tesla Model S, not for longer trips such as driving to cottages and holiday homes. On the other hand, it is expected that the usage pattern of ICEVs and PHEVs is rather similar, i.e. that they are used for all trip types, including holidays.

5.1 Trip type distribution

In the analysis of trip distributions, the samples were limited to people who are employed (full-, part-time or self-employed), to get a reasonable comparison of trip type distribution between comparable groups, as the ICEV and PHEV groups contain a larger share of retired people. The reason for this approach is that the actual share of retired people among vehicle owners in general, is unknown. The trips distribution shows the same tendency when it comes to differences between groups, when including all vehicles in the samples.

BEVs is the vehicle group used most frequently for all trip types apart from vacations, as seen in figure 5.1 - 5.3. PHEVs are less frequently used for daily trips than BEVs, but more frequently used than ICEVs apart from for work trips. These results are expected. It is cheaper to do short distance trips with BEVs than PHEVs or ICEVs, and multivehicle owners are therefore likely to use BEVs for these trips when the vehicle is available, implying that they will use the other household vehicle less. The more frequent use of a vehicle to get to work among BEV owners, is likely related to their longer distances to work, c.f. section 5.2, and it comes as no surprise that they are used more frequently for work related trips.

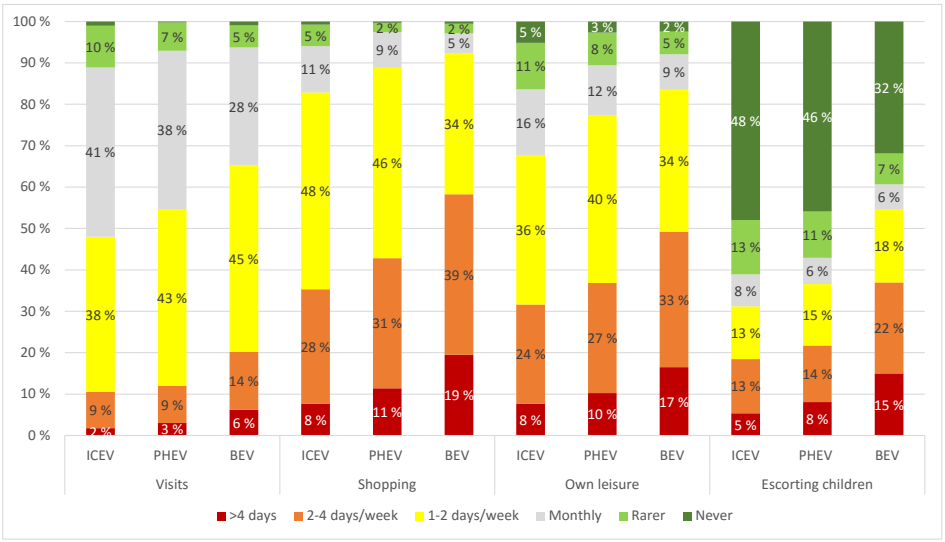


Figure 5.1: Trip type frequencies for trip types: visits, shopping, own leisure, escorting children, for BEV, PHEV and ICEV owners that are employed or self-employed. n_{BEV} = 2812, n_{PHEV} = 1569, n_{ICEV} =2008. Norwegian PEV consumer survey, TØI 2016.

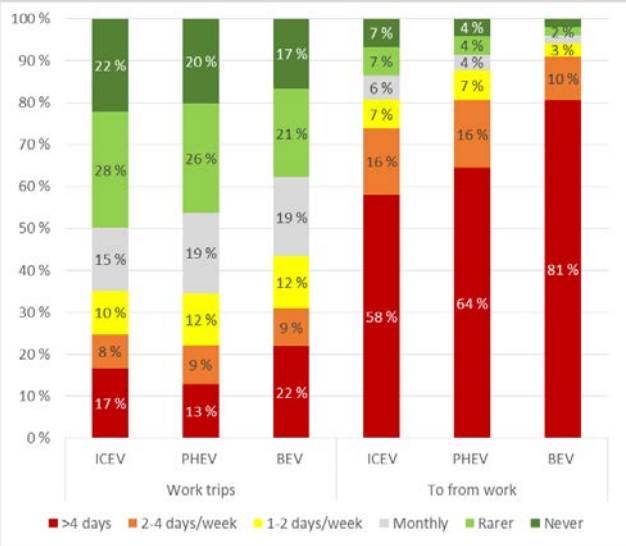


Figure 5.2 Trip frequencies to and from work, and frequencies of work trips for BEV, PHEV and ICEV owners that are employed or self-employed. n_{BEV} = 2812, n_{PHEV} = 1569, n_{ICEV} =2008. Norwegian PEV consumer survey, TØI 2016.

BEV owners use their vehicles less frequently than other vehicle type owners for vacation trips, whereas there is little difference between PHEVs and ICEVs. In 2014, 61% of BEV owners said that they newer drive their BEVs on vacation trips. In 2016, the share is only 37%, a very significant development in the normalization of BEVs as a vehicle type. The share of Tesla Model S was 18% in 2014 vs 20% in the 2016 survey and is, thus, not a factor explaining this development.

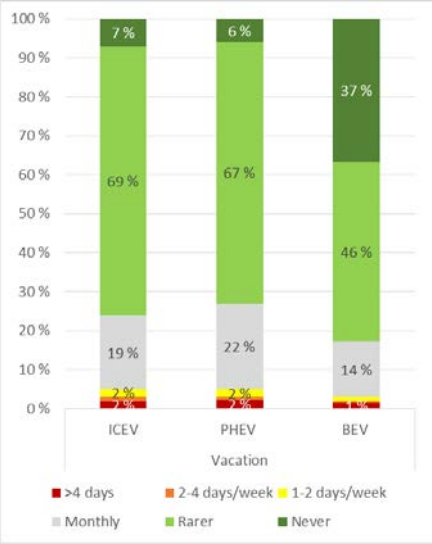


Figure 5.3 Vacation trip frequencies for BEV, PHEV and ICEV owners that are employed or self-employed. n_{BEV} = 2812, n_{PHEV} = 1569, n_{ICEV} =2008. Norwegian PEV consumer survey, TØI 2016.

5.2 Work trips distances and means of transportation

The average distance to work is 24 km for BEV owners and 17 km for PHEV and ICEV owners. The distance to work for multi and single vehicle households respectively, is shown in table 5.1. The accumulated share of respondents as a function of work trip length is shown in figure 5.4. One would expect that the Toyota Prius PHEV, given its short range, would be used by people with shorter distances to work, but this is not the case.

Table 5.1 Average distance to work for employed or self-employed respondents having shorter than 100 km distance to work, by vehicle owning household types. Norwegian PEV consumer survey, TØI 2016.

Household owning 2011 and newer year models, respondent is working	Number of households	Average distance to work (≤100 km)
BEV Single	571	18 km
PHEV Single	646	14 km
ICEV Single	306	15 km
BEV Multi BEV	116	25 km
BEV Multi ICEV	1924	25 km
PHEV Multi ICEV	700	19 km
ICEV Multi ICEV	409	19 km

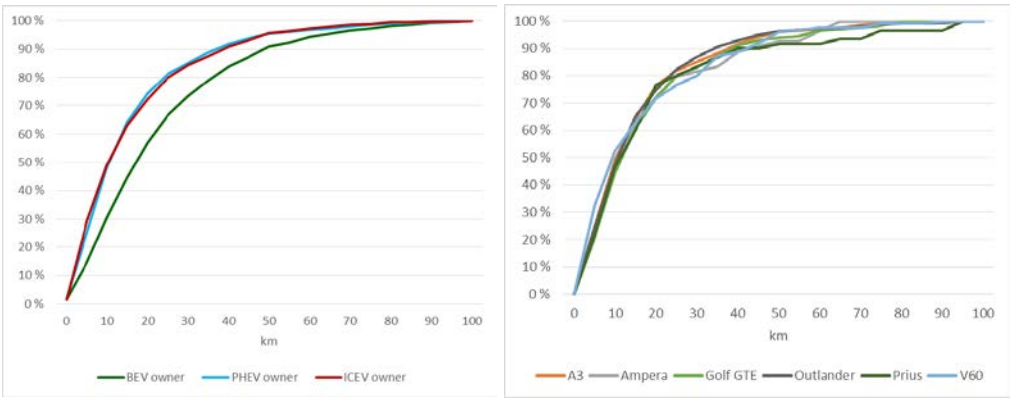


Figure 5.4 Accumulated distances to work for BEV, PHEV and ICEV owners (left), and individual PHEVs (right), km. Norwegian PEV consumer survey, TØI 2016.

Figure 5.5 shows the driving distance to work for each province. Østfold, Vestfold, Hedmark, Oppland, Buskerud and Nord-Trøndelag are provinces with particularly long distances but the survey cannot shed light on why that is the case. The most Northern provinces have shorter distances but the number of vehicles in the survey is rather small for these provinces so the results are not significant. Drivers in provinces with large cities such as Rogaland, Sør Trøndelag and Hordaland also have shorter distances to work.

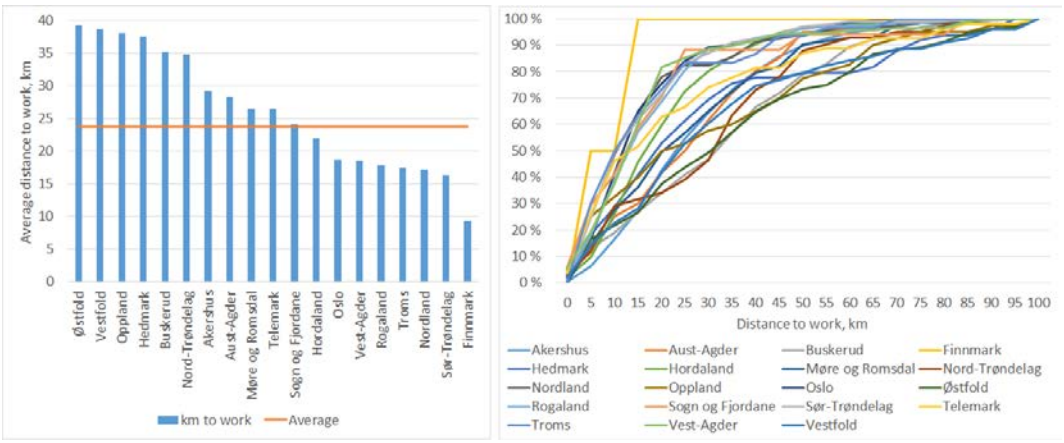


Figure 5.5 Geographical distribution of distance to work, provinces, left average, right accumulated, km. Norwegian PEV consumer survey, TØI 2016.

Most of the respondents previously used another vehicle for the work trip, as seen in figure 5.6. Some came from public transport while some walked or cycled. A reason given for buying an extra vehicle was «poor public transport», as presented in the analysis in chapter 4. Mode changes from walking, cycling or public transport to vehicle-based transportation has much more severe societal impacts when buying an ICEV than a BEV or a PHEV.

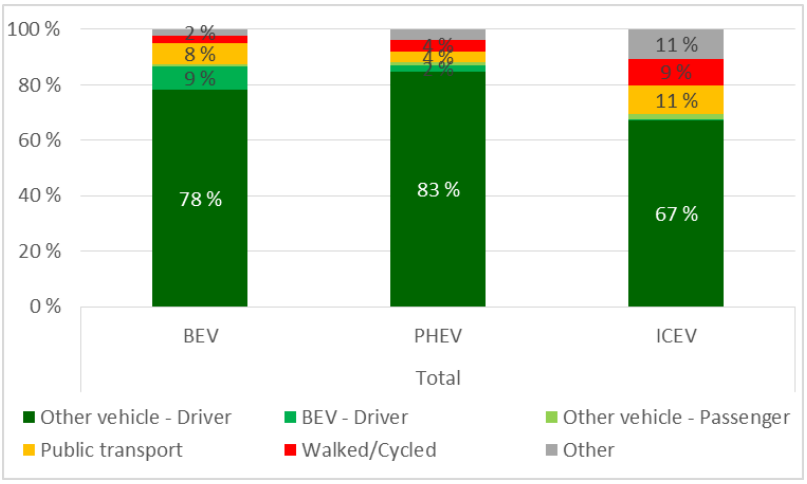


Figure 5.6 Means of transport to workplace prior to buying the new vehicle. Valid answers: n_{BEV} = 2166, n_{PHEV} = 2065, n_{ICEV} =1328. Norwegian PEV consumer survey, TØI 2016.

5.3 Long-distance trips

The ability to undertake long distance trips is an important factor when consumers buy vehicles. On these trips, vehicles are often loaded with luggage and passengers. One of the household vehicles is typically be dimensioned for such trips. About 13% of all respondents of the three main sample groups answered that they do not know whether the household regularly does long distance trips. The other 87% answered one of the alternatives in figure 5.7. Note that the question was about the household's long distance trips in general, and thus not limited to vehicle based trips.

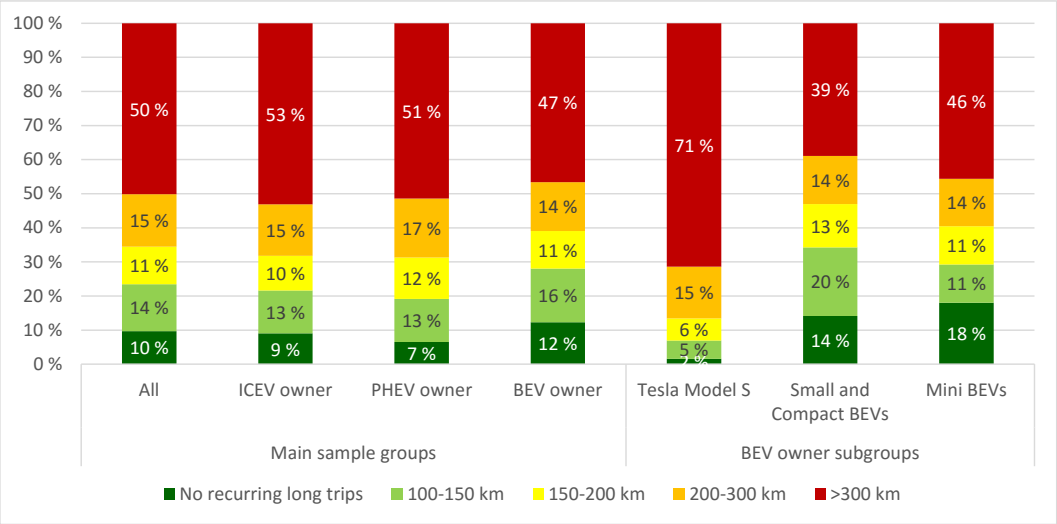


Figure 5.7 Share of owners recurring long distance trips by distance intervals. n_{BEV} = 2775, n_{PHEV} = 1800, n_{ICEV} =2623. «Don't know» category not included. Norwegian PEV consumer survey, TØI 2016.

At first sight there may seem to be surprisingly little difference between BEV owners and other groups. BEV owners have only slightly fewer of these long distance trips. The question was, however, about the *household's* long distance trips and 79% of BEV owning households also have another vehicle available (75% with an ICEV), which could potentially be used for the long distance driving.

About 10% of vehicles in this survey do not regularly drive more than 100 km to recurring destinations. If one assumes that they do not do trips over 100 km or do it so seldom that they could rent a car for occasional long distance travel, then, these owners would fare well with current generation BEVs with a 100 km winter range. Another 14% drive on recurring 100-150 km trips, which is achievable with one fast charge or without charging in the winter if it is one of the newest generation vehicles such as the 30 kWh Nissan Leaf, or during the summer for some current generation BEVs. Tesla Model S can cover all trips up to 300 km even in the winter, i.e. more than 50% of the trip needs of these households, without a need to charge (given that they can charge at the destination).

Looking at BEV subgroups reveals the extreme driving patterns of current Tesla Model S owners, as seen in figure 5.7. They have a much higher share of long distance recurring trips above 300 km than other vehicle owners. It seems obvious that the ability to charge at Tesla superchargers free of charge on long distance trips is attractive to buyers of the Tesla Model S.

Mini BEV owners have fewer long distance trips. Those who make such trips drive longer than owners of compact and small BEVs. Thus, it is likely that they use another household vehicle for these trips.

In about 1-2 years' time a new generation of smaller and medium sized BEVs, that can cover 200-300 km of real life driving during the winter season, will come on the market. Examples are the Tesla Model 3, Chevrolet Bolt and a new generation Nissan Leaf. *The number of ICEV vehicles that are replaceable by BEVs on recurring long distance trips will then increase three- to fivefold, even without fast charging.*

Of BEV owners doing these recurring long distance trips, 64% used their BEV on at least one of the trip types, 43% did it on all of them. The 58% of BEV owners that used another means of transport than their BEV on some or all of these recurring trips did so because of

the limited range, the vehicle size being too small and challenges to do with charging the vehicle as seen in figure 5.8.

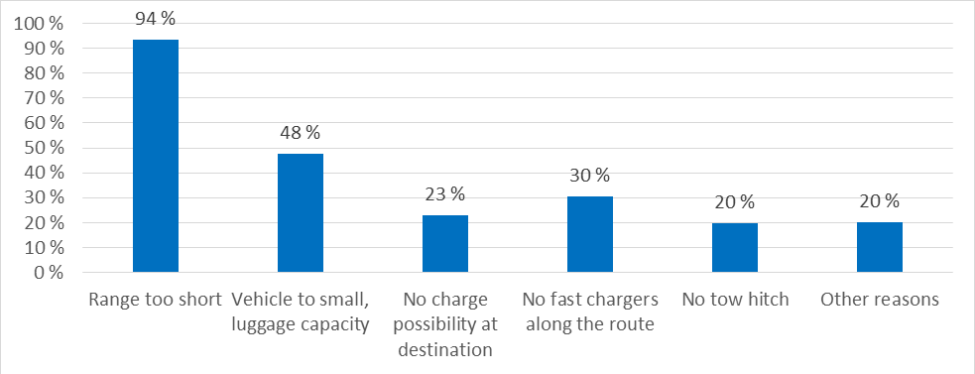


Figure 5.8 BEV owners with recurring long distance trips, reasons not using BEV on these trips. n=1399. Norwegian PEV consumer survey, TØI 2016.

BEVs taken for long distance trips are mainly charged using fast chargers and at the destination, as seen in figure 5.9. PHEV owners have the luxury of not having to charge. 21-22% of both groups stop by friends or family while charging.

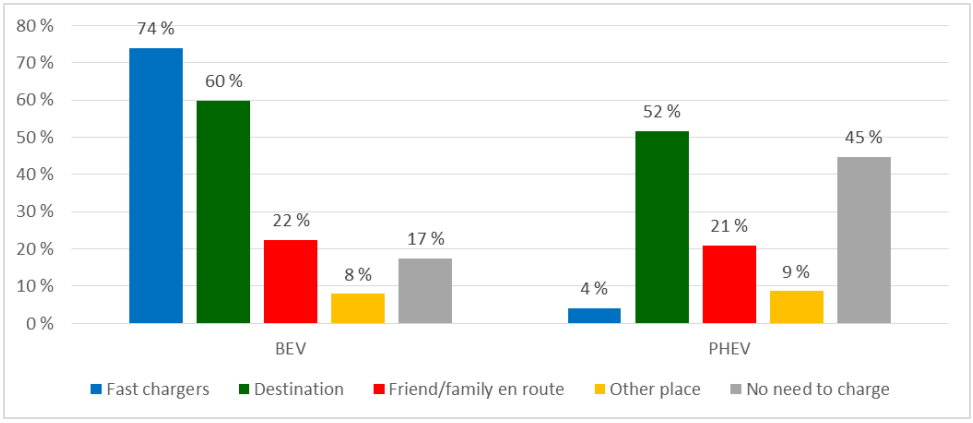


Figure 5.9 Charging BEVs on recurring long distance trips (share of owners that use the BEV on such trips) and PHEVs (share of total number of owners). n_{BEV}=1553, n_{PHEV}=1683. Norwegian PEV consumer survey, TØI 2016.

It is, of course, likely that people also do non-recurring long distance trips. The survey does not provide insights on such trips apart from the information in chapter six, indicating that BEV owners primarily use fast chargers on these trips.

Figure 5.10 shows the geographical distribution of long distance trip lengths for trips above 100 km that the household undertakes. Hordaland has the lowest share of long distance trips. It is one of the provinces with a rapid growth in BEV sales. In Akershus and Oslo, the main markets up until 2015, people go on long distance recurring trips more often.

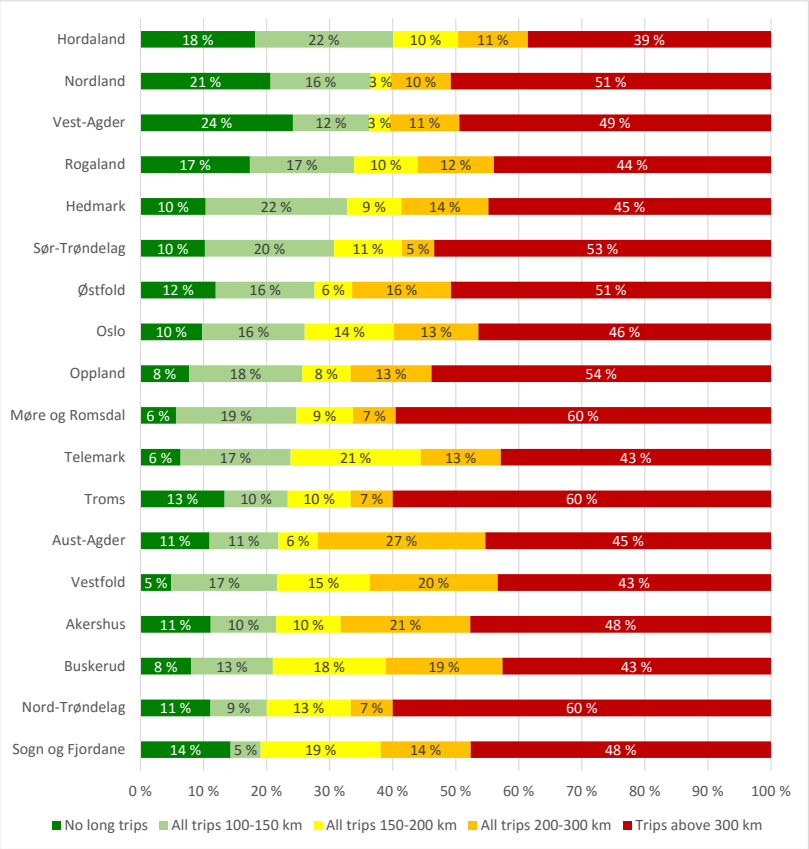


Figure 5.10 Distribution of household long distance trip lengths by provinces. Norwegian PEV consumer survey, TØI 2016.

5.4 Single vehicle BEV owners long distance trips

A total of 524 BEV owners, that only have the BEV in their household, travel on long distance trips and 79% of them use the BEV on all these trips, a further 14% use it on some as seen in table 5.2. The rest use public transport, or borrow or rent another vehicle. The vehicles are recharged using fast chargers along the way, and at the destination as seen in table 5.3.

Table 5.2 Long distance trips undertaken by single BEV owners and use of transport means on these trips. Norwegian PEV consumer survey, TØI 2016.

	Owners with long distance trips					BEV users long distance trips		Other transport means for these long distance trips	
	101-150 km	151-200 km	201-300 km	> 300 km	Total	Number using BEV	Share using BEV	Public transport share	Other vehicle (loan, rent) share
Vacation home	104	65	75	111	355	294	83%	3%	14%
Friends family	170	62	52	168	452	369	82%	7%	11%
Other trips	103	59	64	181	407	321	79%	8%	14%
BEV owners with long trips					524				
BEVs used on at least one trip type						489	93%		

Table 5.3 Long distance single vehicle BEV drivers charging pattern on long distance trips, several alternatives were possible. n=524. Norwegian PEV consumer survey, TØI 2016.

	Users Fast charger	Friends/family along the way	At destination	Other places	No need to charge
Number of long distance drivers charging	428	108	332	50	69
Percentage of long distance drivers charging	88 %	22 %	68 %	10 %	14 %

202 of BEV single vehicle owners in the survey own a Tesla and use it for long distance driving, which would scale up around 3 000 in the total BEV fleet. They have access to their own Tesla "Supercharger" network and are not customers of commercial providers of fast charge. The remaining 322 single BEV owners constitute 10% of the total BEV owner sample, 7 000 drivers. The estimate of single vehicle BEV owners (not including Tesla) that fast charge on long distance trips, for the entire BEV fleet in Norway at the end of 2015, is thus about 10 000 (of 70 000 BEVs in total).

6 Charging the vehicle

BEVs must given the limited range, be recharged frequently in order to be useable, whereas PHEVs must be recharged frequently to be economically beneficial to use, and an environmentally friendly alternative to ICEVs. The main charging location is at home, but consumers also charge, with differing frequencies, at work, public charging stations and use fast chargers. This chapter presents data on the the frequency of charging and challenges of, and opinions, on different charging locations and types.

6.1 Charging at home

Almost all owners charge their vehicle at home on their own property or in a parking space at their disposal, as seen in figure 6.1. 59% of BEV owners and 74% of PHEV owners charge daily at home, predominantly in their garage/carport or at other outdoor parking on own property. A further 20% of BEV owners and 15% of PHEV owners charge in these locations 3-5 times per week. The high share of «daily» chargers among PHEV owners indicates a desire to achieve a high E-mode share. Two thirds of BEV owners use the cable delivered with the vehicle plugged into a domestic household (Schuco) plug, 24% use "wallboxes". For PHEV owners the respective shares are 90% and 9%.

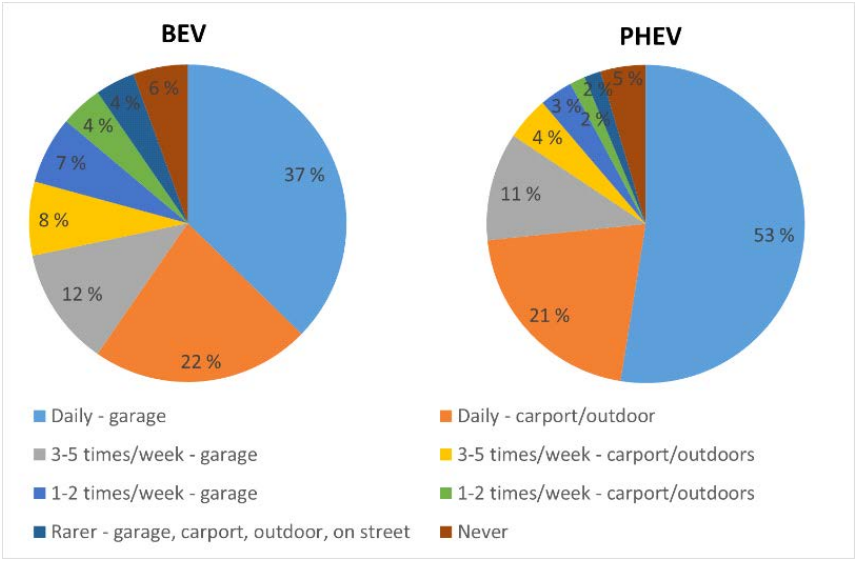


Figure 6.1 Home charging frequency and parking facility among BEV and PHEV owners. n_{BEV} = 3111, n_{PHEV} = 2065. Norwegian PEV consumer survey, TØI 2016.

Only 6% of BEV owners and 5% of PHEV owners never charge at home in these locations. A share of these owners charge their vehicles regularly on the street, at their home location, as seen in figure 6.2. Some owners probably charge at work, see figure 6.4.

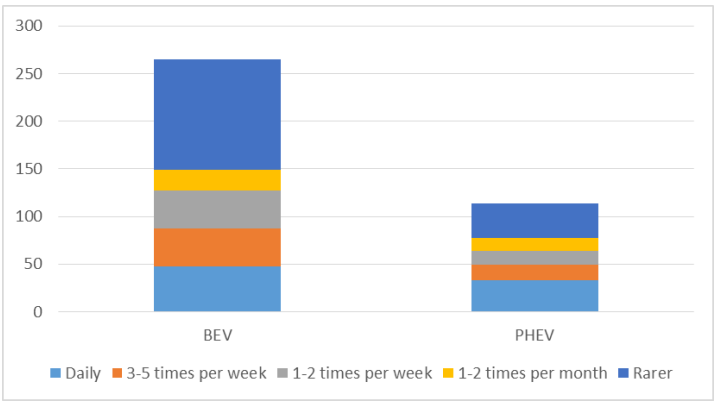


Figure 6.2 Number of vehicles charged at home in on-street parking spaces. Norwegian PEV consumer survey, TØI 2016.

The peak period for initiating a normal charge at home is within the period 14-20, see figure 6.3. The normal charge will then last 3-7 hours on average, as the average BEV is used about 43 km/day (see chapter 8) and a normal charge provides between 7-15 km range per hour of charge (Krutak et al 2015). The peak charge period will then be around 16-20 in the summer and 16-23 in the winter as more and more people plug in, coinciding with the existing peak power requirement of the power grid as seen in figure 6.3. A higher share of people charges daily in winter than in the summer since the winter range is 25-50% lower than in the summer, thereby further increasing the winter peak power and time period.

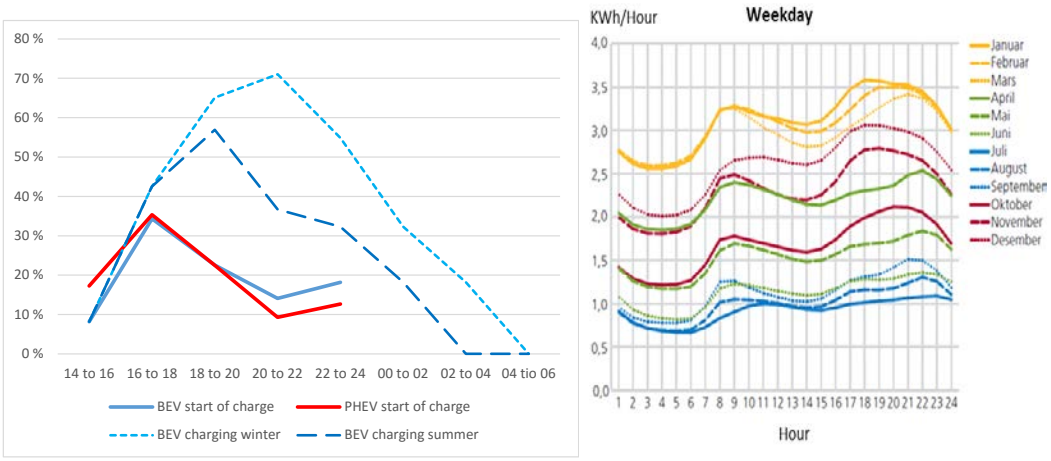


Figure 6.3 Left diagram: Time interval when normal charging normally starts up at home, estimated percentage of BEVs charging (stippled lines) summer and winter. n_{BEV}=1957 n_{PHEV}=1462. Right diagram: Average hourly electricity consumption per day and per month for Norwegian households (Erickson and Halvorsen, 2008). Norwegian PEV consumer survey, TØI 2016.

6.2 Workplace

Charging at work is relatively common among BEV owners, 28% do it more than twice a week, 38% weekly. About 21% of PHEV owners do it at least weekly, see figure 6.4. 78% of BEV and 84% of PHEV owners use the charge cord supplied with the vehicle for charging at work, about 13-14% use a "wallbox".

An interesting question for further research is why PHEV owners charge less frequently at work. Could charging stations be less available to PHEV owners, or do they choose not to

use them to avoid paying for charging, or do they have no need for them? Data on distances to work for PHEV owners suggests that 60-70% can make the trip in E-mode without charging at work. Combined with the 16% that charge at work at least 3 times per week then some 75% of owners could be able to do that trip in E-mode. That compares fairly well with the estimate owners have of their E-mode share when driving to work, cf. chapter 10.

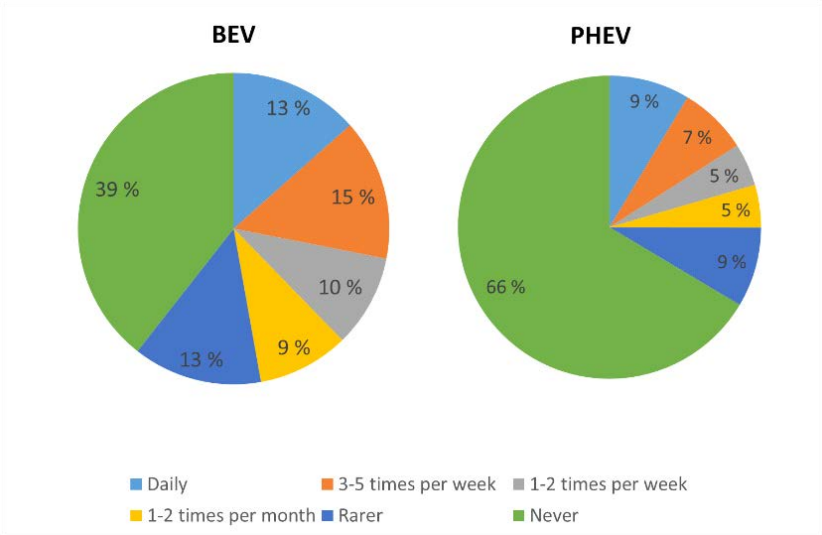


Figure 6.4 Frequency of charging at work. n_{BEV} = 3111, n_{PHEV} = 2065. Norwegian PEV consumer survey, TØI 2016.

6.3 Public normal charging

BEVs are more frequently recharged at public charging stations and shopping centres than PHEVs, as seen in figure 6.5. The reason for this difference is probably related to lesser need to charge, i.e. PHEVs can drive using gasoline or diesel, less availability of charging stations, and because PHEVs pay for parking when charging. BEV owners, on the other hand, enjoy both free parking and free electricity at public charging stations.

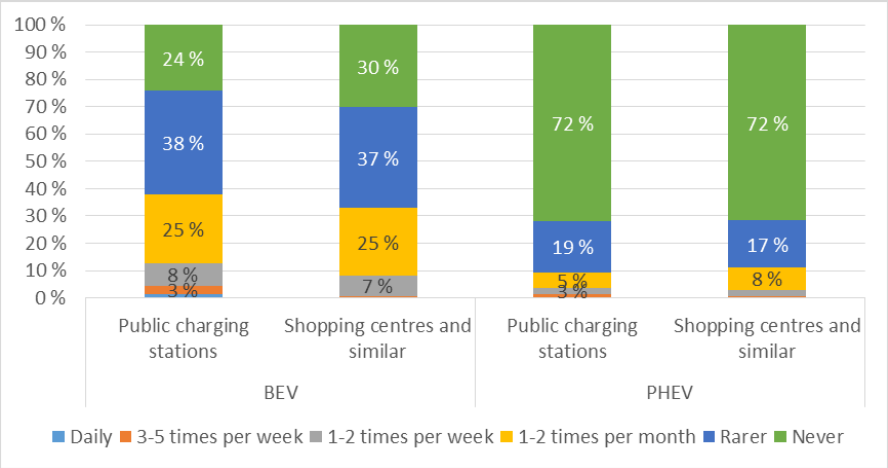


Figure 6.5 Frequency of usage of public charging stations and charging stations at shopping centres and similar locations. n_{BEV}=3111, n_{PHEV}=2064. Norwegian PEV consumer survey, TØI 2016.

6.4 Fast charging

Fast chargers are publicly available to all BEV and PHEV owners, apart from Tesla's reserved supercharger network. The use of fast charging has increased by 10% (the share of respondents never using fast chargers has gone down from 40% to 30%), and the share using it weekly has gone up (from 5% to 8%) and monthly (from 21% to 29%), since the 2014 survey. All fast charging is now charged per minute of charge or per charging session (apart from Tesla owners who had the cost included in the vehicle purchase), whereas in 2014 half of the respondents used fast charging without paying for it. The increase from 2014 is, thus, much greater than the numbers indicate. These findings are also supported by the finding in chapter 11 that respondents more regularly use fast chargers to solve their range challenges. The average Tesla owners fast charge 26 times per year, whereas owners of other BEVs do it 13-16 times per year.

PHEV owners do not use fast chargers much, as the Mitsubishi Outlander is the only PHEV capable of fast charging. The benefit of fast charging PHEVs is small given the very limited range in E-mode.

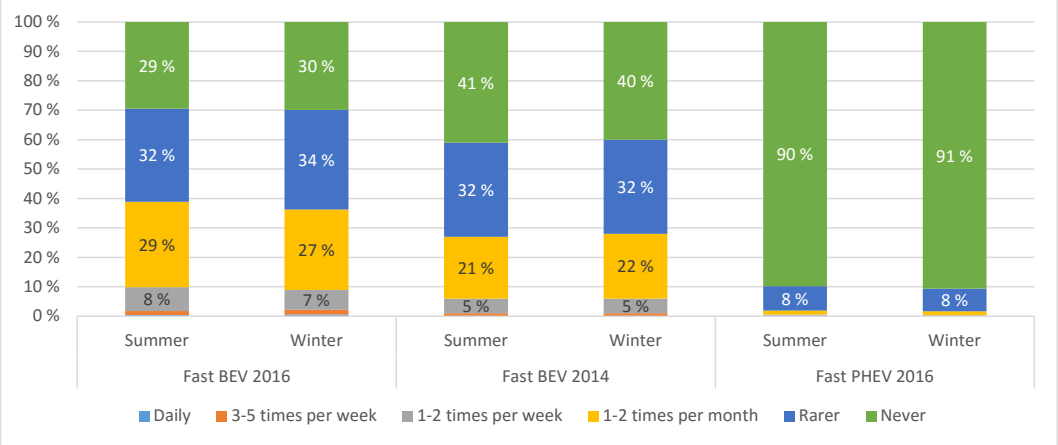


Figure 6.6 Frequency of usage of fast chargers, BEVs 2016 and 2014, PHEVs 2016. n_{BEV216}=3111, $n_{BEV2014}$=1722, n_{PHEV}=2065. Norwegian PEV consumer survey, TØI 2016.

The motives for using fast chargers can be an important parameter in the strategy for deployment of fast chargers. If owners mainly use fast chargers when they are in a range squeeze, then usage will be infrequent with few transactions per vehicle per year. This situation will make it difficult to find sustainable business models for the deployment and operation of fast chargers.

Most owners state that they plan to use fast chargers in order to be able to do trips, as seen in figure 6.7. Twice as many state miscalculating range, forgetting to charge and unforeseen problems as reasons to fast charge in the winter compared to the summer. The consequence of not charging or miscalculating the range is more severe in the winter, given that the range is 25-50% shorter. Although more respondents report reasons for using the fast chargers in the winter than in the summer, the estimated usage is about the same, indicating that the frequency of fast charging in the winter could be underestimated.

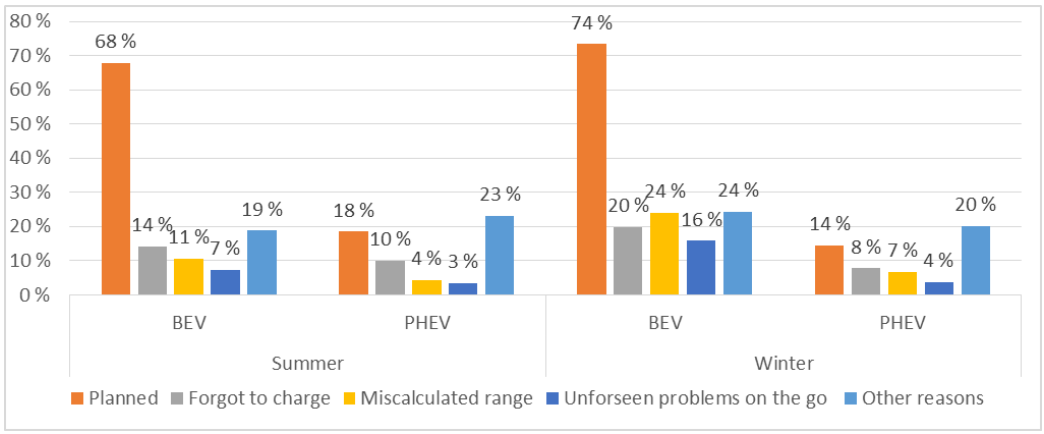


Figure 6.7 Reasons to use fast chargers. n_{BEV}=2195 summer/2181 winter, n_{PHEV}=211/194. Norwegian PEV consumer survey, TØI 2016.

Another key question for the deployment of fast chargers, is where they are used and where users would like to have them available. Should they be deployed where people live and commute, or to facilitate long distance travelling? The most frequent trip type/place where respondents use fast charging today, is on "other trips", as seen in figure 6.8, leading to very limited information on this issue. One could interpret these trips to be non-recurring extraordinary trips, but where they go to is unknown. The information is, thus, difficult to use for planning purposes. The other most important place where people currently fast charge is in the area where they live, i.e. to reduce range anxiety, and for travels to holiday homes. To some extent, these answers could reflect the current position of fast chargers.

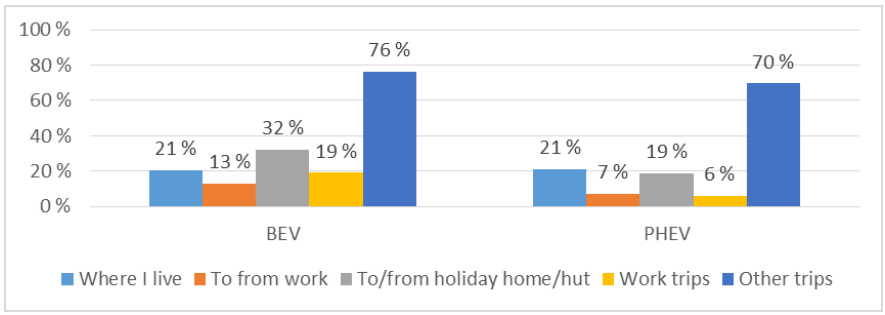


Figure 6.8 Trip types fast chargers are used for. n_{BEV}=2195, n_{PHEV}=211. Norwegian PEV consumer survey, TØI 2016.

6.5 Perception of public charging infrastructure

Figure 6.9 presents the user assessment of the positioning and availability of public charging infrastructure, as well as the quality, reliability and user friendliness of the chargers. An interesting result is the high share that do not know anything about public charging infrastructure. The position of chargers is better known than the other parameters, indicating that many about the offer but do not use it.

BEV owners rely more on public chargers to get around so it is natural that they also know more about public charging. PHEV owners are much less satisfied with the offer. They might not have access to all normal public chargers, and must in principle pay for parking while charging, whereas BEV owners park and charge without paying.

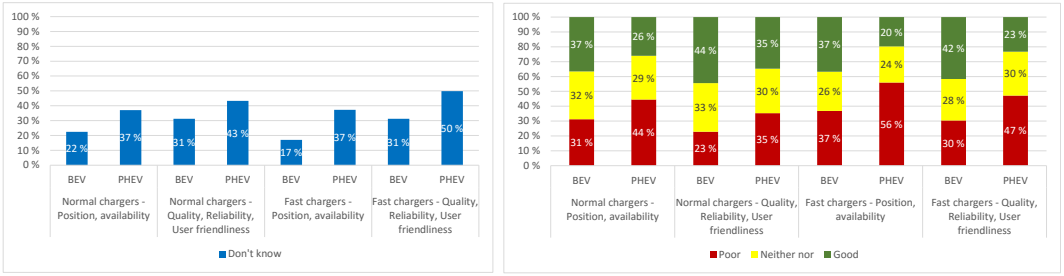


Figure 6.9 Share of BEV and PHEV owners that do not know anything about the public charging infrastructure (left) and the assessment of those that do, of position/availability, quality/reliability/user friendliness (right). n_{BEV}=3111, n_{PHEV}=2065. Norwegian PEV consumer survey, TØI 2016.

6.6 Charging problems

BEV owners rely on charging infrastructure, and 29% have experienced charging problems compared with only 10% of owners of PHEVs, as seen in figure 6.10. BEV owners have been BEV drivers for longer than PHEV owners have used PHEVs, possibly explaining the difference.

The biggest charging problems are "no power available" and damaged cable or charge socket. For some reason, PHEV owners seem to experience the charge cable being stolen or vandalized more often than owners of BEVs, but the survey does not provide information that could explain this difference.

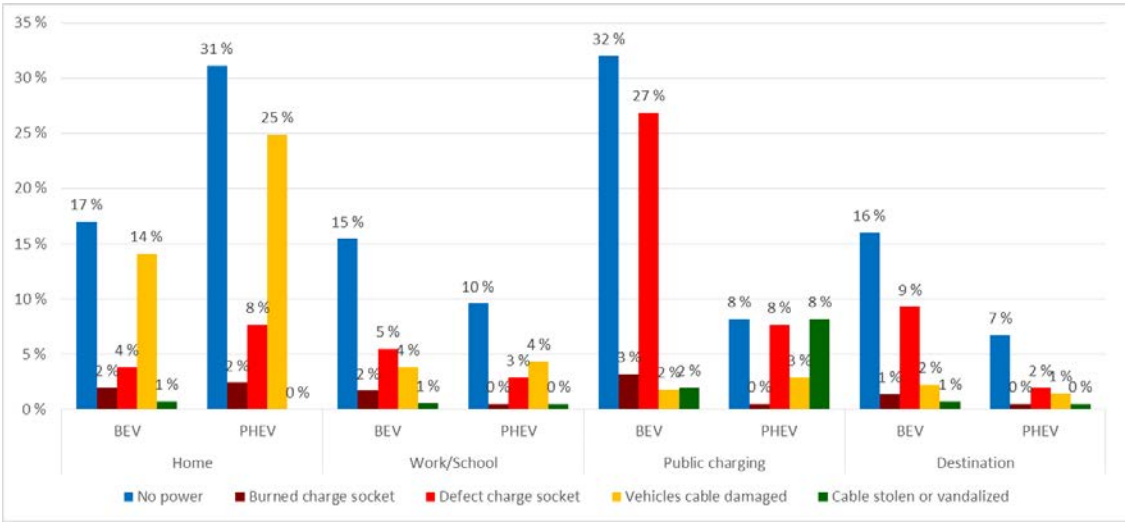


Figure 6.10 Occurrence of various charging problems. n_{BEV}=894 n_{PHEV}=209. Norwegian PEV consumer survey, TØI 2016.

6.7 Challenges in choosing or establishing a charging solution

84% of all households own their residence according to Statistics Norway, (SSB 2016). Establishing charging should in general be less difficult for households that owns their residence, and only 15% of BEV owners and only 6% of PHEV owners said they had challenges choosing their charging solution, whereas 14% and 10% respectively had

problems establishing it. People living in flats have challenges with establishing charging solutions roughly twice as often as those living in a detached house. Still, only 23 % of BEV owners who live in flats have had challenges. There is little difference between cities and built up areas for people owning flats, whereas detached house owners in rural areas have less problems than those living in cities. PHEV owners in flats in cities have slightly more problems than BEV owners, but less in smaller cities and built up areas.

In general, one would expect flat owners to have more problems as they often have shared parking facilities, and lack control of the electricity supply at their parking space. One cannot conclude that the problems are small simply because only 20-25% had problems. It could be that many had verified that charging would be possible before buying the vehicle. Then the number would only include the share that in the end were able to get a charging solution established, not the ones that failed and gave up buying a vehicle with a charge cord.

7 Travel pattern changes

The low cost of driving using electricity as the energy source might lead to BEV and PHEV owners driving more than a typical ICEV owner. This chapter presents the response to questions designed to investigate this issue.

7.1 Changes to travel modes by main groups

33% of all BEVs, 13% of all PHEV and 11% of all ICEV owners, changed their travel pattern after buying the vehicle. The changes to these owners' travel pattern are shown in figure 7.1. Green color is a positive and red a negative modal change for the environment and the national target of curbing vehicle based transport growth in cities.

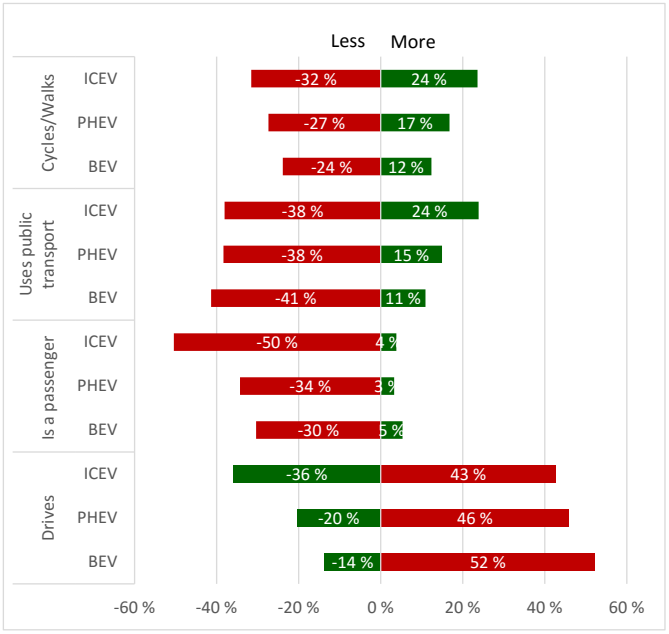


Figure 7.1 Changes to travel pattern after buying the vehicle among all owners that said the pattern changed. n_{BEV} = 1018, n_{PHEV} = 274, n_{ICEV} =339. Green = positive change, Red=negative change. Norwegian PEV consumer survey, TØI 2016.

7.2 Changes to travel modes by sub-groups

Different BEV owner groups' travel changes are of particular interest, as BEVs are extremely cheap to run, once bought. Results for BEV owners that replaced a vehicle, are shown in figure 7.2 together with similar groups of PHEV and ICEV owners. The results are rather equal for single and multi-vehicle households. Households with increasing levels of electrification tend to be driving more after buying the electric vehicle compared to those with lower levels of electrification or ICEVs in the households. They also tend to use

public transport less. A larger share of ICEV households than of BEV/PHEV households report walking, cycling or using public transport more after purchasing the vehicle. On the other hand, they report being passengers to a much lesser extent after.

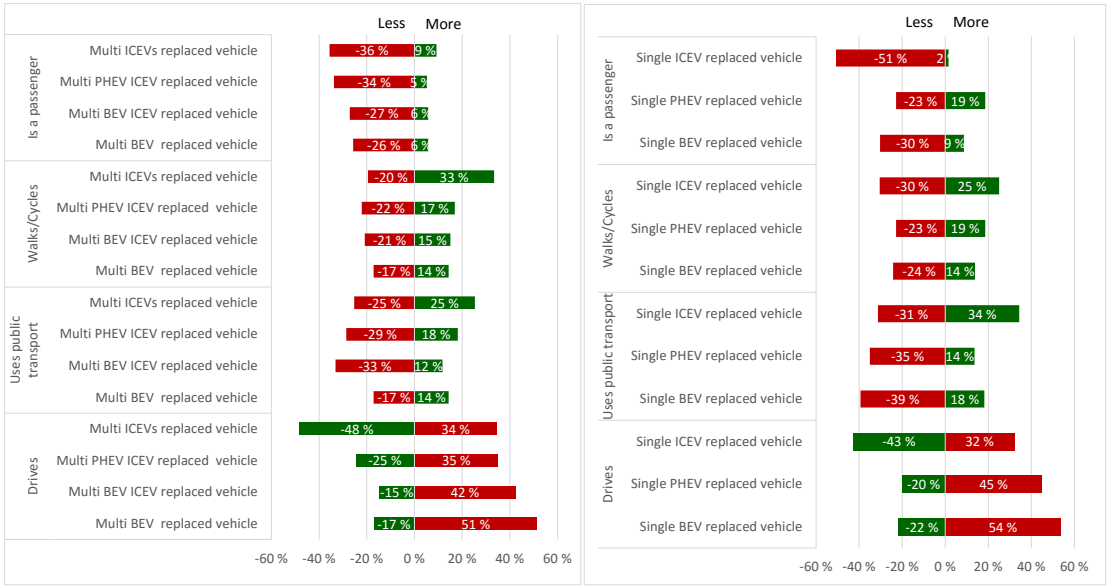


Figure 7.2 Changes to travel pattern in BEV, PHEV and ICEV owner groups replacing existing vehicles, that said the pattern changed. Positive=more, Negative=less, Green = positive modal change, Red=negative modal change. $n_{MultiICEV}$=87, $n_{MultiPHEVICEV}$=77, $n_{MultiBEVICEV}$=453, $n_{MultiBEV}$=35, $n_{SingleICEV}$=128, $n_{SinglePHEV}$=140, $n_{SingleBEV}$=231. Norwegian PEV consumer survey, TØI 2016.

Figure 7.3 shows how the travel pattern changes in households that bought their first vehicle or an additional vehicle to the vehicle(s) already in the household. There are small differences between the groups apart from the tendency that BEV owners have more negative changes than other groups. Each group, however, contains few owners, so the results are uncertain.

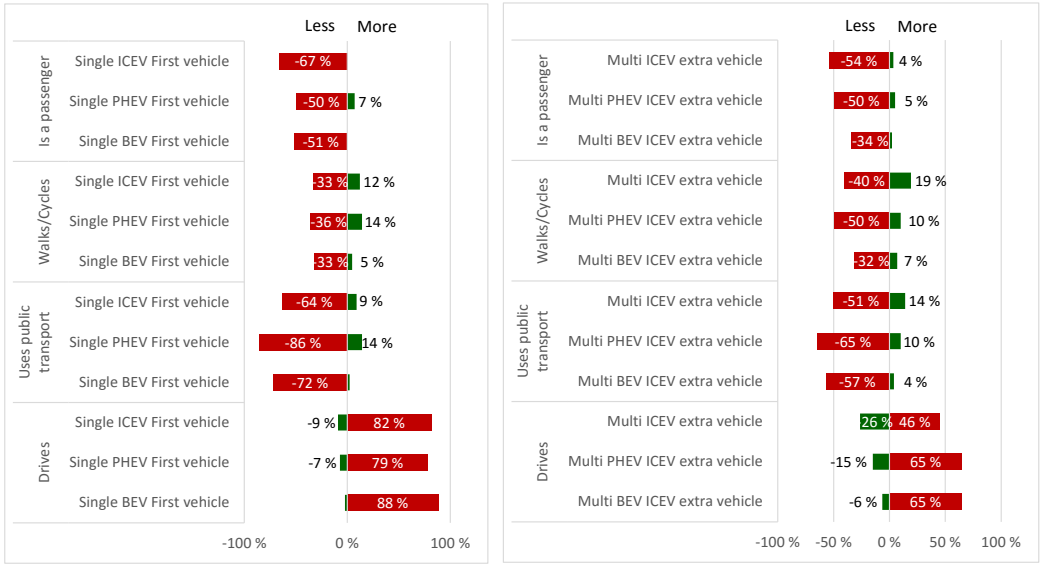


Figure 7.3 Changes to travel pattern among BEV, PHEV and ICEV owner groups buying their first or an extra vehicle, that said the pattern changed. Positive=more, Negative=less, Green = positive modal change, Red=negative modal change. $n_{MultiICEV}$=57, $n_{MultiPHEVICEV}$=20, $n_{MultiBEVICEV}$=57, $n_{SingleICEV}$=33, $n_{SinglePHEV}$=14, $n_{SingleBEV}$=43. Norwegian PEV consumer survey, TØI 2016.

7.3 Changes to total driving length of vehicle insurances

Another question was about changes to the driving distance in the vehicle insurances of the households. The results for those that replaced a vehicle and own 2011 and never vehicles, is shown in figure 7.4.

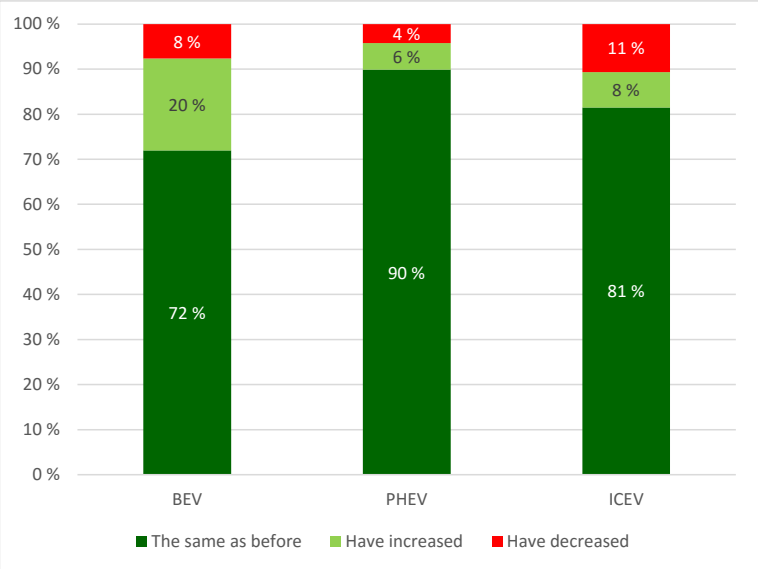


Figure 7.4 Changes to the total driving length of the household's vehicle insurances, owners of 2011 and newer year models that replaced a vehicle. Categories «Don't know» and «Have owned the vehicle less than a year» not shown. n_{BEV} = 2813, n_{PHEV} = 1896, n_{ICEV} =3002. Norwegian PEV consumer survey, TØI 2016.

The answers are consistent with the changes in the driving patterns of BEVs and PHEVs. 20% of BEV owners report the total driving distance having increased versus 6% and 8% of PHEV and ICEV owners respectively, indicating a potential rebound effect. When factoring in the effect of more BEV owners having children and looking at only households were a BEV replaced an ICEV and an ICEV an ICEV respectively, the difference becomes less. These households could have many different reasons for increasing their driving such as those seen for people that bought extra vehicles (chapter 4). On the other hand, the lack of toll road costs for BEV owners, the low cost of electricity and the access to bus lanes, make BEVs more competitive relative to public transport than ICEVs.

8 Total mileage

The total yearly mileage of BEVs and PHEVs is a metric that says something about these technologies' ability to meet drivers total transportation needs over the year, and provides a basis for the calculation of how many kilometres of ICEV driving that are replaceable when people buy a BEVs or a PHEV.

8.1 Distance driven yesterday

The accumulated share of owners driving distance, by those who drove the previous day (Monday-Friday), is shown in figure 8.1. 20% of ICEV owners, 12% of PHEV owners and 5% of BEV owners did not drive the day before answering the survey. Higher shares of BEV owners drove longer the day before than owners in the other groups, whereas ICEV and PHEV owners are rather equal. The average distance driven, by those that used the vehicle, was 66 km for BEV owners, 52 km for PHEV owners and 50 km for ICEV owners. The median distance was 50 km for BEV owners, 30 km of PHEV owners and 29 km for ICEV owners.

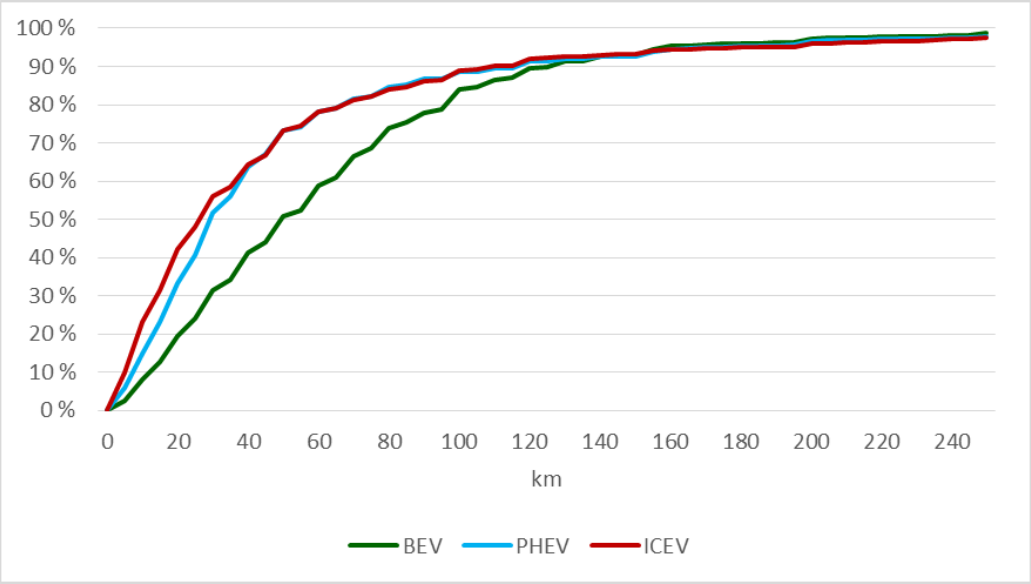


Figure 8.1 Accumulated distance driven with the vehicle «yesterday» (Mondays-Fridays). Km. n_{BEV}=1392, n_{PHEV}=2041, n_{ICEV}=2995. Norwegian PEV consumer survey, TØI 2016.

8.2 Yearly mileage in vehicle insurance

The yearly mileage on the vehicle insurance was one of the questions in the survey. BEV owners have slightly longer distance than the other groups, with an average of 15 800 km, compared to 15 200 km for PHEVs and 15 000 km for ICEVs, see figure 8.2.

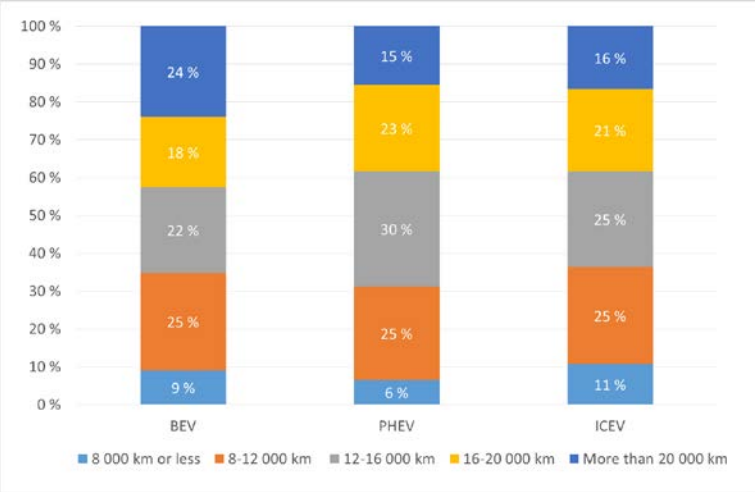


Figure 8.2 Yearly mileage intervals of vehicle insurances. Norwegian PEV consumer survey, TØI 2016.

The variation in driving length per vehicle subgroup is shown in figure 8.3, per model in figure 8.4 and province in figure 8.5. The most striking information is the high share of Tesla owners and, thus, multi BEV owners (60% of them own Tesla Model S) that have a driving distances over 20 000 km per year. More than 20% of E-Golf and Leaf owners and 18% of small BEV owners have also insured the vehicle for over 20 000 km per year. The majority of BEV owners drive more than 12 000 km per year.

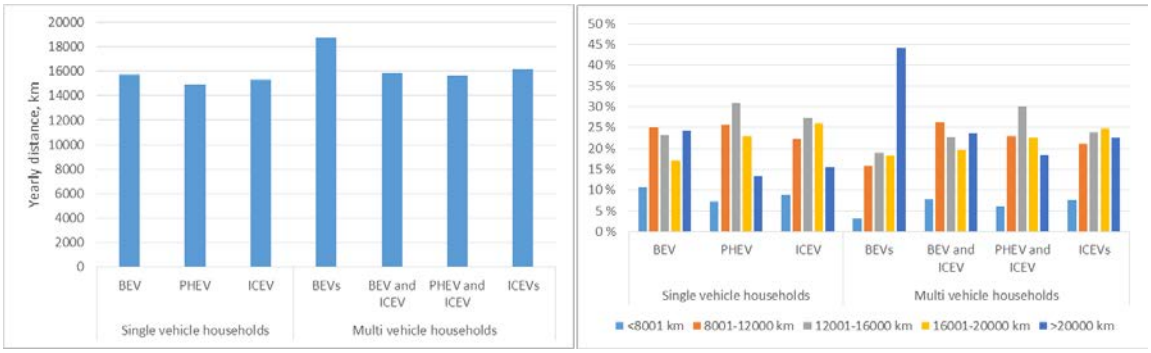


Figure 8.3 Average yearly insured km (left) and km interval (right) by subgroups. Norwegian PEV consumer survey, TØI 2016.

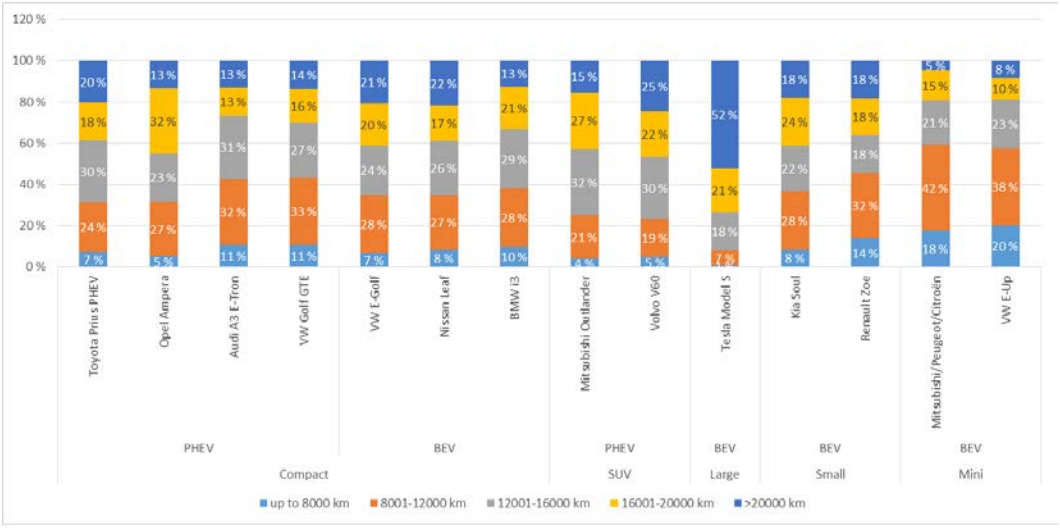


Figure 8.4 Yearly insured km intervals, by individual models and segments. Norwegian PEV consumer survey, TØI 2016.

The annual vehicle mileage of PHEVs is higher than for BEVs in three out of 19 provinces, and about equal in four provinces. In other, provinces BEVs are driven most. In particular, BEVs have a high mileage in provinces large provinces where the population lives spread out, such as Oppland, Buskerud and Nord-Trøndelag. Oslo and Rogaland are provinces with large cities and are at the other end of the scale together with the most Northern provinces.

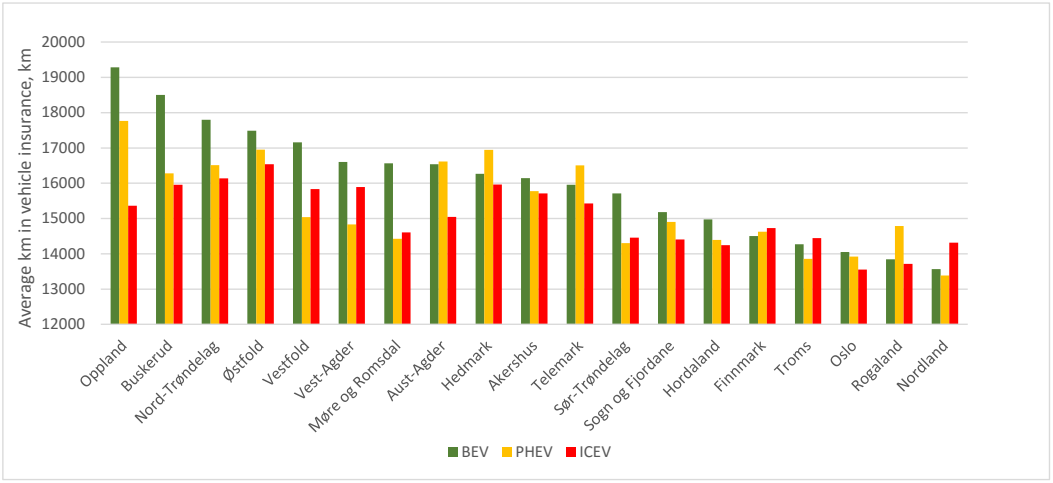


Figure 8.5 Average yearly insured km by province, km. Norwegian PEV consumer survey, TØI 2016.

8.3 Odometer readings

The odometer status and the year and month of the first time registration of the vehicle provided a second method for calculating annual mileage of the vehicles as seen in figures 8.6 and 8.7. A regression analysis of individual models driving distance were compared with the annual insured driving distance, and the average monthly driving calculated using the odometer data. The result was three different estimates of annual driving, as presented in tables 8.1 and 8.2. All three estimates show that BEVs' mileage is higher than that of PHEVs, which in turn have a higher mileage than ICEVs.

Table 8.1 Annual km, linear regression from odometer, average, and estimate from insurance km by brand, PHEVs. Norwegian PEV consumer survey, TØI 2016.

	Average km after first year, regression	Average all driving	Insurance average all vehicles
Mitsubishi Outlander	15 438 km	16 422 km	15 694 km
VW Golf GTE	13 172 km	15 029 km	14 220 km
Audi A3	12 527 km	14 403 km	14 051 km
Volvo V60	16 794 km	18 706 km	16 567 km
Toyota Prius	14 464 km	15 311 km	15 578 km
Opel Ampera	No trend	15 070 km	15 367 km
Average estimate fleet	14 614 km	15 965 km	15 220 km

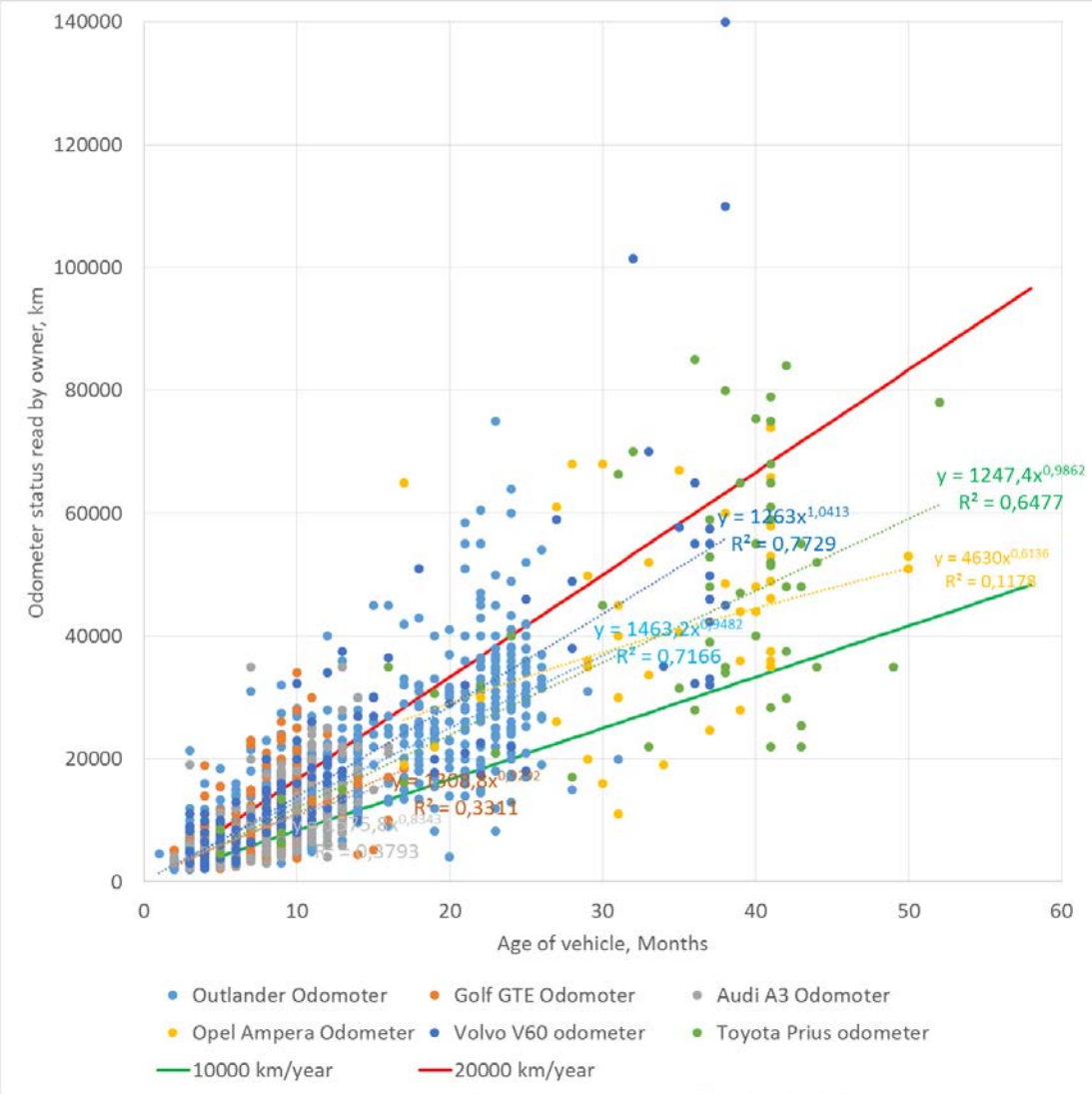


Figure 8.6 Odometer status of PHEVs by brand. $n_{MitsubishiOutlander}$=891 $n_{VWGolfGTE}$=302, $n_{AudiA3E\text{-}Tron}$=213, $n_{OpelAmpera}$=46, $n_{VolvoV60}$=128, $n_{ToyotaPrius}$=55. Norwegian PEV consumer survey, TØI 2016.

Table 8.2 Annual km, linear regression from odometer, average, and estimate from insurance km by brand, BEVs. Norwegian PEV consumer survey, TØI 2016.

	Average km after first year regression	Average all driving	Insurance average all vehicles
Tesla Model S	21 284	23 367	20 256
Nissan Leaf	14 817	15 850	15 514
Volkswagen E-Golf	14 737	16 692	15 570
Kia Soul	15 583	17 680	15 269
Volkswagen E-Up	11 290	12 558	12 615
BMW i3	14 186	15 297	14 495
Mitsubishi/Peugeot/Citroën	10 782	12 215	12 382
Renault Zoe	12 992	14 967	14 606
Average estimate fleet	14 983	16 494	15 543
Average non Tesla fleet	13 858	15 563	14 697

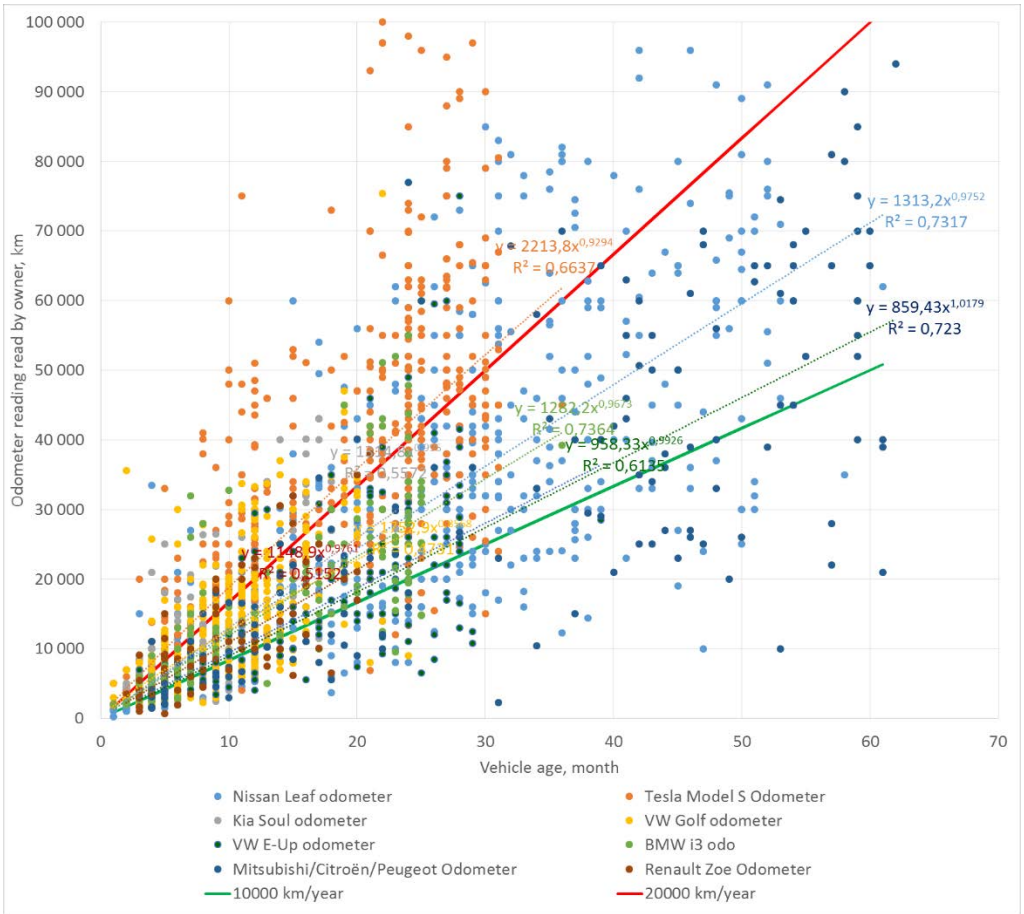


Figure 8.7 Odometer status BEVs by brand. Norwegian PEV consumer survey, TØI 2016. $n_{TeslaModelS}$=531, $n_{NissanLeaf}$=534, $n_{KiaSoul}$=196, $n_{VWE\text{-}Golf}$=444, $n_{VWE\text{-}up}$=150, n_{BMWi3}=168, $n_{MitsubishiPeugeotCitroen}$ =159, $n_{RenaultZoe}$=70. Norwegian PEV consumer survey, TØI 2016.

The odometer data and the insurance km estimated suggest that BEVs have slightly longer annual driving distances than PHEVs, with ICEVs having slightly less than PHEVs. Combining this finding, with the information that BEVs are driven more often on every day trips but less on vacation than the other vehicle types, and that owners have long distances to work, it can be concluded that *BEVs are used more in everyday traffic than the other two vehicle types.*

9 Incentives, effects and user benefit

Incentives have played a large role in the diffusion of BEVs in Norway as seen in Fearney et al (2015) and Figenbaum and Kolbenstvedt (2015). In addition to the reduced purchase taxes, including exemption from the 25% Value Added Tax (VAT), owners of BEVs can park free of charge on municipal parking spaces, pass toll roads without having to pay and enjoy reduced rates on Norwegian coastal ferries. In addition, they can use bus lanes, some places with local restrictions. Owners of PHEVs do not enjoy the same privileges, but PHEVs do have a reduced purchase tax compared with ICEVs. Appendix 3 provides an overview of the incentives and the latest proposed revisions. These revisions have not taken effect yet and some are at an early planning stage. The revisions will result in a gradual reduction of the incentives over time, assuming that technology improvements over the next years will make BEVs attractive with a lesser need for the incentives. Fearnley et al (2015) discuss the effectiveness of current incentives on promoting BEVs.

9.1 Frequency of use of incentives

BEV owners use toll roads twice as much as PHEV and ICEV owners when driving to work, as seen in figure 9.1. Figure 9.2 presents an overview of the current toll roads scattered across the country.

Figure 9.1 Usage of toll roads on the way to work by group. n_{BEV} = 2166, n_{PHEV} = 1098, n_{ICEV} =1328 (part of sample discarded). Norwegian PEV consumer survey, TØI 2016.

The share of BEV owners using toll roads on the way to work has gone slightly down since 2014 when 70% did so (Figenbaum et al 2014) versus 63% in 2016.

878 BEV owners in the survey use the BEV to drive to work and can use a bus lane (39% of BEV owners that drive to work, 28% of all BEV owners). In the 2014 survey, 48% of those driving to work could use the bus lane.

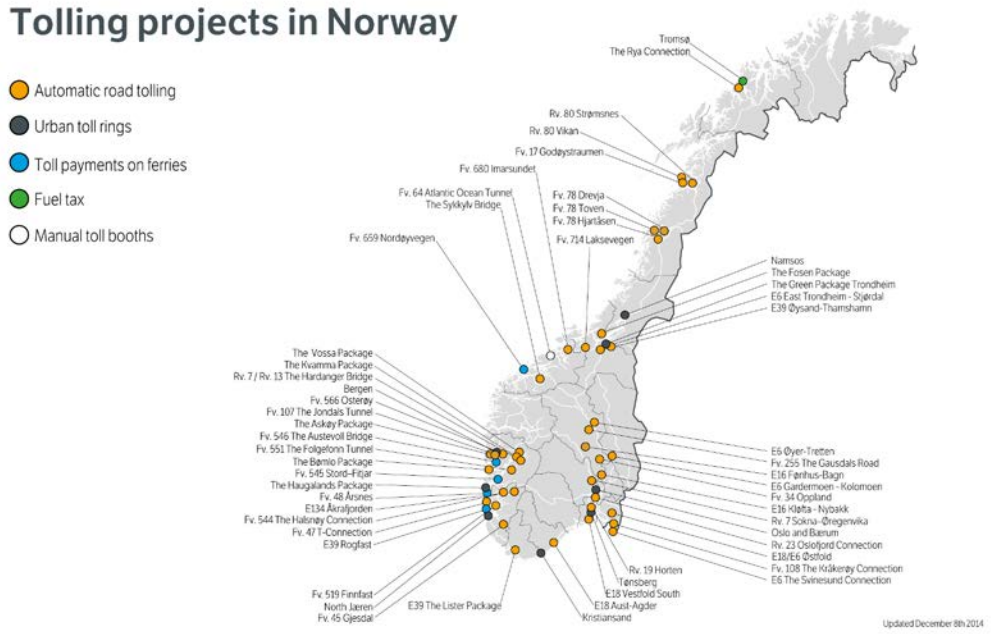


Figure 9.2 Overview of toll road projects in Norway (NPRA 2015).

The spread of and average time savings per trip as estimated by users, i.e. those that drive in the bus lane, is shown in table 9.1 for the 2016 and the 2014 survey (Figenbaum et al 2014).

Table 9.1 Time-saving per trip for BEV owners driving in the bus lane to work, 2016 and 2014 surveys. Norwegian PEV consumer survey, TØI 2016.

	<11 minutes	11-20 minutes	21-30 minutes	>30 minutes	Don't know
Total					
2016	49 %	14 %	10 %	12 %	16 %
2014	39 %	20 %	15 %	16 %	10 %
Without «don't know»					Average users
2016	58 %	17 %	12 %	14 %	13 min
2014	43 %	22 %	17 %	18 %	16 min

The average time saved by those driving in the bus lanes is about 13 minutes per day. Time when driving in the rush hour has a value of 280 NOK/hour (Figenbaum et al 2014). The average value of using the bus lane is then 60 NOK/day/user.

The share of users of incentives is lower than in 2014. The time saved by those using the bus lane has gone down from 16 to 13 minutes, potentially an effect of some bus lanes in the Oslo area now only open to those who have a passenger in the vehicle in the rush hours.

9.2 Cost saving/cost of toll roads, ferries and parking

The toll road costs for ICEV and PHEV owners, and savings for BEV owners are shown in figure 9.2. Respondents were asked about weekly cost and saving. These numbers have converted to annual numbers by assuming that the vehicles are in use 46 weeks per year. On average, BEV owners save 7 240 NOK per year, PHEV owners spend 3 600 NOK and ICEV owners spend the least, at 2 960 NOK. In the 2014 survey the cost saving was calculated by making an assumption of which toll road they were using and that they passed once per day. In 2016, the users have assessed their total savings on an average week, thus leading to a higher number.

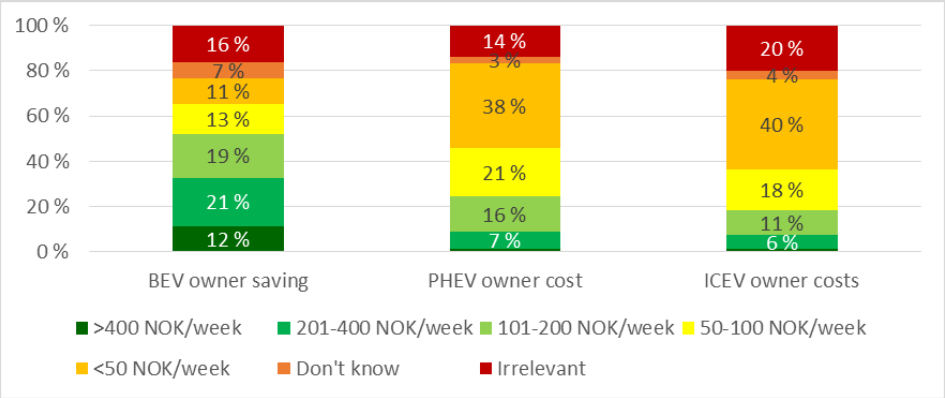


Figure 9.2 Weekly cost of toll roads for PHEV and ICEV owners, and BEV owner's weekly savings. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

On average, BEV owners save 2 350 NOK per year on free parking per year, whereas PHEV owners spend 1 210 NOK and ICEV owners 1 530 NOK, see figure 9.3.

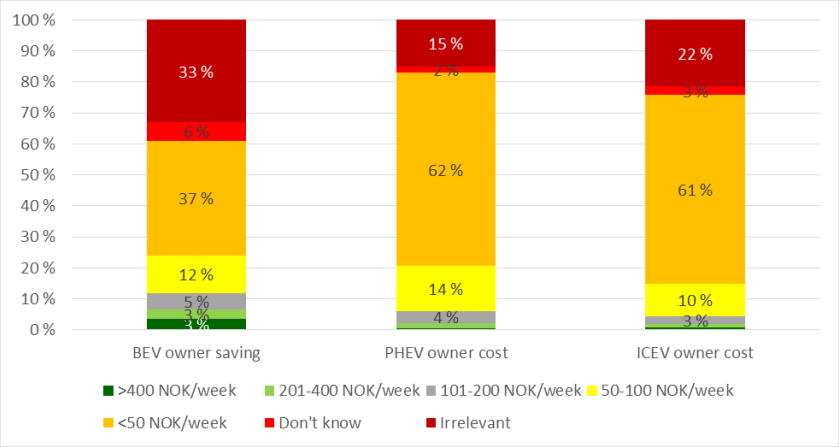


Figure 9.3 Weekly cost of parking for PHEV and ICEV owners, and BEV owner's weekly savings. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

On average, BEV owners save 580 NOK per year on reduced ferry rates, whereas PHEV owners spend 500 NOK and ICEV owners 740 NOK, as seen in figure 9.4. BEV owners have about 50% rebate, not a total exemption, so they actually spend 50% less than they otherwise would have done.

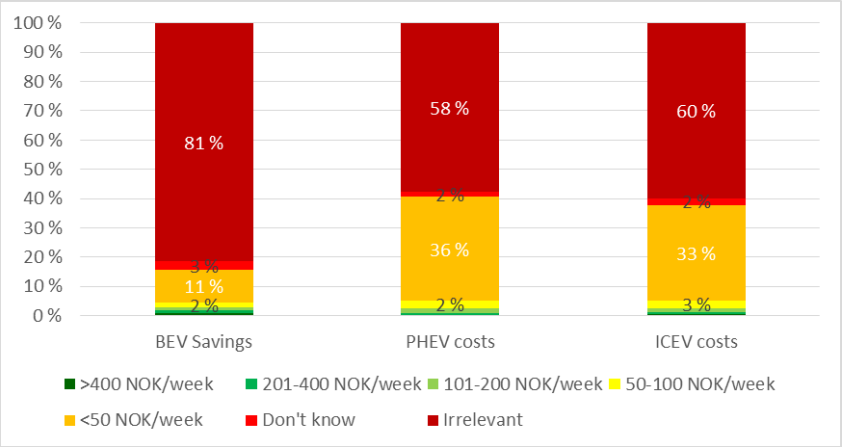


Figure 9.4 Weekly cost of ferries of PHEV and ICEV owners, and BEV owners weekly saving. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

9.3 Total average value of user incentives and costs

The average value of the local incentives varies geographically, as seen in figure 9.5. BEV owners in Oslo, Akershus and Buskerud have the largest benefits and owners in rural inland, northern and some coastal provinces have the lowest benefits. Incentives such as the ferry incentive, although insignificant on a national scale, may still be the main reason why people buy a BEV in some provinces.

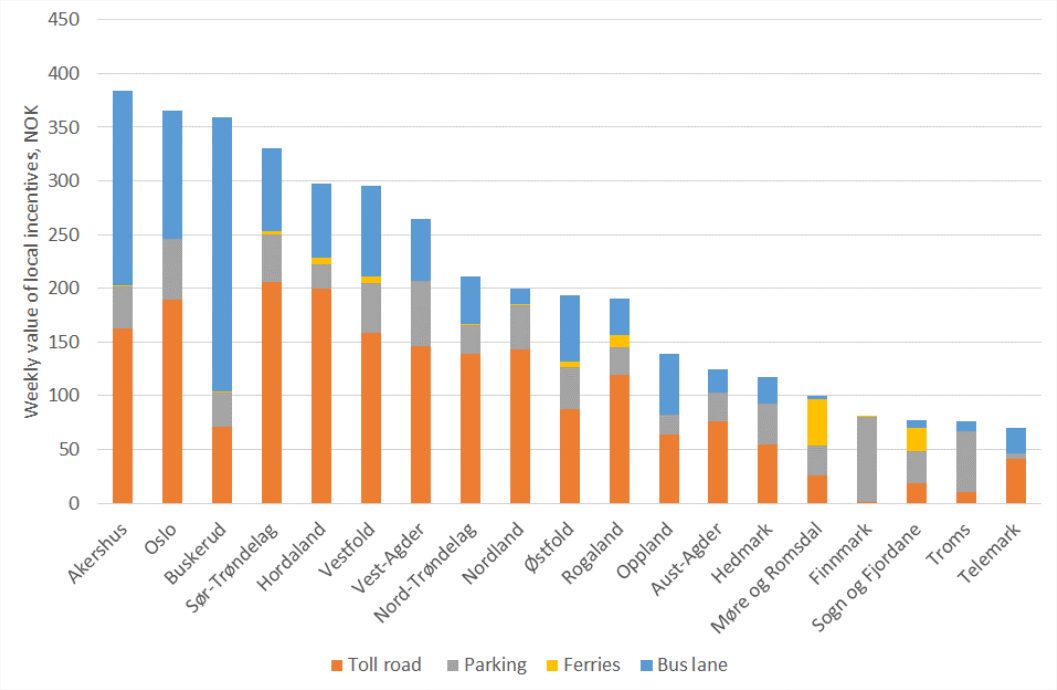


Figure 9.5 Average weekly value of incentives per BEV owner by province, NOK. n_{BEV} = 3111. Norwegian PEV consumer survey, TØI 2016.

As shown in figure 9.6 there is little correlation between value of parking and ferry incentives and the BEV share of the fleet. There is a clear linear correlation for the toll road incentive and the sum of the incentives. The correlation for the bus lane incentive is much weaker. The toll road exemption is, thus, the most important BEV incentive.

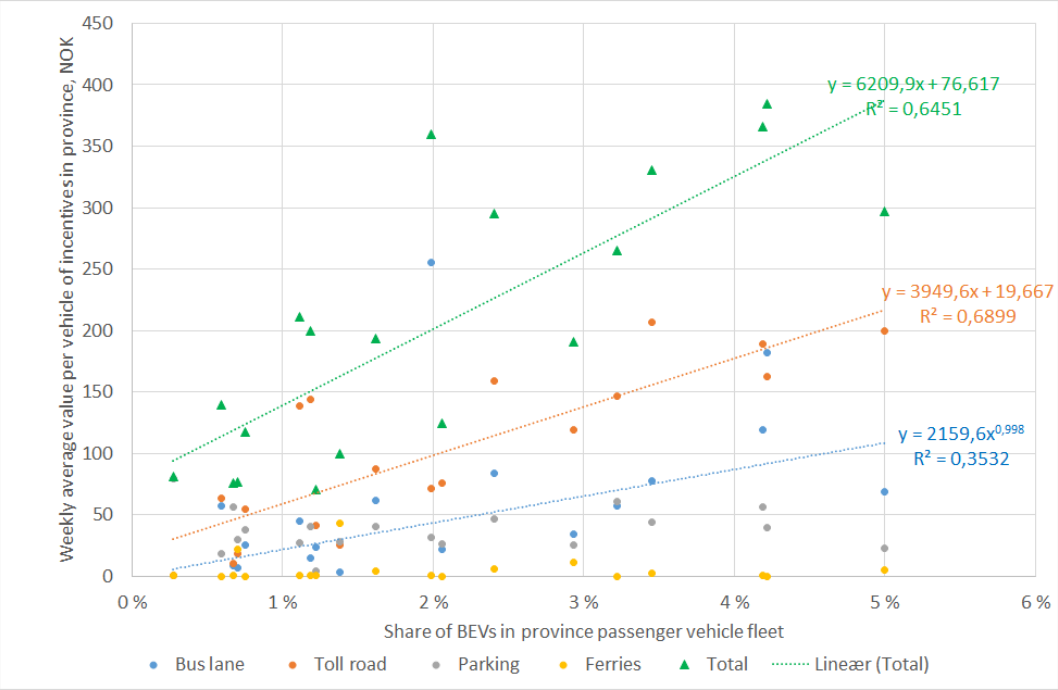


Figure 9.6 Share of BEVs in fleet versus estimated value of incentives by the users of incentives. Norwegian PEV consumer survey, TØI 2016.

The total value of these incentives and other annual user costs per year, is shown in table 9.2. One can clearly see that BEV owners are saving about twice as much on toll roads and public parking as PHEV and ICEV owners are spending. A fact that indicates that BEVs appeal to people who regularly use toll roads and who park or would like to park in public places without paying.

Table 9.2 Total cost and saving of local user incentives by vehicle type. NOK. Norwegian PEV consumer survey, TØI 2016.

	BEV owner (saving)	PHEV owner (spending)	ICEV owner (spending)
Toll roads	-7 241	3 595	2 955
Parking	-2 349	1 214	1 526
Ferry saving	-579		
Ferry spending	*	504	739
Bus lane time saving value	-4 498		
Total	-14 088	5 313	5 220

*BEV owners spend roughly the amount they save, as they have about 50% rebate, but they were not asked how much they save.

The total value of incentives vary widely among the users. Only about 10% of users seem to have zero value of the incentives. A reason for this situation is that it is difficult to own a vehicle and not pass toll roads occasionally at least in Norway. The 10% with the most advantages can receive benefits with a value exceeding 50 000 NOK per year, as seen in figure 9.7. The median is around 10 000 NOK/year.

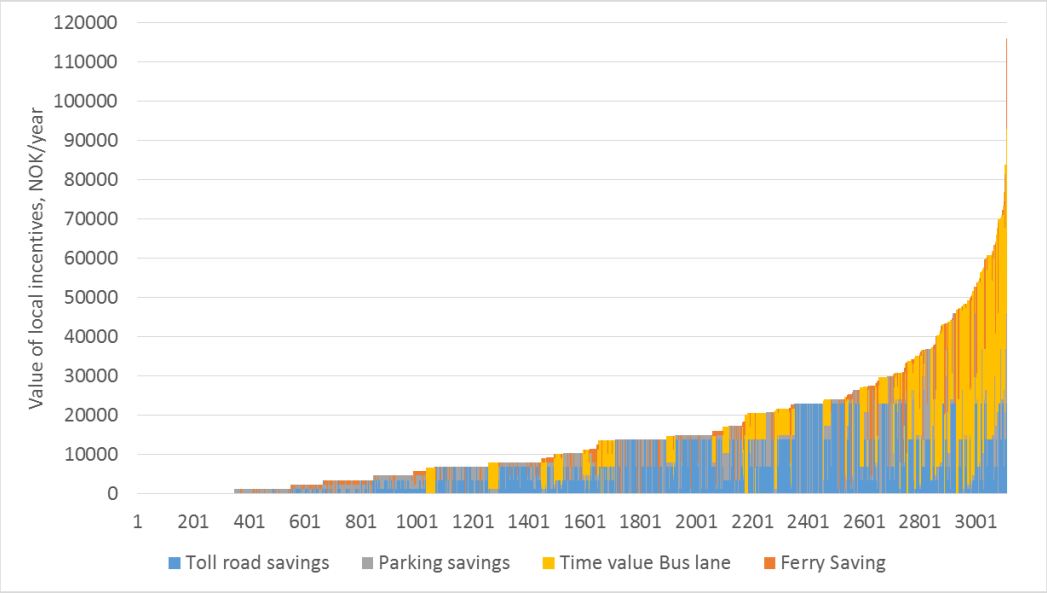


Figure 9.7 Estimated value of local incentives for all BEV owners in the survey, arranged in order of increasing value per owner. NOK/year. n_{BEV}=3111. Norwegian PEV consumer survey, TØI 2016.

As will be presented in chapter 12, BEV owners, as well as PHEV and ICEV owners, say that the toll road incentive is the most important *local* incentive for purchasing a BEV.

10 PHEV E-mode km driven

Most PHEVs have a "full" electric drive mode, E-mode, using electricity charged into the battery from the electricity grid prior to starting the trip. The estimated travel in E-mode is the most important parameter of PHEVs. The higher the share, the less polluting is the vehicle, and the lower is the energy cost of running the vehicle for the user, since electricity is much cheaper per energy unit consumed per km to propel the vehicle.

10.1 Estimated percentage in EV mode

The average PHEV user in the survey drives 60% of the total kilometres in E-mode in the summer and 53% in winter. The estimate for work trips is clearly higher at 70% respectively 59%, as seen in figure 10.1.

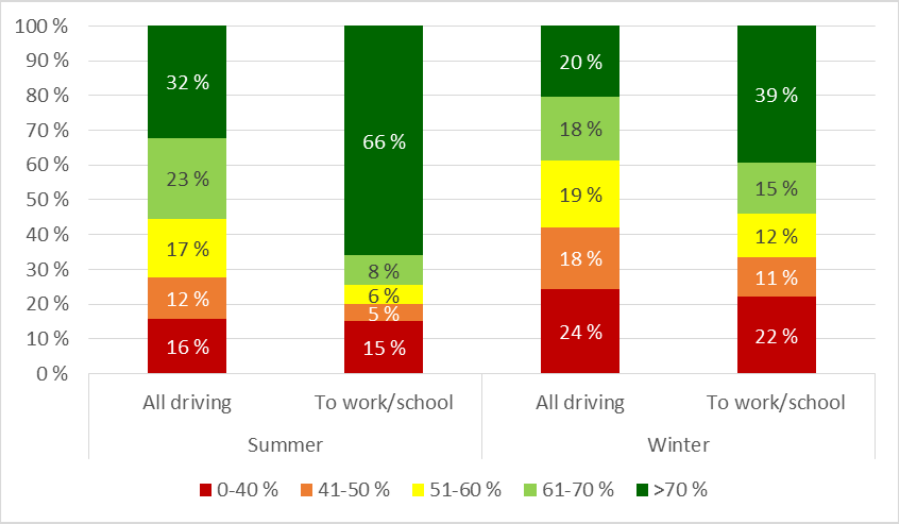


Figure 10.1 Estimated percentage of average PHEV owner's km travelled in "E-mode", summer and winter, to work/school and the average of all trip types. n=2065. Norwegian PEV consumer survey, TØI 2016.

Data for individual models together with estimates for the range in the "E-mode" and the «weighted average» of the range and share of driving in E-mode, is shown in table 10.1. The weighted E-mode average share is 55% for all driving and about 63% for work trips. Vehicles with obviously erroneous range data, such as where the winter range was longer than the summer range, where removed from the sample. The E-mode share in table 10.1 and figure 10.2 has been calculated by using the mid value of the intervals in figure 10.1, i.e. 0-40% = 20%. It was when setting up the survey, expected that most answers would be in the interval 40-70%, but as shown in figure 10.2 this was not the case.

According to data from the on board computer in the Volvo V60 PHEV they are driven 46.3% of the time on electricity in E-mode based on data from 341 Norwegian vehicles that have been driven a total of 7 923 040 km, according to press release and personal communication with press manager at Volvo). The users in the survey estimated 48% in

EV mode in the winter and 55% in the summer, 51% over a year as an average of all travel, thus potentially being 10% too optimistic.

Table 10.1 Estimated range and percentage of PHEV users' km travelled in "E-mode" by model. Norwegian PEV consumer survey, TØI 2016.

Model	Yearly average range in E-mode	Summer average Range E-mode	Winter average Range E-mode	Official Range	Yearly average E-mode share	Summer average E-mode share	Winter average E-mode share	Number of vehicles
A3	34	40	29	50	59 %	64 %	54 %	197
Ampera	56	68	44	83	72 %	77 %	68 %	46
C350e	21	23	18	31	41 %	44 %	38 %	11
Golf GTE	34	40	28	50	57 %	62 %	52 %	283
Outlander	36	41	30	52	55 %	62 %	48 %	806
Prius	17	20	15	25	38 %	43 %	33 %	67
V60	41	46	37	50	51 %	55 %	48 %	104
Weighted average	35	41	29	51	55 %	61 %	49 %	1515

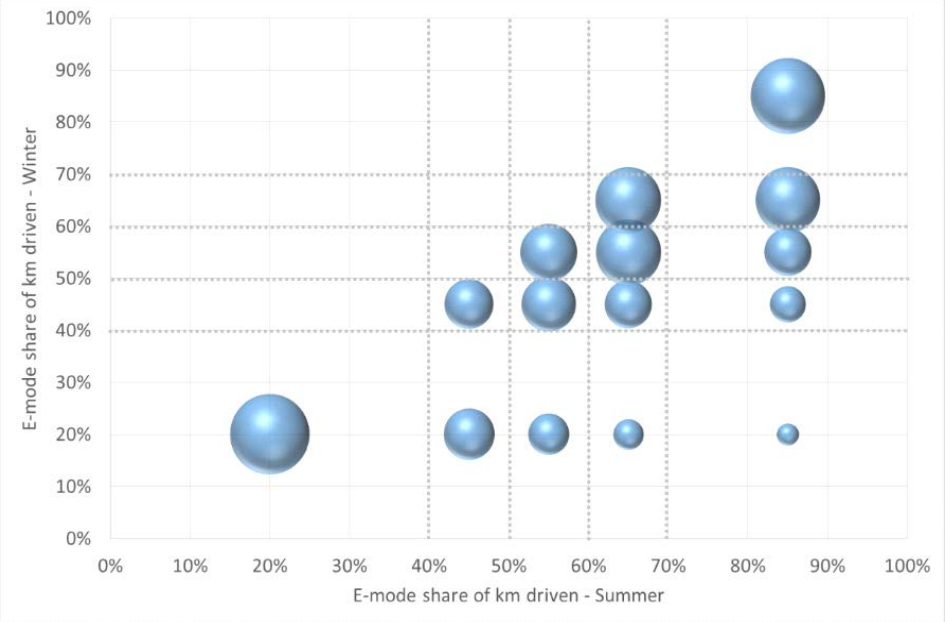


Figure 10.2 Share of PHEV users driving in E-mode, summer versus winter. Bubble size represents relative number of respondents. Grids marks limits used in questionnaire. (x=20% and y=20% means that both in summer and winter the E-mode driving is less than 40%). n=2065. Norwegian PEV consumer survey, TØI 2016.

10.2 Users estimate of range in E-mode

Users' estimated range is shown in figure 10.3 for different confidence intervals, together with the official range of the vehicles. Even the 90th percentile is below the official range. The deviation is, as expected, much larger in the winter.

The estimate of range in the summer versus winter is shown in figure 10.4.

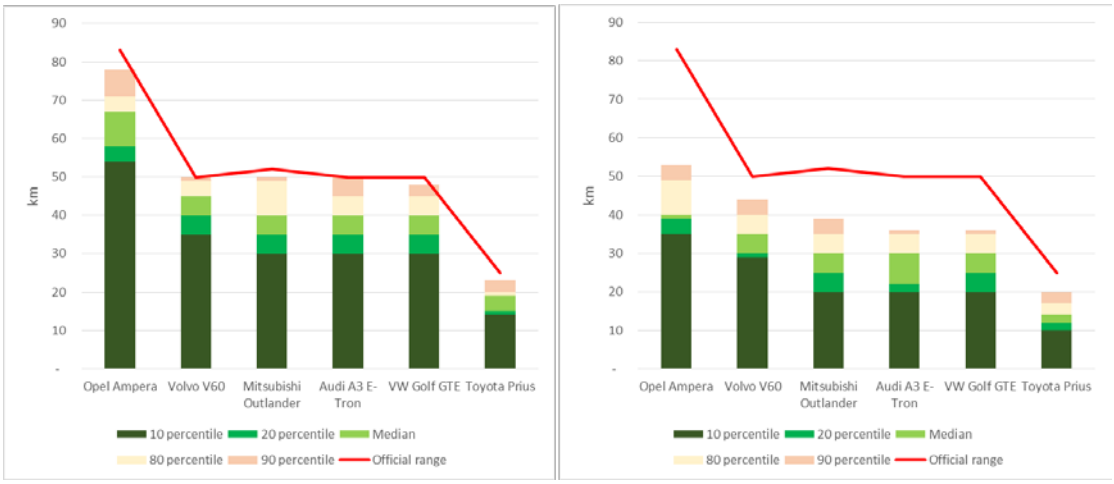


Figure 10.3 PHEV users average experienced summer and winter range and official range in E-mode, km. Norwegian PEV consumer survey, TØI 2016.

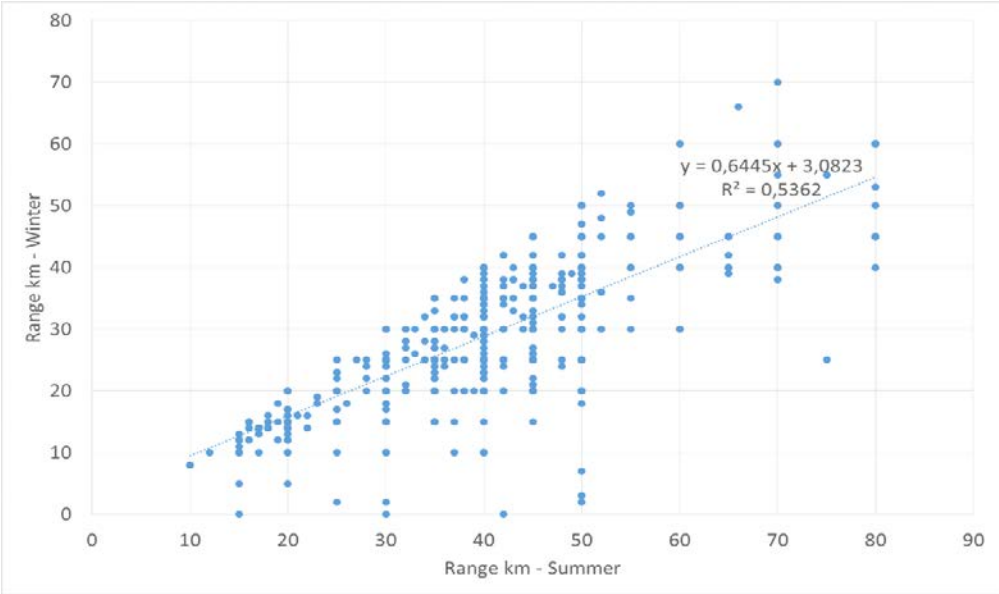


Figure 10.4 PHEV users estimated range in E-mode in summer versus winter, n=1534. Norwegian PEV consumer survey, TØI 2016.

10.3 Combining range and the share of driving in E-mode

Figure 10.5 shows average range and average share of driving in E-mode by PHEV model. Opel Ampera vehicle owners consistently drive above 50% of km in E-mode. Buyers of the Prius plug-in (25 km range in E-mode) must have an optimum driving pattern, as quite a few of them say they achieve E-mode shares above 50%. The other vehicle types have a highly variable share of EV mode driving. Note that 20% EV mode could be any value between 0-40% and 85% could be any value above 70%. The midpoint value was used for further analysis in this chapter.

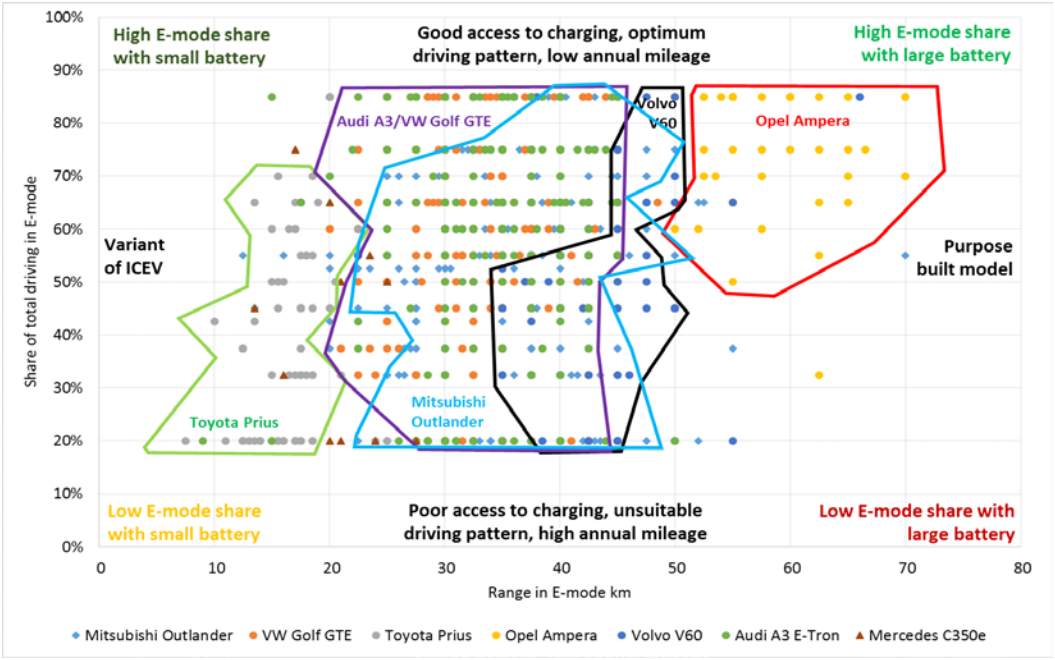


Figure 10.5 Average of PHEV users estimate of average of winter and summer range in E-mode vs average of estimated share of total driving in E-mode. Coloured boundaries show the typical spread of values of various models. n=1534. Norwegian PEV consumer survey, TØI 2016.

10.4 Total annual mileage versus E-mode share

The annual driving distance also comes into play. All PHEVs analysed have a reduced share of driving in E-mode when the annual mileage increases, except for the Opel Ampera, which, as seen in figures 10.6 and 10.7, has an increasing share. The reason is likely that the vehicle has longer range in E-mode than the other vehicles, so that much more of daily driving will be in E-mode and a higher share of longer distance trips.

There might thus be a threshold E-mode range, above which PHEVs will have a positive relation between annual mileage and E-mode share.

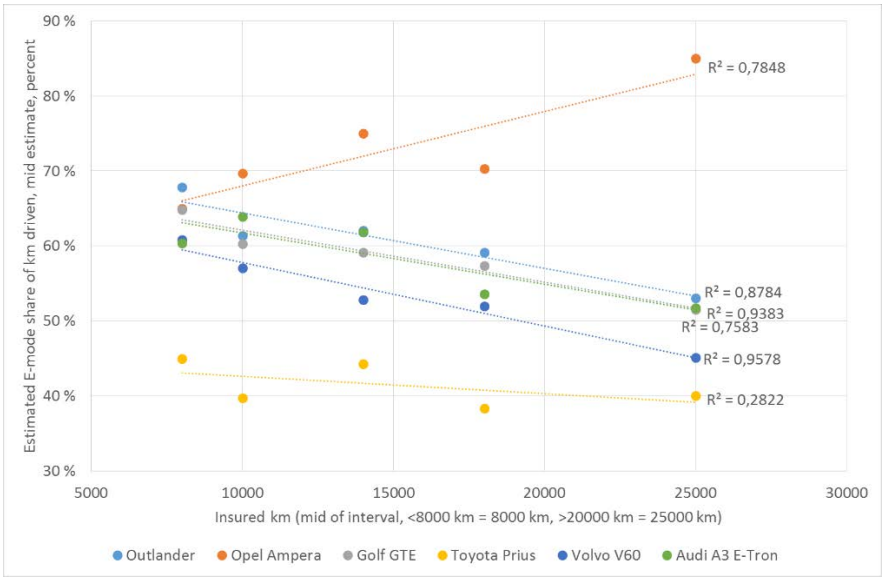


Figure 10.6 Estimated E-mode share of PHEV owner's km driven versus total annual km in insurance by model. Norwegian PEV consumer survey, TØI 2016.

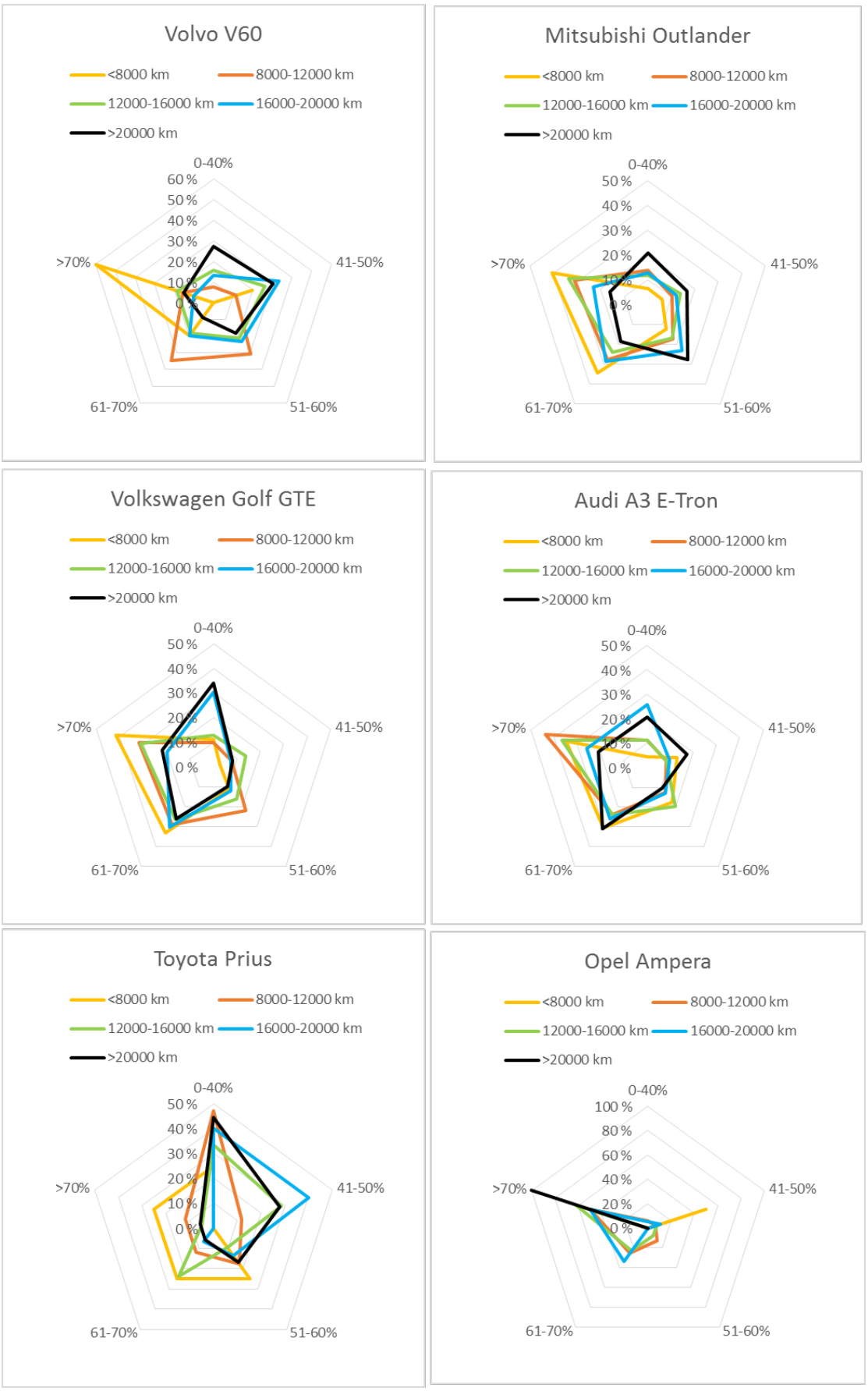


Figure 10.7 Insurance km intervals and total share of PHEV owners driving in E-mode (summer) by model. Norwegian PEV consumer survey, TØI 2016.

The estimated annual mileage in E-mode, is shown in figure 10.7. These values are calculated by combining the estimated E-mode share per insurance interval per vehicle, with the average km driven per interval (i.e. 8 000-12 000 = 10 000 km average).

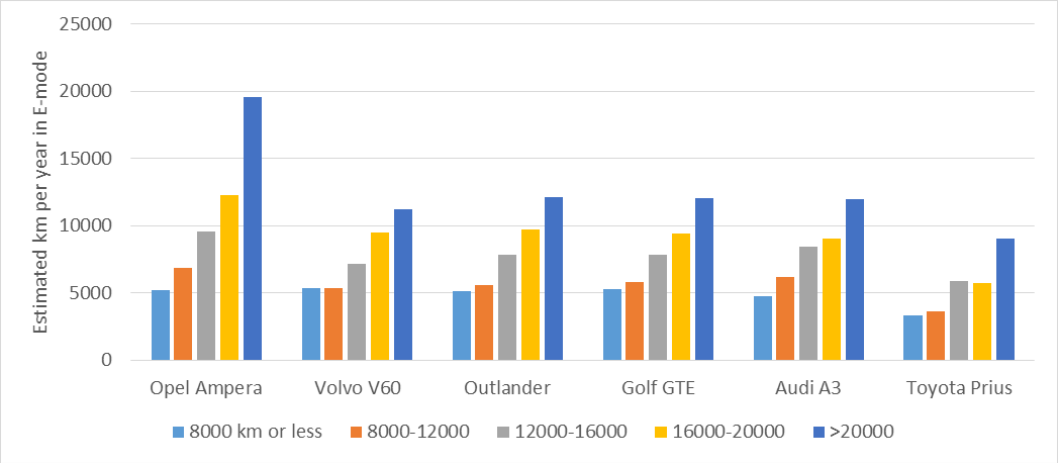


Figure 10.8 Estimated yearly average km driven by PHEV owners in E-mode, based on mid-point of insurance km interval and average of E-mode share intervals summer and winter by brand. (8 000 km or less=8 000 km, >20 000 = 25 000 km. Norwegian PEV consumer survey, TØI 2016.

10.5 Charging frequency, influence on E-mode share

There is a correlation between frequently charging at home and at work and a higher E-mode share, as seen in figure 10.9. People also charge in carports or outdoors and the tendency is the same for those locations as well, indicating that good access to charging factors into achieving a high E-mode share.

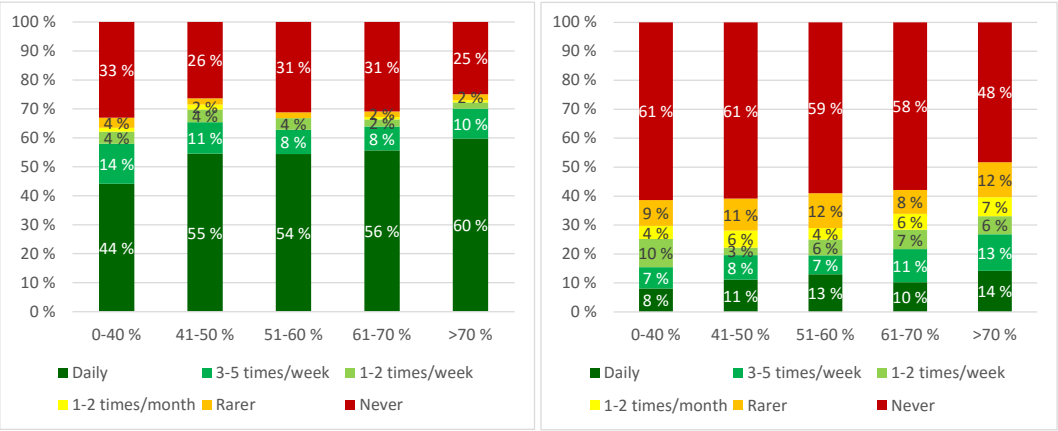


Figure 10.9 Share of PHEV winter driving in E-mode as function of frequency of charging at home in the garage (left) and at work (right). n_{home}=1892, n_{work}=1502. Norwegian PEV consumer survey, TØI 2016.

11 Travel challenges for BEV owners

The general expectation is that BEV owners will have occasional travel challenges due to BEVs' limited range and long refill time. In addition, as they are a newer form of technology, unexpected issues may arise. Several questions included in the survey provide insights into various potential travel challenges.

11.1 Estimated range when planning trips

It is well known (Laurikko et al, 2013) that BEV range is overestimated and the energy consumption under estimated, when using the official range test in Europe, which is also the case for ICEV vehicles (Tietge et al, 2015). In the test, the range is measured using the unrealistic NEDC drive cycle, and all accessories such as heater or Air-conditioning equipment are in the off position. BEV owners, therefore, plan for a range substantially lower than the official range value as seen in figure 11.1. The variation in range estimates is larger in the summer than in the winter and for bigger vehicles. The Tesla Model S has a median range estimate of 300 km in the winter, and 400 km in the summer (not shown in figure 11.1 due to differences in scale).

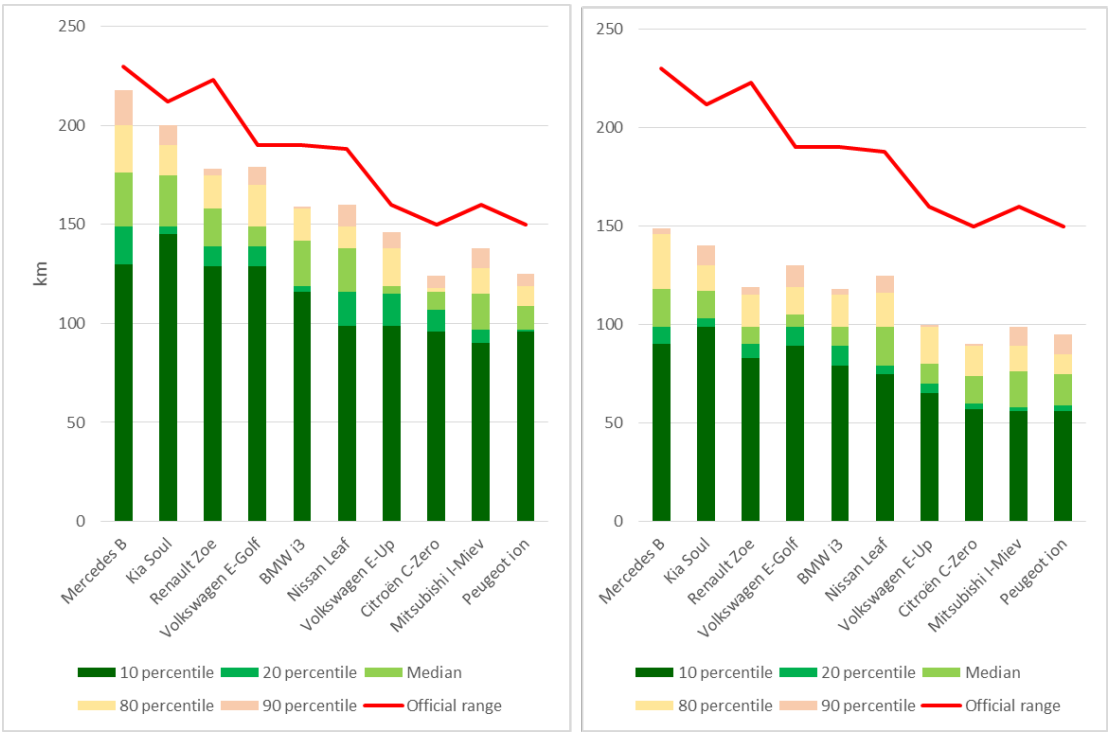


Figure 11.1 BEV users range estimate used for planning trips in the summer (left) and winter (right), by vehicle model (Leaf and Zoe: The official range shown is weighted by number of vehicles per year model for years when official range has changed), km. Norwegian PEV consumer survey, TØI 2016.

The Nissan Leaf is a model that has evolved technically over the years, since its introduction in 2011. The original vehicle had a range of 160 km and a simple PTC element electric heater. In 2013, a new version came with range of 199 km and a more energy efficient heat pump based heating system. A larger battery for the 2016 model introduced as an option with 250 km range. Figure 11.2 shows the Leaf users' assessment of the range used for planning trips and the the improvement in range of the newer models is clearly seen. It is likely that all owners of 2016 Leaf models in the survey have the largest battery, and a large share of the 2013 models are 199 km versions with heat pumps.

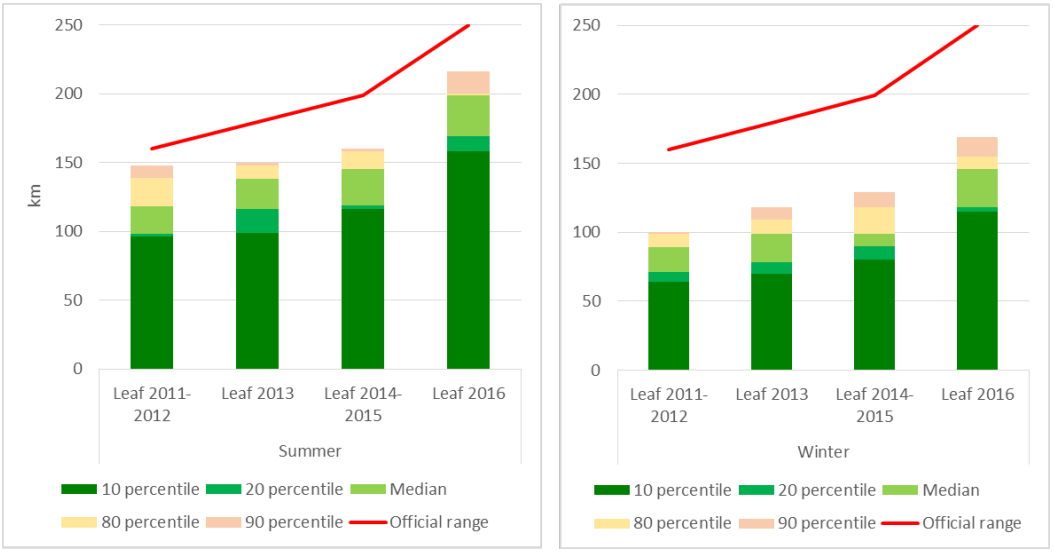


Figure 11.2 Nissan Leaf (BEV) users' estimate for summer and winter range used when planning trips, versus official range by year model. Km. Official range 2013 assumes half are 160 km version and the other half the 199 km version. Norwegian PEV consumer survey, TØI 2016.

Figure 11.3 shows that users estimated range in summer versus winter is relatively linear. The summer range estimates above 240 km are Tesla Model S vehicles.

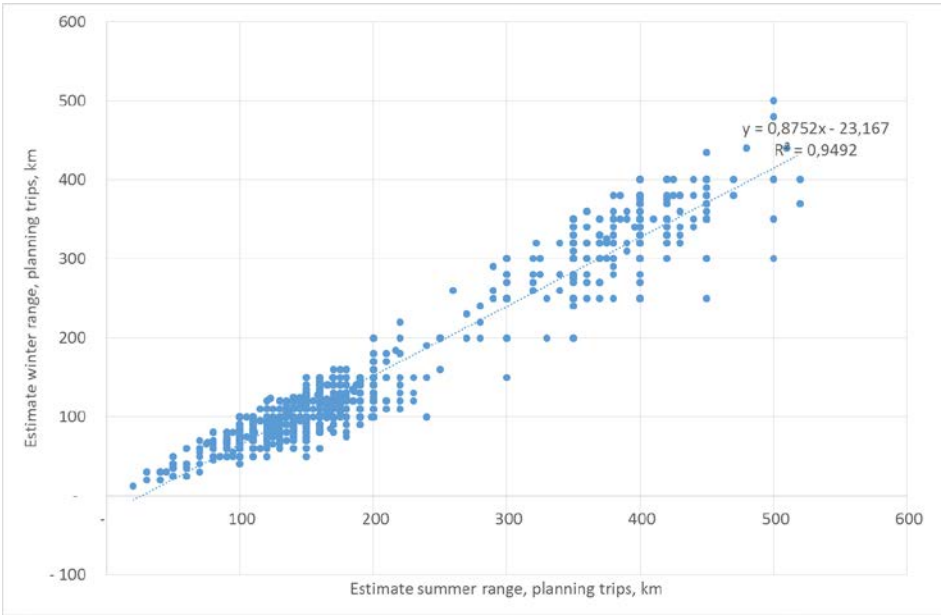


Figure 11.3 BEV owners estimated summer and winter range used for planning trips, km, n=2588. Norwegian PEV consumer survey, TØI 2016.

11.2 Avoided or aborted travel

A metric on how well the BEV satisfies their driving needs is how often users have had to avoid or abort travels with their BEVs. Avoided travel has occurred for 854 (27% of total) BEV owners, whereas only 176 (6%) have aborted travels. The main reasons for avoiding and aborting travel are shown in figures 11.4 and 11.5.

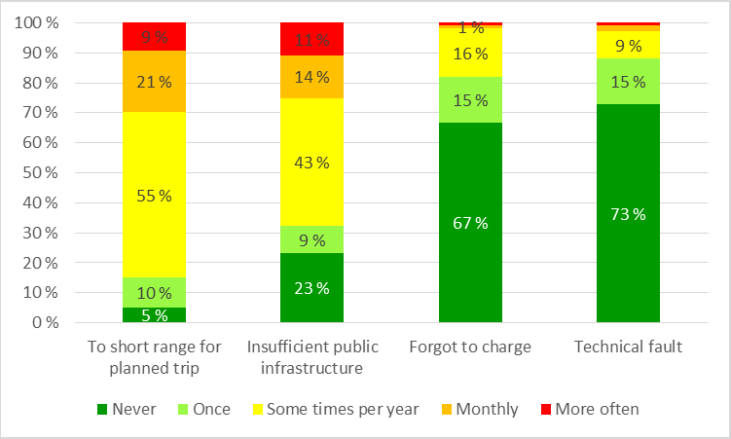


Figure 11.4 BEV owners reasons for avoiding travel mentioned by those that had avoided travelling with their BEV, n=854. Norwegian PEV consumer survey, TØI 2016.

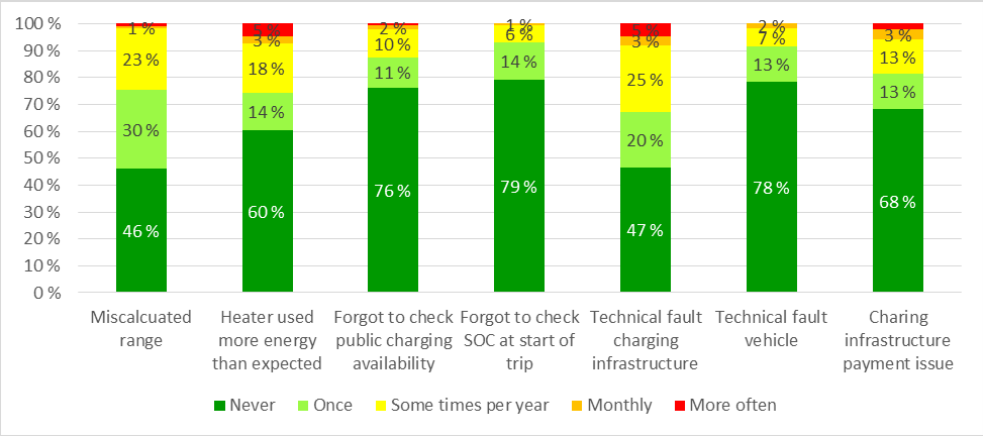


Figure 11.5 BEV owners reasons for aborting trips travel mentioned by those who had aborted trips with their BEV. n=176. Norwegian PEV consumer survey, TØI 2016.

The number of days per year of avoided and aborted travel for those who have experienced these problems, and the average for all BEV owners, i shown in figure 11.6.

Avoided travel occurs on average five days per year for all BEV owners, but 18 days per year for those having this problem. Half of the problems are associated with insufficient charging infrastructure, a clear case for the importance of public support in improving the charging infrastructure. Tesla owners have almost no problems, on average a third of a day per year, indicating that most Tesla owners have enough range, rarely need to charge on the go, and that the Superchargers network is reliable. Aborted trips are a rare event, less than one day per year as an average for all BEV owners and about 12 days per year for the 6% BEV owners that have aborted trips.

The two main reason leading to avoided trips are range and the lack of public infrastructure, whereas technical fault in the charging infrastructure and the cabin heater's energy consumption are the two most important reasons for aborting a trip.

Building out better coverage of public and reliable infrastructure could make about half of the avoided travel possible to carry out, and the number of aborted trips could be 50% reduced.

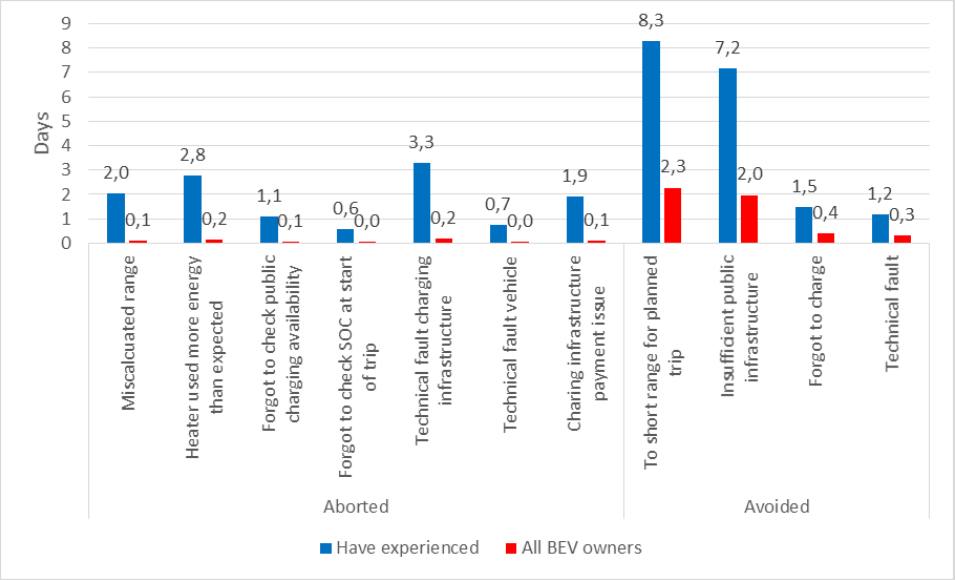


Figure 11.6 Average number of days of avoided and aborted travel of BEV owners that have avoided or aborted trips and the average of all BEV owners. $n_{Aborted}$=176, $n_{Avoided}$=854, $n_{Allowners}$=3111. Norwegian PEV consumer survey, TØI 2016.

There was no significant difference between the BEV owning groups when it came to aborted travel. The households that own BEVs in combination with ICEVs, experience having to avoid trips more often than the other groups. Multi BEV owners have the fewest problems on average, but the worst problems among those who have had to avoid travelling or have aborted a trip, as seen in figure 11.7.

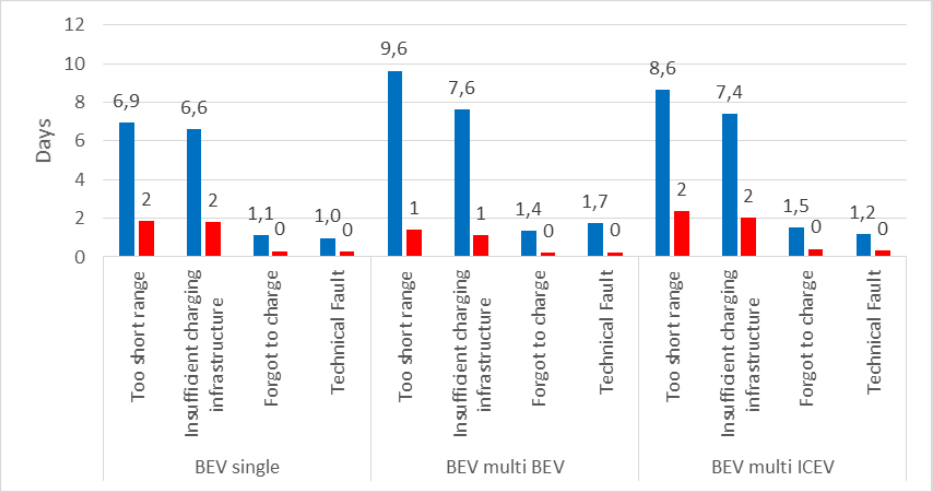


Figure 11.7 Average number of days of avoided travel of those that have avoided trips in different BEV owner groups (blue), and the average of all BEV owners in these groups (red). $n_{BEV\,single}$=185, $n_{BEV\,multiBEV}$=19, $n_{BEV\,multiICEV}$=630. Norwegian PEV consumer survey, TØI 2016.

11.3 Adaptations when range is too short

All BEV owners were asked what they would do when range is too short for a planned trip. The answers shown in figure 11.8, that people would plan better, find and alternative vehicle, drive more efficiently and use fast chargers on the go, are very similar to the answers given in 2014. An exeption is the larger share of owners stating that the may not be done, that more people would plan better in 2016, and that fast chargers would be used more, as seen in figure 11.9. Since only 27% of BEV owners have avoided travel because the vehicle could not fulfil their driving needs, and range related issues were the main reason for half of these challenges, it is likely that many have answered hypothetically.

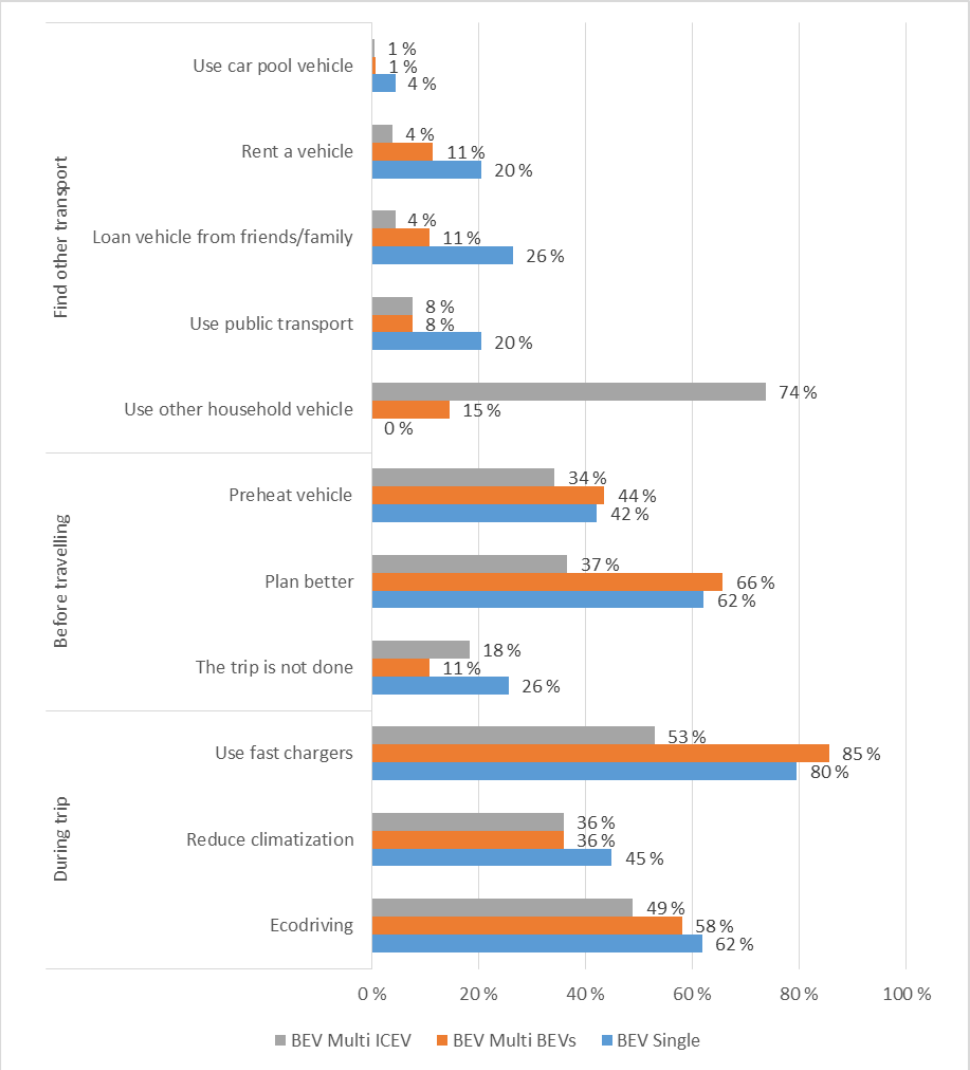


Figure 11.8 Adaptions when range is too short, by different BEV owner groups, n=3111. Norwegian PEV consumer survey, TØI 2016.

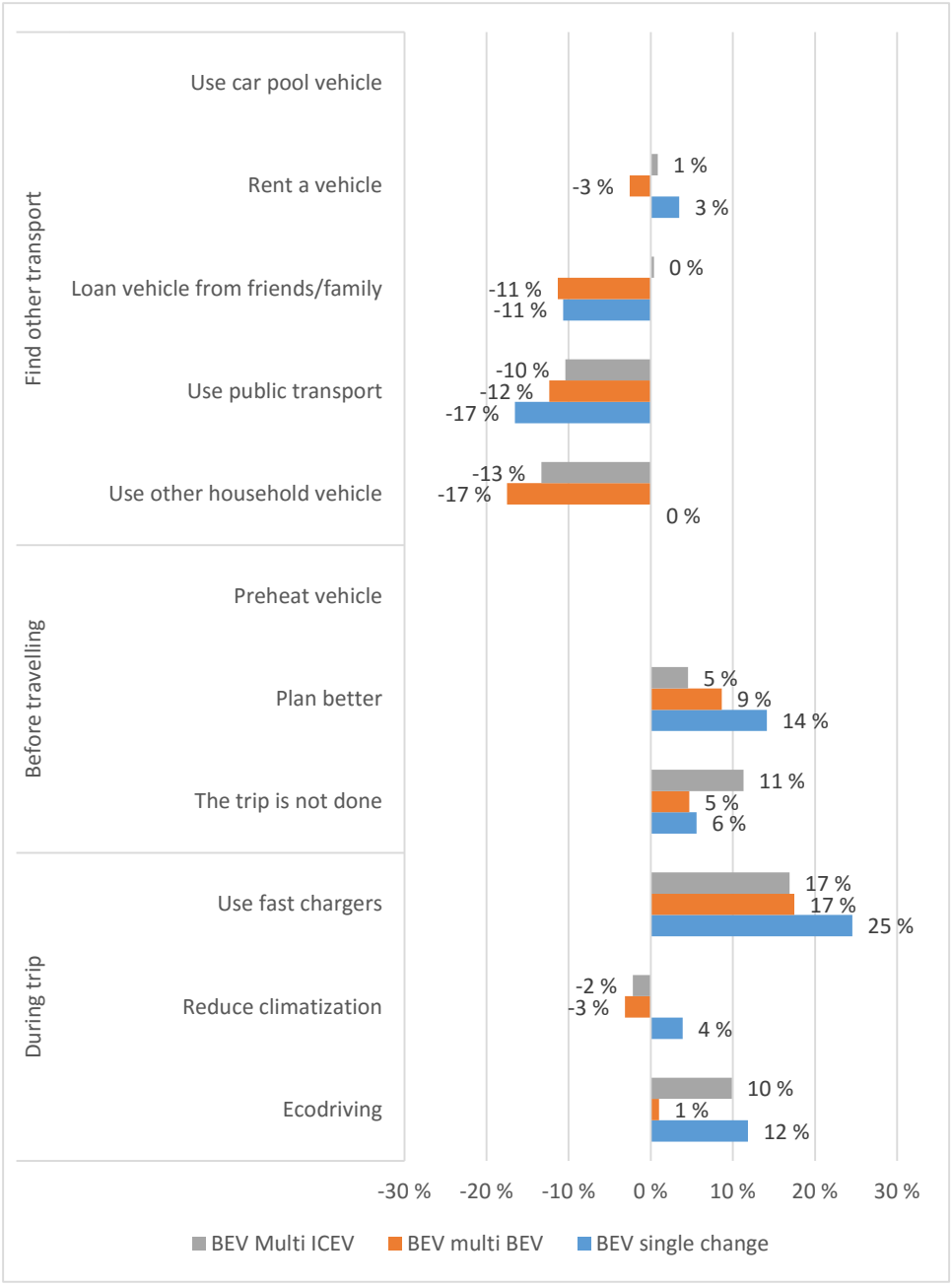


Figure 11.9 Changes between 2014 and 2016, in adaptation when range is too short by different BEV owner groups, n_{2016}=3111, n_{2014}=1722. Norwegian PEV consumer survey, TØI 2016.

11.4 Are low noise BEVs a potential safety challenge?

All the respondents were asked if they had ever experienced dangerous situations due to pedestrians, cyclists or children not hearing the vehicle coming, which has been raised as potential safety hazard related to BEVs' noiseless travel at low speeds.

BEV drivers, in particular female BEV drivers, say they experience this problem much more often than others, as seen in figure 11.10. About one percent of BEV, PHEV and ICEV drivers experience this problem annually, and more BEV owners have experienced it several times than in the other groups. The biggest difference is the category that has

experienced it once, 11% of BEV owners but only 5% of ICEV owners with PHEV owners in the middle.

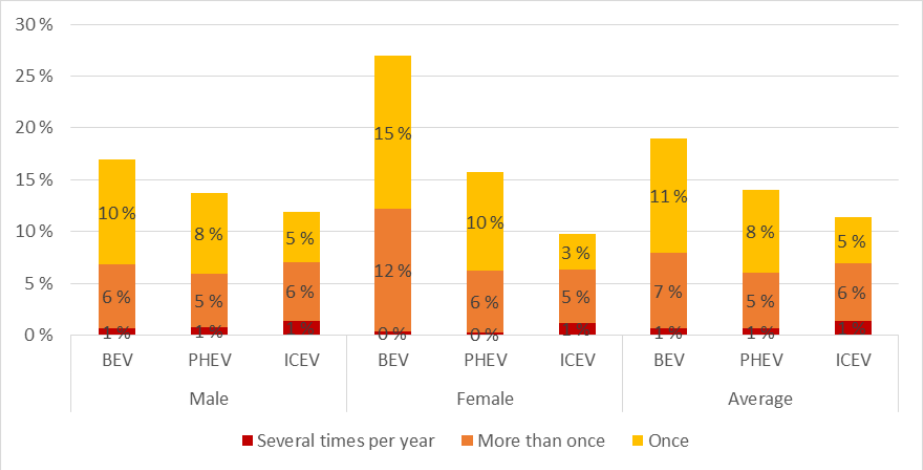


Figure 11.10 Frequency of perceived dangerous situations because pedestrians, cyclists or children do not hear the vehicle, by gender and type of technology. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

The number of incidents increases by the number of years of being a BEV or PHEV driver, as seen in figure 11.11, but the first year is the most unsafe, indicating a learning effect.

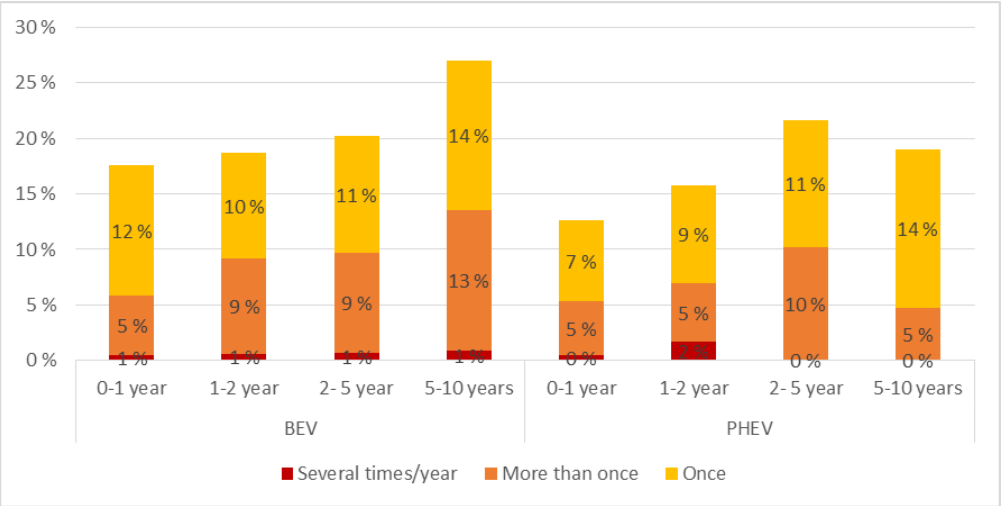


Figure 11.11 Frequency of perceived dangerous situations because pedestrians, cyclists or children could not hear the vehicle, by duration of being a BEV or PHEV driver. n_{BEV} = 3111, n_{PHEV} = 2065. Norwegian PEV consumer survey, TØI 2016.

One might suspect that the higher share of incidents among women could have something to do with exposure. One possibility was to see whether women who have experienced these incidents escort children more than men do. There was no correlation with the incident occurring once, but for those experiencing it more than once, women on the average escorted children 3 days per week, and men 2.5, indicating some exposure related effects. Female ICEV drivers, on the other hand, say they experience such incidents most seldom.

On average, female BEV drivers drive 13% fewer km per year than male drivers, further increasing the difference but also indicating that they are less experienced BEV drivers. Male BEV drivers have been BEV drivers about 14% longer than the female BEV drivers.

Another possible explanation is that women take more notice of such situations, or considers more situations hazardous and thus reports a higher incident rate.

12 Technology diffusion

This chapter focuses on factors that may inhibit or support technology diffusion, i.e. who are the buyers now versus earlier, what is the perception of the technologies and how have these attitudes evolved between 2014 and 2016.

12.1 Interests and values

In the 2014 survey, BEV owners were more often members of environmental NGOs than ICEV owners, and BEV owners who only had BEVs, even more so. In the 2016 survey, the proportion of members of such organisations is lower in all groups. BEV owners are still twice as often members compared with ICEV owners, but there is little difference between different sub groups of BEV owners, as seen in figure 12.1. PHEV owners are like ICEV owners in this respect.

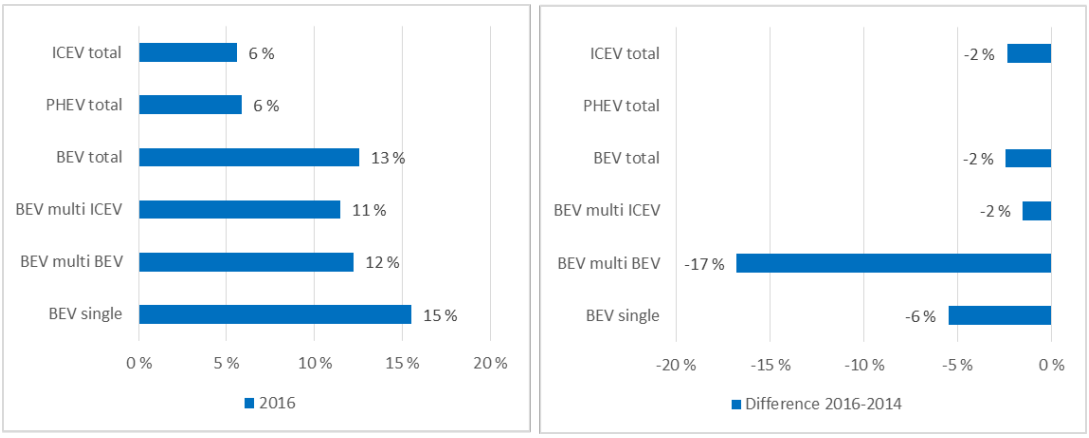


Figure 12.1 Membership in Environmental NGOs in 2016 (left) and absolute change since 2014 by vehicle owner groups (right) $n_{BEV2016}$ = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

There is no evidence that interest in vehicles is a major driver of the decision to adopt BEVs or PHEVs. All the owners of vehicles in the three groups are about equally interested in vehicles, as seen in figure 12.2, but they could be interested in different types.

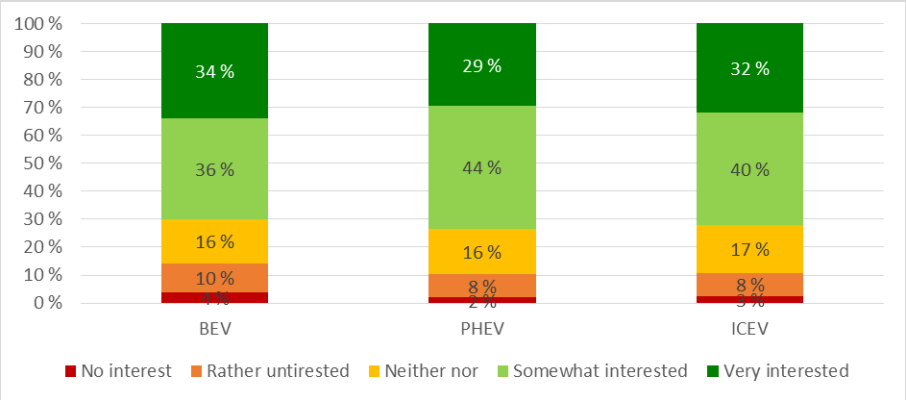


Figure 12.2 Interest in vehicles by vehicle owner groups. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

12.2 Advantages and disadvantages of BEVs

Respondent's opinions about the advantages and disadvantages of BEVs' general characteristics, technology specific characteristics, as well as their view on economic parameters, are shown in figures 12.3 to 12.5. BEV owners are in general the most positive to BEVs, followed closely by PHEV owners. ICEV owners are more sceptical to BEVs on all parameters.

The environment is seen as the biggest general advantage of BEVs, most so by owners themselves, slightly less by PHEV owners, and least so by ICEV owners. A small minority of ICEV owners have a very negative opinion of BEVs' environmental characteristics, possibly a result of discussions in the press and among scientists, on the environmental impacts of the electricity used to power these vehicles, and the environmental impact of producing the vehicles.

Comfort and acceleration are parameters rated much more positively by BEV and PHEV owners than ICEV owners. Design and image and safety are rated above average by BEV and PHEV owners, and slightly below average by ICEV owners. Size is not an important parameter.

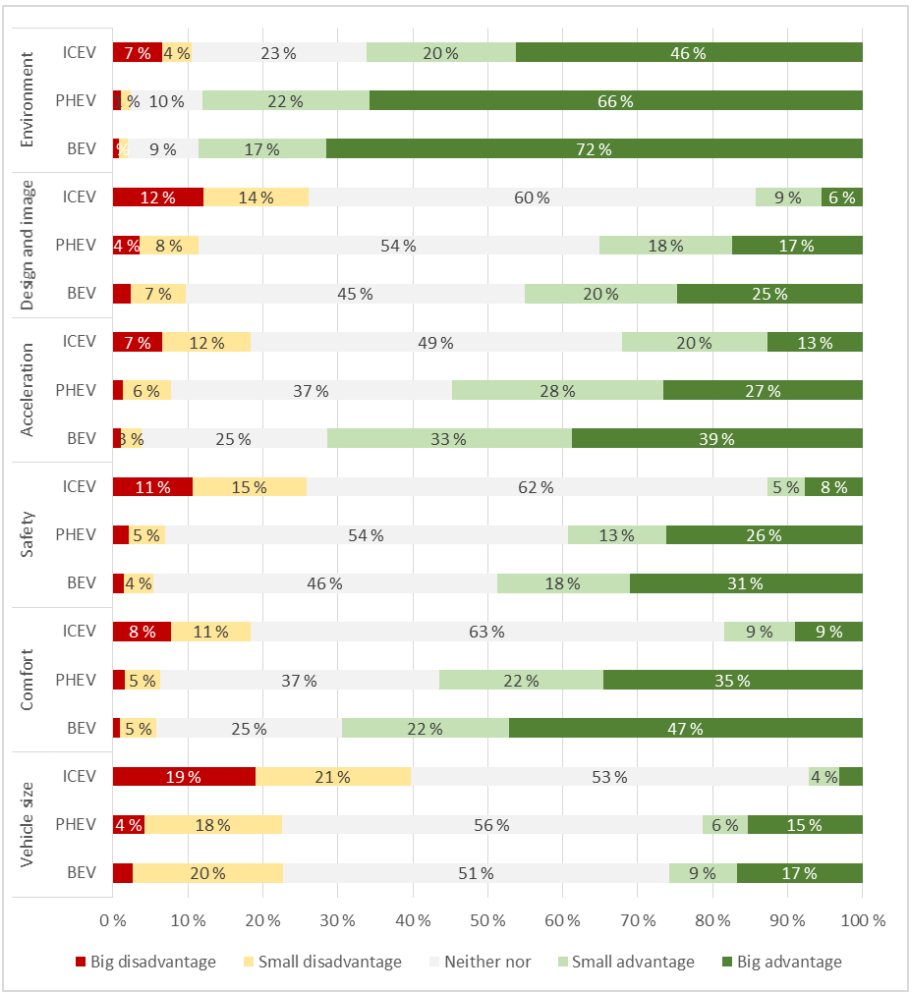


Figure 12.3 Perception of general characteristics of BEVs among different vehicle owning groups. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

Looking at EV specific parameters, all three groups agree that home charging is an advantage. The limited range is the biggest disadvantage, with ICEV owners twice as sceptical as the other owner groups. There is som scepticism related to the handling of charging cables among ICEV owners, so plug-less charging could resonate well with that group. Charge time is a disadvantage, especially for ICEV owners. The heating system does not cause a stir, but more ICEV owners see disadvantages and more BEV owners see advantages.

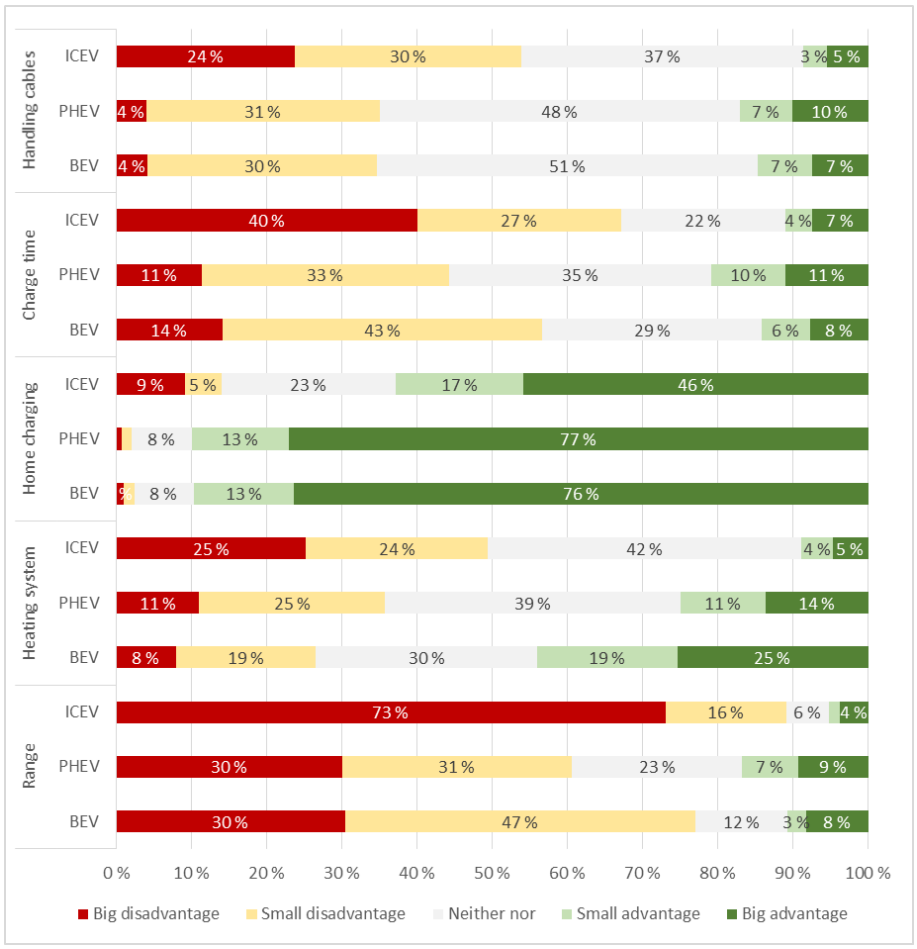


Figure 12.4 Perception of technology parameters of BEVs among different vehicle owning groups. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV} =3080. Norwegian PEV consumer survey, TØI 2016.

Operating cost is the main economic parameter, seen as a very big advantage by BEV owners, a little less so by PHEV owners, and even less so, although still important, by ICEV owners. Secondhand value was not an important parameter to BEV and PHEV owners, but ICEV owners are still cautious. Purchase price is seen as advantageous by BEV and PHEV owners and more averagely so by ICEV owners. The purchase incentives in Norway, making BEVs more competitively priced, are part of this parameter.

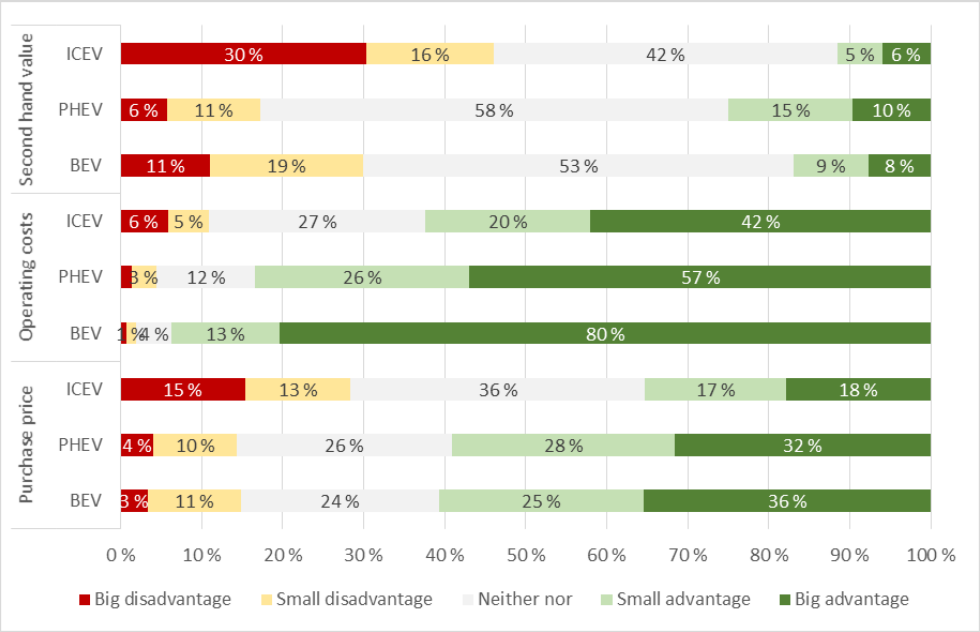


Figure 12.5 Perception of economic parameters of BEVs among different vehicle owning groups. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV}=3080. Norwegian PEV consumer survey, TØI 2016.

The biggest change in perception between 2014 and 2016 is that the second hand value of BEVs is now less of a problem to BEV and ICEV owners, as seen in figure 12.6. The handling of cables to charge has also become less of a problem. BEV owners now see charge time, handling cables and the heating system as less of an issue, whereas range and vehicle size are more problematic than before. The latter two results are rather unexpected, and could indicate new user groups that have new requirements, or that owners would like to go electric on longer trips with luggage. On other questions, both extreme values have gone down, which could indicate a normalization in the way people view BEVs.

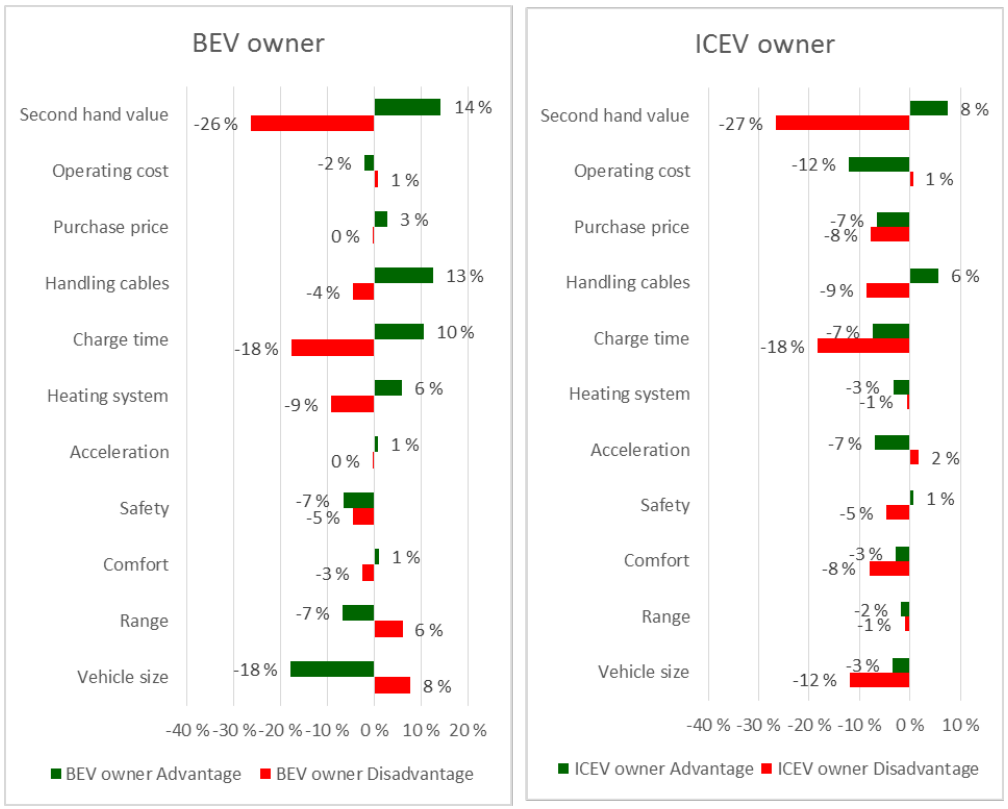


Figure 12.6 Changes in perception of BEVs by BEV owners and ICEV owners between 2014 and 2016. $n_{BEV2016}$ = 3111, $n_{BEV2014}$ = 1722, $n_{ICEV2016}$ =3080, $n_{ICEV2014}$ =2241. ICEV 2014 were only in Oslo-Kongsberg area. Norwegian PEV consumer survey, TØI 2016.

No questions were asked about the perception of disadvantages or advantages of PHEVs. The reasoning was that these vehicle types have few limitations for users and the obvious advantage is the ability to drive on electricity in daily traffic and on fuel when doing long distance driving. In hindsight, some questions regarding, for instance the range or E-mode driving ability, could have been included.

12.3 Opinions on means and measures

The respondents were asked about the importance they believe that various factors have in improving BEV and PHEV marketability, as seen in figures 12.7-12.9.

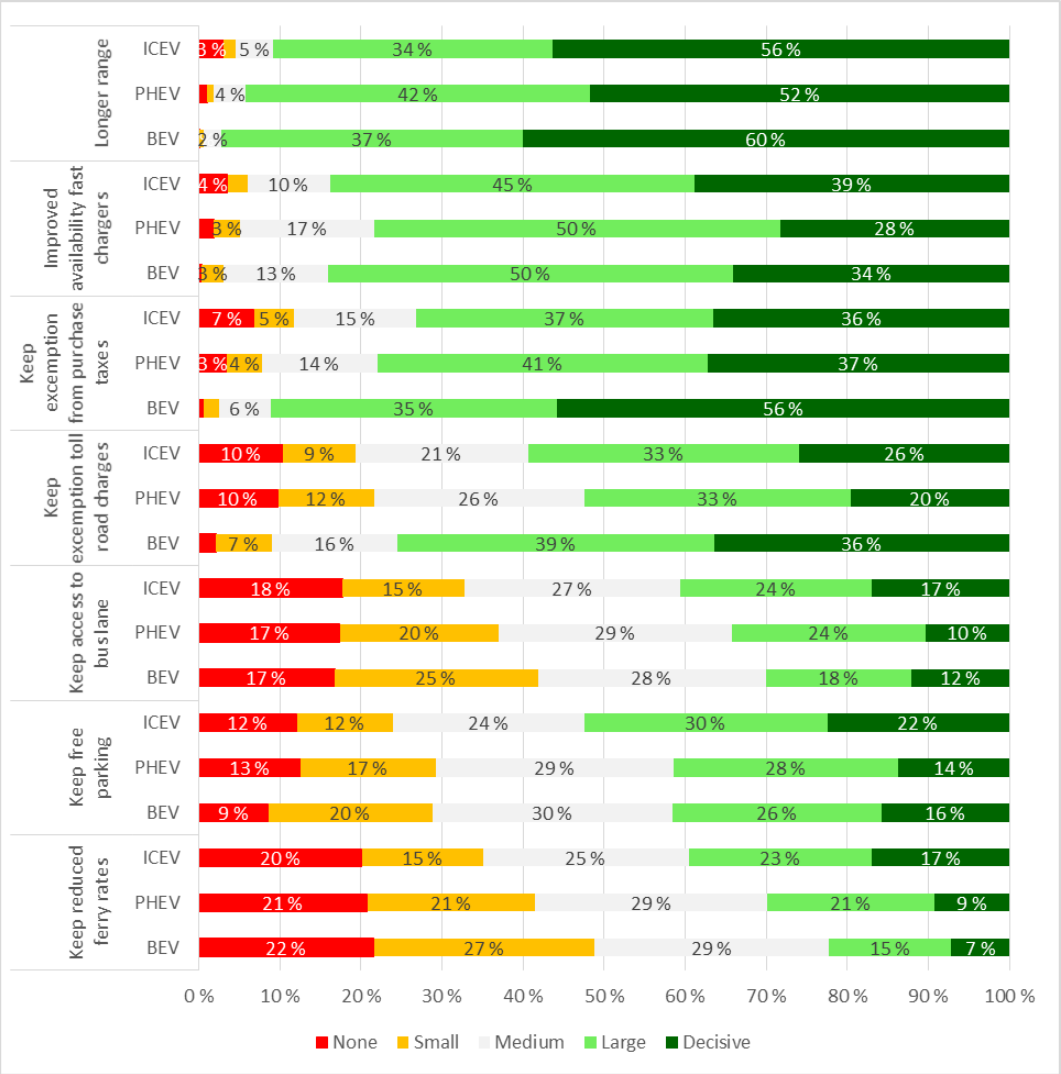


Figure 12.7 Opinions among vehicle owning groups on the importance of various measures for enlarging the BEV market. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV}=3080. Norwegian PEV consumer survey, TØI 2016.

It is not a big surprise that respondents stated that BEVs need a greater range and PHEVs greater E-mode driving capability. PHEVs are too expensive. The purchase and toll road incentives of BEVs should remain in place, while building out fast chargers and other infrastructure. It is also important that authorities allow BEVs and PHEVs into cities if they restrict driving on days with excessive local pollution. Many also find the ability to charge their vehicle at work important. ICEV owners do not want higher price on polluting vehicles. If PHEVs should get any incentives, then free parking and toll roads are rated as equally important, but less so than the factors already mentioned.

Factors that influence both BEV and PHEV diffusion rates are in figure 12.9. It is a bit surprising that an improved selection of vehicles and models was not that important to the respondents

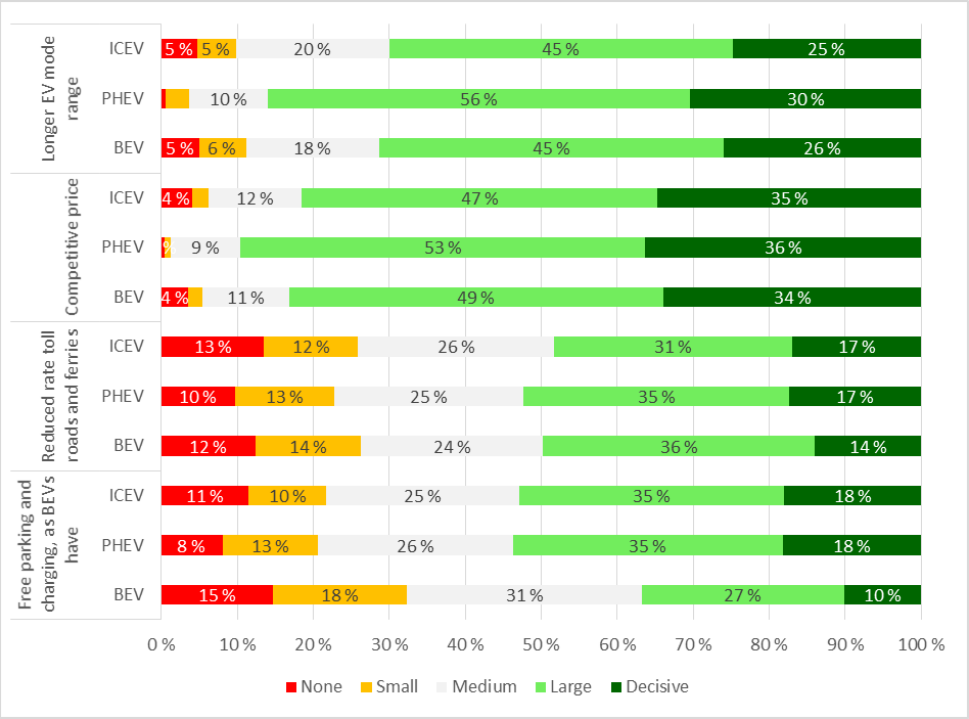


Figure 12.8 Opinions among vehicle owning groups on the importance of various measures for enlarging the PHEV market. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV}=3080. Norwegian PEV consumer survey, TØI 2016.

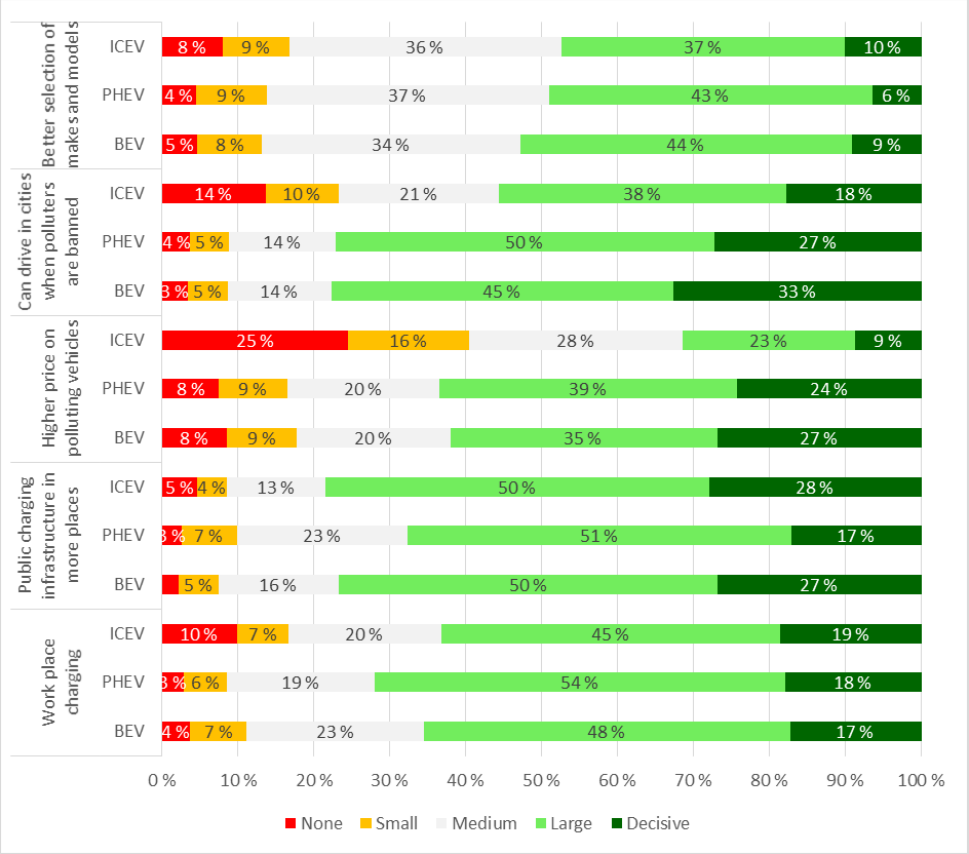


Figure 12.9 Opinions among vehicle owning groups on the importance of various measures for enlarging BEV and PHEV markets. n_{BEV} = 3111, n_{PHEV} = 2065, n_{ICEV}=3080. Norwegian PEV consumer survey, TØI 2016.

12.4 Minimum winter range

Everyone wants greater BEV range, as seen in figure 12.10, which displays the minimum winter range the three groups believe to be required to make BEVs more popular. The median minimum winter range is within the reach of current technology. BEV owners say about 240 km, which the Chevrolet Bolt and Tesla Model 3, and next generation Leaf will most likely be able to do. ICEV owners want about 300 km, which is the capability of the Tesla Model S.

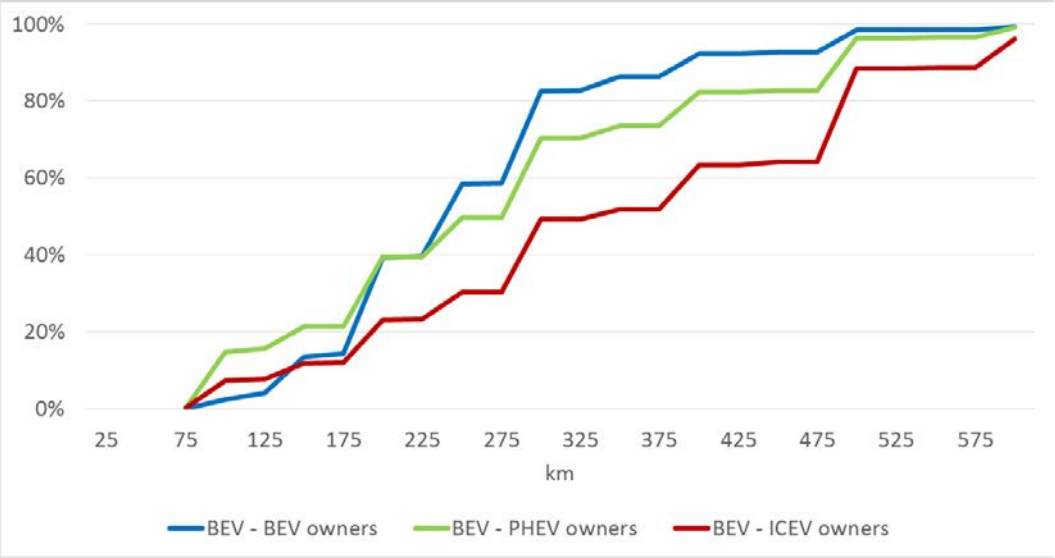


Figure 12.10 Minimum BEV winter range that different vehicle owning groups suggest is required for more people to become interested in BEVs. Norwegian PEV consumer survey, TØI 2016.

The situation is different for PHEVs, as seen in the assessment in figure 12.11. The majority want an E-mode range longer than the technology is likely to be able to deliver over the next few years.

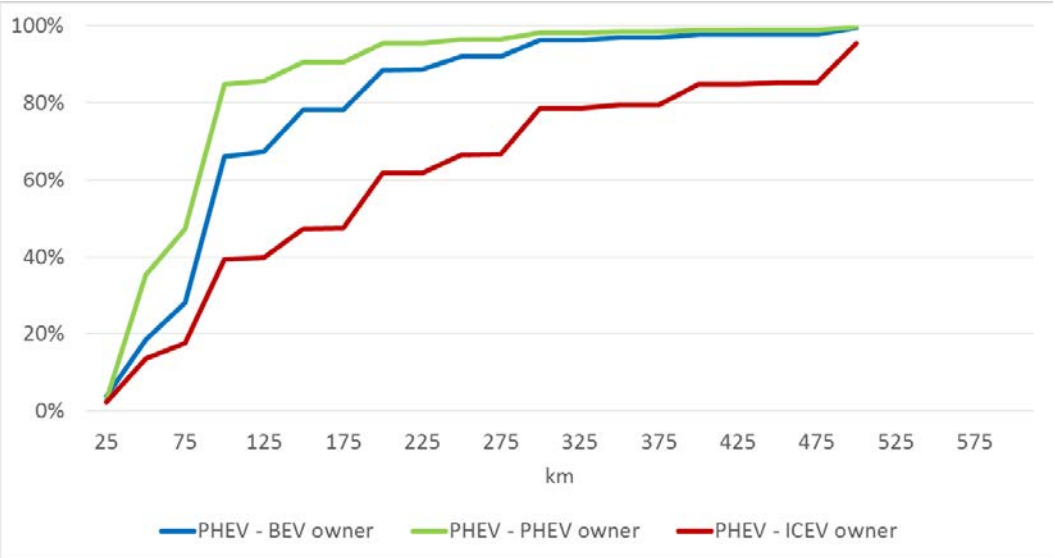


Figure 12.11 Minimum PHEV "all electric mode" winter range that different vehicle owning groups suggest is required for more people to become interested in PHEVs. Norwegian PEV consumer survey, TØI 2016.

The only PHEVs that are able to deliver a range sufficient for larger market shares according the respondents in this survey, are the EREVs BMW i3 REX and the new GM Volt which will come in an Opel version in Europe in 2017.

It might also be that some ICEV owners have misunderstood the question or do not understand the technology properly. A range of PHEVs in E-mode of 100 km in the winter only satisfies about 40% of this group. PHEVs also have attractive performance, since many manufacturers design the electrical system to be an add-on to an ICE vehicle. A big boost in power will be available for acceleration and may attract performance oriented vehicle buyers to the technology.

Comparing actual range in the winter with the minimum winter range todays' owners say is required, displays a big spread, as seen in figure 12.12, for BEVs and PHEVs. Those below the straight line in the figure propose a range shorter than they have themselves with their current vehicle. Most would like a longer range than what they have to make BEVs or PHEVs appeal to more people.

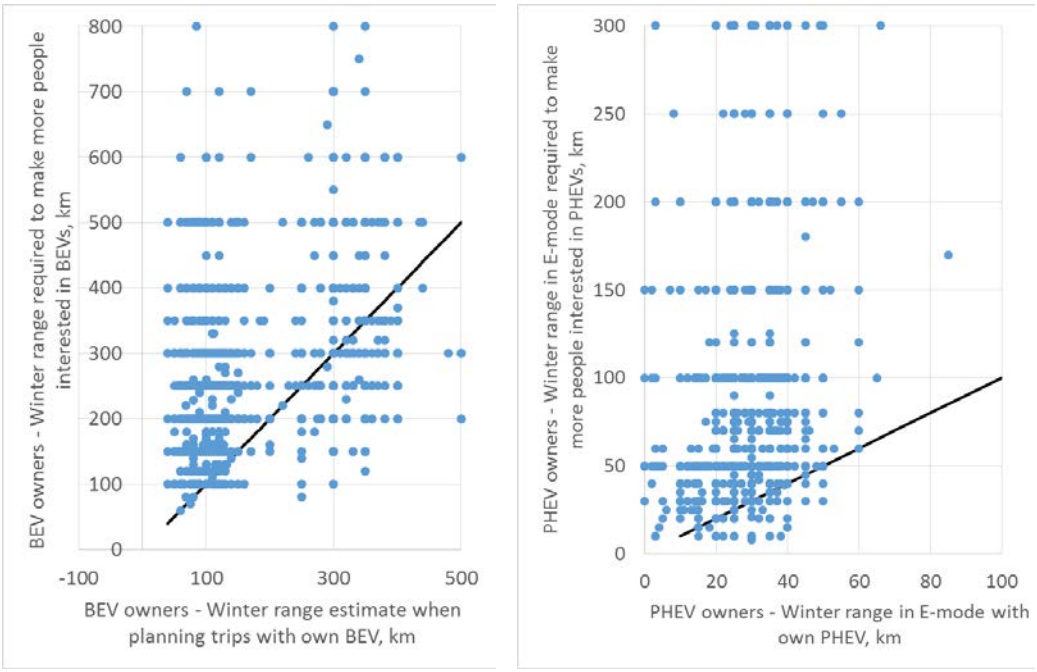


Figure 12.12 BEV and PHEV owners suggested winter range (values above 300 km not shown), for more people to be interested in the vehicle type, versus range they achieve in the winter with their own vehicle. Above line in diagram: current range shorter than suggested. Km. Norwegian PEV consumer survey, TØI 2016.

Figure 12.13 shows regional differences in the range BEV owners say BEVs need. Owners in rural areas wants more range than what owners in central areas want.

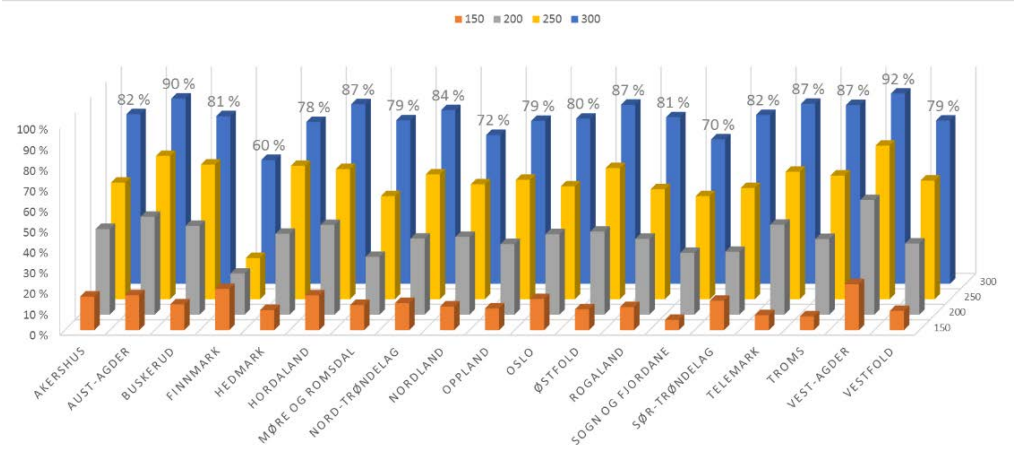


Figure 12.13 Share of BEV owners stating 150, 200, 250 and 300 km is sufficient for more people to become interested in BEVs, by province. Norwegian PEV consumer survey, TØI 2016.

12.5 Importance of social networks

Social networks play a large role in the pace of diffusion of new technologies according to Rogers' (1995) theory of diffusion of innovations. Friends and family were the most important sources of information for BEV owners when buying the vehicle, as presented in chapter four. BEV respondents where therefore asked whether they have friends who have bought or have considered buying a BEV, after they told them about their BEV driving experience. Results are shown in figure 12.14 by the number of years as a BEV driver, and in figure 12.15 by vehicle models.

In general, most BEV owners inspire others to buy and consider buying BEVs, with some variation based on years as a BEV driver and the type of vehicle. 10-20% of BEV owners inspired three or more friends or family members to buy and about the same number to consider buying.

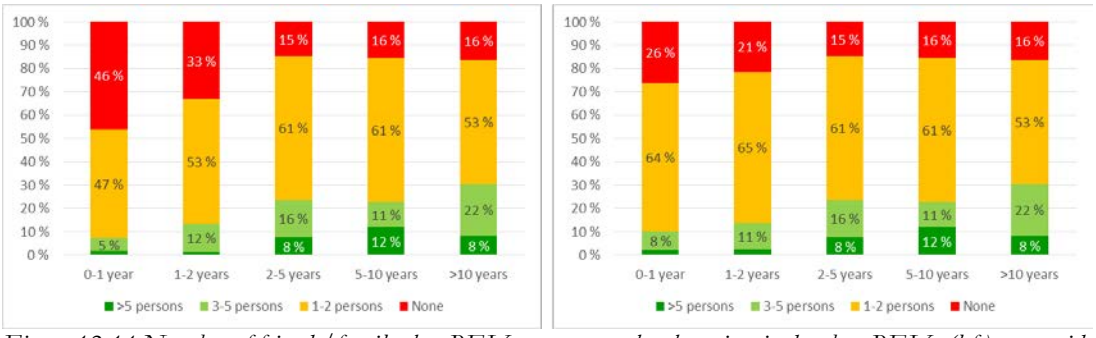


Figure 12.14 Number of friends/family that BEV owners say they have inspired to buy BEVs (left) or consider buying (right), by number of years as BEV driver, "don't know" answers not shown. $n_{0\text{-}1year}$=1397, $n_{1\text{-}2year}$=807, $n_{2\text{-}5year}$=736, $n_{5\text{-}10year}$=111, $n_{>10year}$=61. Norwegian PEV consumer survey, TØI 2016.

Tesla owners have inspired the most persons followed by Leaf owners and owners of Mitsubishi I-Mievs and Citroën C-Zeros, as seen in figure 12.15. These models have been in the market for longer than, for instance, the E-Golf, so the numbers are not comparable. Figure 12.15 does prove that all BEV owners are «BEV ambassadors».

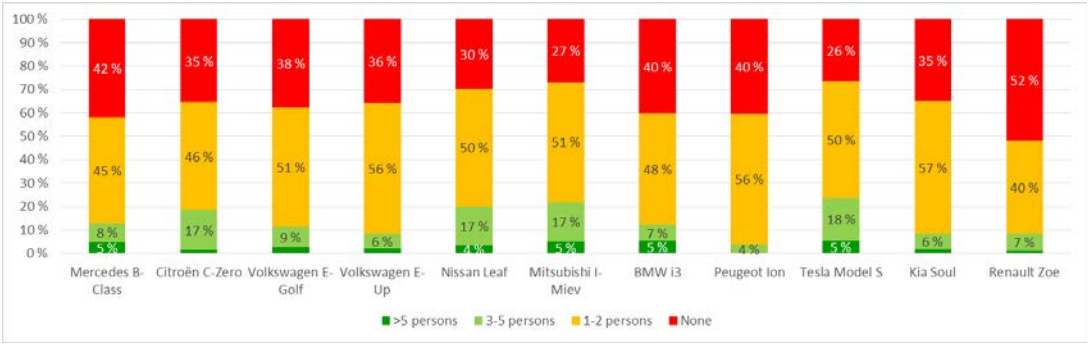


Figure 12.15 Number of friends/family that BEV owners say they have inspired to buy BEVs, by model. Norwegian PEV consumer survey, TØI 2016.

12.6 Information sources after purchase

Owners will after the purchase experience the limit of what the technology can do, when venturing on longer trips. Many BEV owners in Norway have a lot of experience with their BEVs, and they share it on the «Elbilforum» (EV forum) a website for BEV owners run by the Norwegian EV association. New owners can find reliable information about what the BEVs can do when it comes to range, how to accomplish certain trips etc. The EV association also shares information on their web page and various pages present an overview of charging stations. The Norwegian Automobile Federation has a magazine and a web page also disseminating information.

The EV association (including EV forum run by the association) is by far the most important source of information for BEV owners after the vehicle purchase, followed by blogs, media, dealers and the owners' friends/family, as seen in figure 12.16. The answers illustrate that an efficient EV organization, that disseminates information and helps owners in various other ways, can aid the diffusion of BEVs.

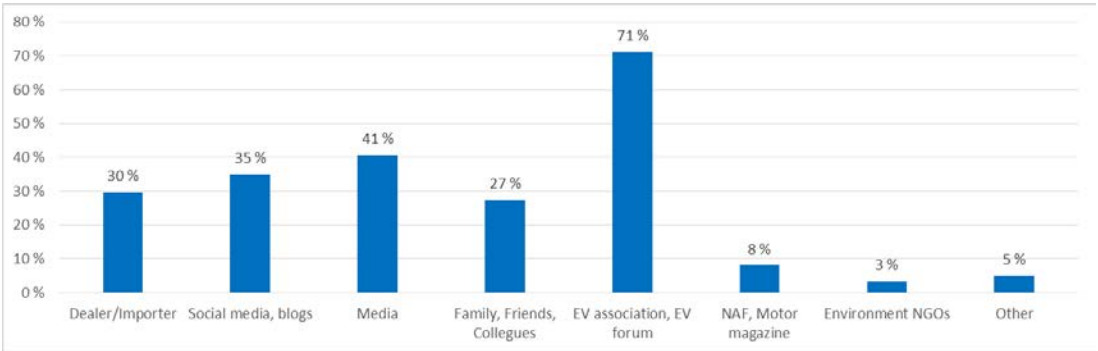


Figure 12.16 BEV owner information sources on how to utilize vehicle better after purchase. Norwegian PEV consumer survey, TØI 2016.

12.7 Future buying behaviour

Most BEV and PHEV owners say that they will buy the same vehicle type again, only 29 BEV owners and 44 PHEV owners say that they will not. ICEV owners are much less decided as seen in table 12.1.

Table 12.1 Number of owners that will buy the same vehicle type (BEV, PHEV, ICEV) again. Norwegian PEV consumer survey, TØI 2016.

	Yes	No	Don't know
BEV	2754 (88%)	29 (<1%)	328 (11%)
PHEV	1665 (81%)	44 (2%)	356 (17%)
ICEV	1927 (63%)	221 (7%)	932 (30%)

Figure 12.17 shows that people in some provinces are slightly more negative than in others. Single BEV owners are more negative than those that also owns ICEVs.

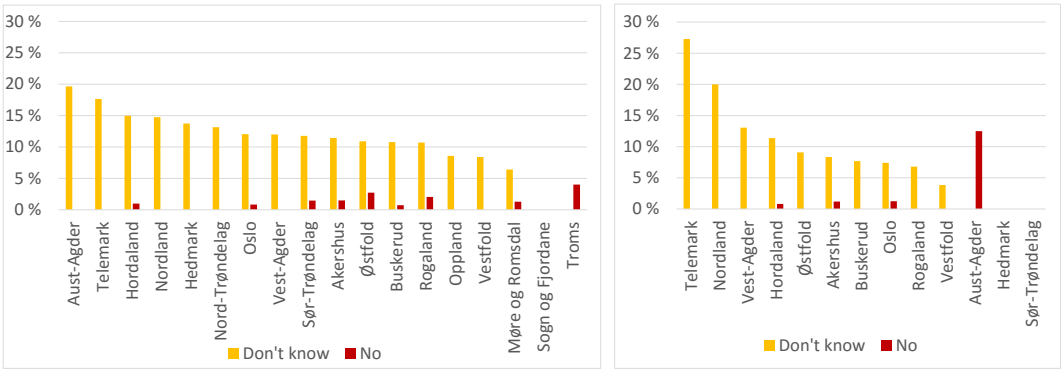


Figure 12.17 Share in each province of Multi BEV ICEV (left) and Single BEV (right) households that do not know if they will buy a BEV again, and those that definitively will not (provinces with at least 10 responders). Norwegian PEV consumer survey, TØI 2016.

The "Economy of use", Environment, Future proof technology and the Exemption from toll road costs are the most important reasons to buy againa as seen in figure 12.18. Limited range and charging issues are reasons not to buy again.

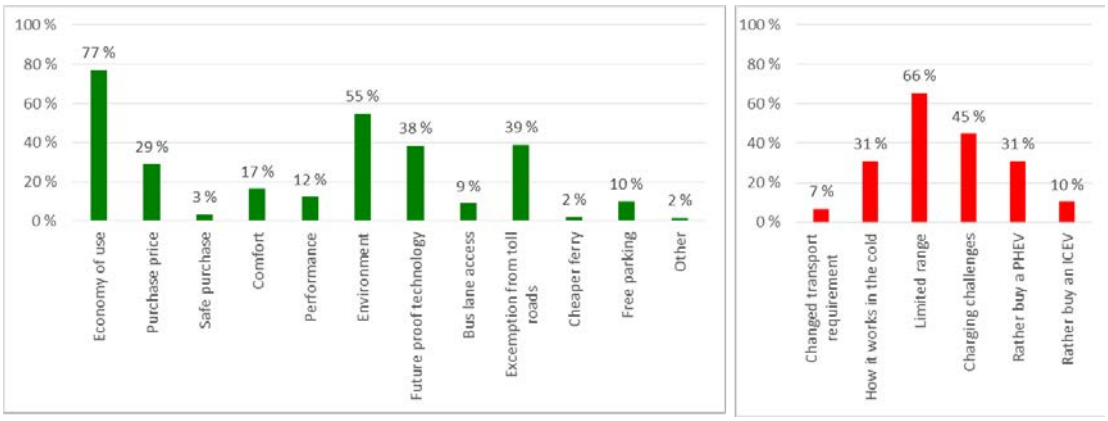


Figure 12.18 BEV owner's reasons to buy a BEV again (left) or not (right), n_{yes}=2765, n_{no}=29. Norwegian PEV consumer survey, TØI 2016.

PHEV owners' reasons to buy again are also Economy of use, Environment and Future proof technology as seen in figure 12.19. Weaknesses with current models are reasons not to buy again, such as short E-mode range and the lack of E-mode ability in the cold season.

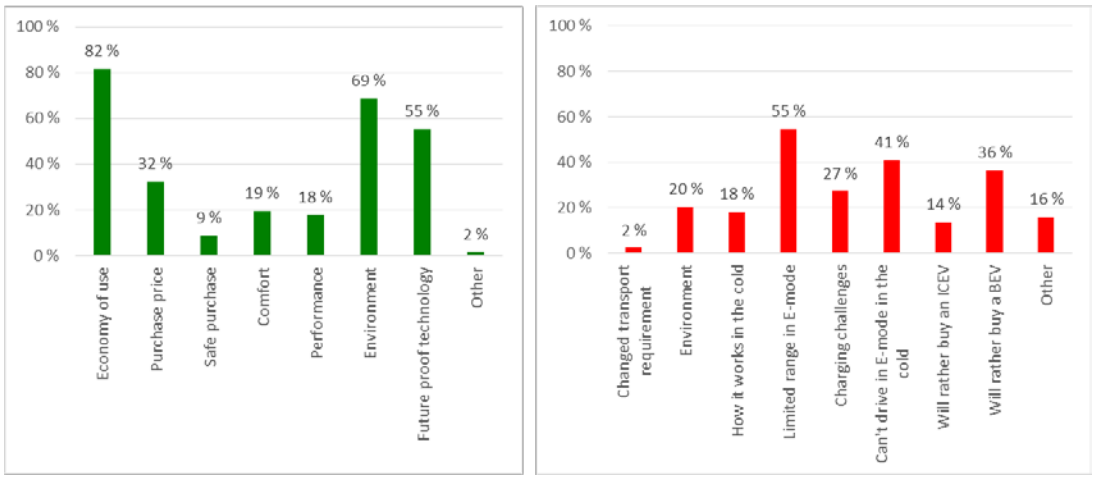


Figure 12.19 PHEV owners reason to buy a PHEV again (left) or not (right). n_{yes}=1665, n_{no}=44. Norwegian PEV consumer survey, TØI 2016.

Only ICEV owners who said that they would not buy the same vehicle again where asked why. The two main reasons are «environment» and that they would rather have a PHEV as seen in figure 12.20.

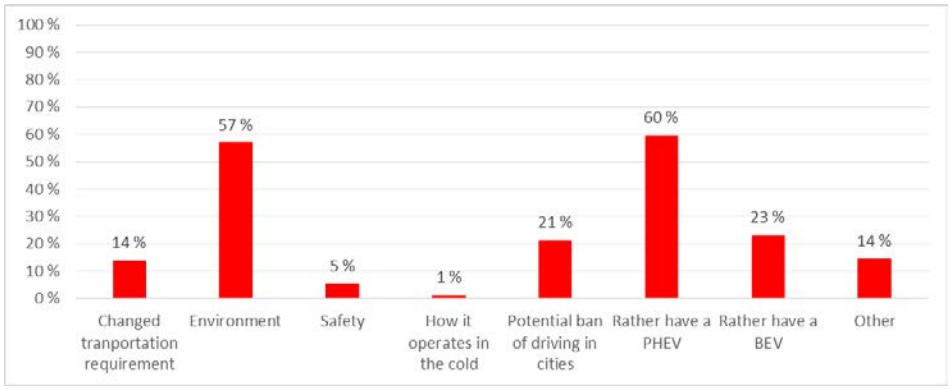


Figure 12.20 Reasons why ICEV owners will not buy an ICEV again. n=221. Norwegian PEV consumer survey, TØI 2016.

13 Conclusion

A key conclusion from this survey is that Electromobility is attractive for the consumers when the supporting incentives are strong enough, and when there are attractive vehicles on the market. For many it is also valuable that one can combine the daily transport requirements of families with low cost, clean transportation solutions. The continuous improvement of the technology has also influenced the Norwegian success. On this basis the Norwegian Prime Minister expressed (Solberg 2016) that; "We (Norway) are already a laboratory for low emission transportation".

The learnings from this nationwide laboratory should be available to other countries through continuing research activities.

13.1 Electromobility makes daily life easier

BEV and PHEV owners are distinctly different when it comes to age and other sociodemographic characteristics and, thus, different in the way they use vehicle based transportation. This result was expected. The incentive structure in Norway provides BEV owners with more incentives than PHEV owners, and the result supports findings from earlier studies.

Norway has very high purchase taxes on vehicles and the general value added tax rate is 25%. BEVs and hydrogen vehicles are exempted from both. These purchase incentives have made BEVs the cheapest vehicle based transport available since other vehicles' taxes push their sales price beyond that of BEVs. The additional local user incentives, such as free toll roads, keep the daily cost of motoring lower than for other vehicle types and make environmentally friendly cars accessible and attractive to more people.

PHEVs are a competitive alternative to diesel vehicles in some vehicle classes, although they are more expensive to buy and to operate than a BEV. The registration tax system strongly favours low CO_2-emission, and with revisions to other elements of the registration tax system, many compact PHEVs have close to zero registration tax. They thus attract those who cannot utilize a BEV but would like to reduce the negative impact of their motoring.

BEVs serve as workhorses in the everyday transport of families with children. These households use them for commuting to work and evening travel activities such as escorting children. The average BEV is used more frequently for such daily travel activities than what the average PHEV or ICEV is. The low operating cost is then particularly attractive. BEV owners own more vehicles, have longer distances to work and more children than PHEV and ICEV owners. PHEVs are bought by people older than BEV buyers. Their daily use of their vehicle lies between BEV and ICEV owners' vehicle usage patterns.

BEVs' limited range and long charge time, should in theory discourage potential buyers, and still seem to be the main reasons why ICEV or PHEV owners did not consider buying one. Surprisingly few BEV drivers have avoided doing trips, and even fewer have had to abort trips due to range or charging issues. Most get by charging at home and occasionally

using public or work place charging, mostly without problems. These findings should be interpreted on the basis that most BEV owners also own an ICEV, and the high share of Tesla owners in the BEV sample. It could also be a self-selection mechanism, i.e. people do not buy a BEV if they suspect that they might face challenges because of its range. In addition, the majority of BEV owners, (79 %) belong to multivehicle households, while only 54 % of PHEV and 52 % of ICEV owners do so.

Single vehicle ownership should not necessarily be a severe barrier to diffusion of BEVs neither in Norway, nor in other "western" countries. It is important to study both the barriers to single BEV ownership when technology improves, for instance the 50% range increase offered on vehicles entering the market in 2016, as well as the potential for increasing the market share under different conditions. One also needs more knowledge on new and creative forms for complementary car ownership such as car pools, car sharing, sharing of privately owned cars and how that could influence the market.

13.2 Technology market and infrastructure development

Progress has occurred on many fronts since a similar survey in Norway in 2014. It is, for instance, more common to use BEVs on vacation, which might be a result of an improved fast charger infrastructure, and the second hand value of BEVs is seen as much less of a challenge. A decreasing share of owners utilize local incentives, such as bus lane access, or passing toll roads at no cost, indicating that the market is less incentive driven than before.

In the future, many models will get larger batteries or differently sized batteries, but the model name will be the same. This is already true of the Tesla Model S. To be able to track the progress of individual BEV models, and to see whether different variants are used differently, more information about the vehicle, such as battery size, official range and type of heater, must be collected in future surveys. Future studies must use broader sets of methods to clarify and register the actual use of different vehicles. Of particular interest are long distance travel requirements, the use of charging infrastructure and the changed use of vehicle based transport after a new vehicle has been bought, as well as the motivation for buying additional household vehicles.

The outlook for the BEV market seems bright. The market will, however, be strongly influenced by how BEV incentives are adjusted over time. If BEVs continue to attract young buyers, and the existing owners continue to buy BEVs in the future, then the market will expand through a cohort effect. A larger second hand market will also gradually emerge. There are good chances of realizing such a scenario as BEVs better matching the users' requirement for range will come on the market starting in 2016, with even longer range vehicles meeting over half of users' stated range preferences in the 2017-2020 time frame. For PHEVs, the market is more uncertain. The models flooding the market in 2016 and the coming years have an E-mode range that is much shorter than what most users would like to see, and potential buyers may consider a long range BEV instead.

13.3 Possible negative environmental effects?

The three dimensions of sustainability, environment, economy and social justice, as well as conflicts between the main goals for transport, will lead to challenges for decision makers at different levels when shaping future transport policies and measures. In further studies. it is crucial to find under what premises (energy production, quota system or patterns of

use) electric vehicles can contribute most efficiently to the reduction of environmental problems.

The survey shows differences between BEV, PHEV and ICEV owners that could indicate rebound effects. The majority of BEV, PHEV and ICEV owners replaced another vehicle, usually an ICEV, when buying a new one. The BEV-owner group, however, had a higher share of additional cars (22%). survey also shows that "hard facts", such as switching jobs or the household having moved, are important factors when buying extra vehicles. However, the most important factor is that public transport does not seem to meet their transport needs. More questions on the availability and the quality of public transport could shed more light on this issue.

About 10% more BEV owners than ICEV owners who belong to multi vehicle households, reported the total vehicle km driven with the household's vehicles to be increasing after the vehicle was bought, but they were not asked by how much and why. The survey could therefore not quite nail whether BEV households drive more, i.e. a rebound effect, due to the low cost of electric motoring and the incentives for users, or if they drive more because of changed driving requirements. The results show that they drive more, but we also know that newer vehicles have longer annual mileage than older vehicles, and that many households with children are more likely to have more than one vehicle.

The discussion above shows that deeper studies are needed to clarify and understand the root cause and effects of different owner groups' changes of travel behaviour, as well as data on the magnitude of different changes.

13.4 Communicating electromobility

Many theories of diffusion of technology innovations stress the importance of communication in the diffusion process (Rogers, Axsen & Kurani).

The survey shows that most BEV owners got the information which led to the procurement of their vehicle from their peers, i.e. friends, family or work colleagues. The fact that most BEV owners themselves have convinced a couple of persons to buy an electric vehicle supports the finding of the importance of social networks in communicating new environmental technologies. Information about the characteristics of BEVs will probably trickle through the population more easily, when spread by trustworthy friends and family. How to use and develop this mechanism to foster a market is an important theme for further studies in lieu of the targets in the proposed National Transportation Plan, and the white paper on the future energy policy, as amended by the Parliament in June 2016, that all new passenger vehicles sold in Norway, shall be zero emission by 2025.

13.5 Evaluation of policy and incentive changes

Norway has evidently had many of the prerequisites for a successful diffusion of BEVs and PHEVs put forward in leading theories of diffusion. Broader studies of the factors that are required at different diffusion stages and how one can avoid setbacks are required to support this development in other countries.

The survey clearly shows the importance of incentives at early diffusion stages. The Norwegian BEV incentives will be revised, and gradually reduced. These changes will occur

partly on a national scale and partly on a regional scale. Future surveys should capture the effect of these changes on the interest in buying BEVs and other types of vehicles, on the types of people buying BEVs, and the changes to their patterns of travel. Such knowledge will be of interest in order to develop strategies to avoid a reversal of the positive diffusion process.

To use Norway as a test-site is smart because this country has users on all levels and across the nation, with real life long time experiences of the different types of BEVs and PHEVs. This could give decision makers a better basis for their policies and strategies than studies of what people without experience believe about and think of PEVs in other countries.

It is also important to find out why different countries have developed different framing conditions and how cost/benefit analysis positions PEVs relative to other vehicle technologies in different countries. Such analysis would require comparative and multidisciplinary studies in several countries.

14 References

Erickson, T, Halvorsen, G. (2008). Hvordan varierer timeforbruket av strøm i ulike sektorer? SSB, Økonomiske analyser 6/2008. https://www.ssb.no/a/publikasjoner/pdf/oa_200806/ericson.pdf

Figenbaum, E., Kolbenstvedt, M. (2015). Pathways to electromobility – perspectives based on Norwegian experiences. TOI Report 1420/2015. Institute of Transport Economics.

Figenbaum, E., Kolbenstvedt, M., Elvebakk, B. (2014). Electric vehicles – environmental, economic and practial aspects. As seen by current and potential users. TØI rapport 1329/2014.

Laurikko, J., Granström, R. Haakana, A. (2013). Realistic estimates of EV range based on extensive laboratory and field tests in Nordic climate conditions. Paper presented at the Electric Vehicle Symposium in Barcelona (EVS27) 17. Nov. 2013.

OFVAS 2016. Vehicle registration data from the Norwegian vehicle register.

NPRA (2015). Map updated on 26th November 2015. Downloaded from Autopass.no on 07.06.2016. http://www.autopass.no/_attachment/650649/binary/1074545

NPRA (2016). BEV and PHEV vehicle registration data from the national vehicle register. Status as of 31.12.2015.

NTP 2018-2029 (2016). Nasjonal transportplan 2018-2029 (National Transportation Plan 2018-2029, in Norwegian). Grunnlagsdokument. National Transportation Authorities. Feb-Mar, 2016.

Rogers, E. M. (1995). Diffusion of innovations, fifth edition. Free Press. ISBN-13: 978-0-07432-2209-9.

SSB (2016). Statistics on vehicles and households. Statistics Norway.

Tietge, U., Mock, P., Zacharof, N., Franco, V. (2015). Real-world fuel consumption of popular European passenger car models. Working paper 2015-08. The International Council on Clean Transportation.

Wikipedia 2016. http://no.wikipedia.org/wiki/Norges_fylker#mediaviewer/Fil:Norway_counties.svg

Annexes

Annex 1 Overview of questions

Questions to all respondents

- Choice a vehicle alternative to answer questions about: BEV, PHEV, ICEV
- What is the model and make of the vehicle?
- Are you a private owners of the vehicle or is it a company car
- How many kilometres did you or others in the household drive this vehicle yesterday
- Does the household have other vehicles at disposal?
- How many and what type of vehicles (EV, PHEV, ICEV) are at the households disposal?
- What is the share of time that you operate this vehicle?
- What types of trips (drive to work/school, leisure, kid's leisure, visits, vacation, shopping, work related) is the vehicle used for and wat is the frequency of these trips?
    - Is it you that most often use this vehicle to travel to work or school (if such trips)?
    - What is the distance to work in km (one way)? (if such trips)
    - How did you travel to work prior to buying the vehicle (if such trips)?
- Do you pass a tolling station during the trip to work/school?

Targeted questions

- How much does the household save on avoided toll road costs per week (BEVs)?
- Can you use the bus lane when driving to work (BEVs)?
    - How much time do you save per trip to work/school using the bus lane (BEVs)?
- How much does the household save on reduced ferry rates per week (BEVs)?
- How much does the household save on free parking per week (BEVs)?
- How much does the household use on toll road costs per week for this vehicle (PHEVs, ICEVs)?
- How much does the household use on parking costs per week for this vehicle (PHEVs, ICEVs)?
- How much does the household use on ferry costs per week for this vehicle (PHEVs, ICEVs)?
- Does the household yearly or more often go on longer trips (>100 km) to any of the following travel targets (Vacation homes/cabins, friends/family, other) and how long are they (ALL respondents)?
    - Which means of transport (BEV, PHEV, ICEV, Rental/Loaner, Public transport) is used on these trips?
        - Why was the EV not used on these trips (BEVs, if BEVs not used)?
        - How was the vehicle charged on these trips (BEVs/PHEV using BEVs/PHEVs)?
- How would you characterize (availability/position, quality/reliability/user friendly) public charging stations (Fast, Normal) where you live (ALL respondents)?
- How (Fast, Normal), where (home, work etc.) and how often (daily, x times per week etc.) is the vehicle charged (BEV and PHEV owners)?
    - Why did you use fast chargers (if fast charge)?
    - Where did you use fast chargers, geographic location (if fast charge)?
- What type of grid connection (domestic socket, wall box, other) do you normally use (home, work) to "normal" charge the vehicle (BEVs, PHEVs)?
- When does the charging of the vehicle at home normally start (BEV, PHEV)?
- Has the household had to refrain from or interrupt trips with this vehicle (BEV)?
    - Have the household refrained from doing trips with this vehicle due to any of the following problems (technical fault, forgotten to charge, range too short, insufficient public infrastructure)?
    - Have the household interrupted trips with this vehicle due to any of the following problems (technical fault, range miscalculated, unexpected high energy-consumption, forgot to check SOC or charge stations, faulty public infrastructure, charge payment problem)?
- Have the household experienced problems related to recharging the vehicle?
    - Have the household experienced any of the following problems (matrix of issues and charge locations)?
- Did the household buy the vehicle new or second hand (dealer or private) (ALL respondents)?
- How long have you been driving BEV/PHEV (years)?

Questions to all respondents

- From which source did the household get the information that made you consider this type of vehicle (friends/family/media/organisation, dealer, advertisements) (ALL respondents)?
    - Which organisation did the household get the information leading to the purchase from?
- From which source does the household get information on how to utilize the vehicle better?
- Which factors were decisive when buying the vehicle?
    - Which other factors?
- Had the household made the decision to buy this type of vehicle prior to going to the dealer?

Targeted questions

- Will you buy a BEV/PHEV/ICEV again? (programmed as three separate questions)
    - What are the three main reasons for buying again (programmed as three questions with different alternatives depending on BEV/PHEV/ICEV)?
    - What are the three main reasons for not buying again (programmed as three questions with different alternatives depending on BEV/PHEV/ICEV)?

- What yearly mileage is the vehicle insured for (All respondents)?
- What is the range (in all-electric mode for PHEVs) you expect the vehicle to have when you plan your trips summer/winter?
- What is the share of EV mode driving (PHEV) in summer/winter (total all driving, driving to work/school)?
- Was it challenging to take the vehicle into use for any of the following reasons (range, more planning, winter, choosing/establishing charging solution)?
- How will the household adapt to situations where the vehicles range is insufficient (BEV)?

Questions to all respondents

- Have you changed travel habits after buying the vehicle?
    - In what way did the travel habits change (more/less driving/walking/cycling/public transport)?
- Did this vehicle replace another vehicle?
    - If extra vehicle then: Was the vehicle purchase influenced by any of the following reasons (household relocation, new job, family enlargement, changed driving needs, poor public transport)?
- Has the household changed the total driving length in the household's assurances after buying this vehicle?

Targeted questions

- Do you (BEV) have friends/family that have bought or consider buying an EV after you have told them about your experiences?

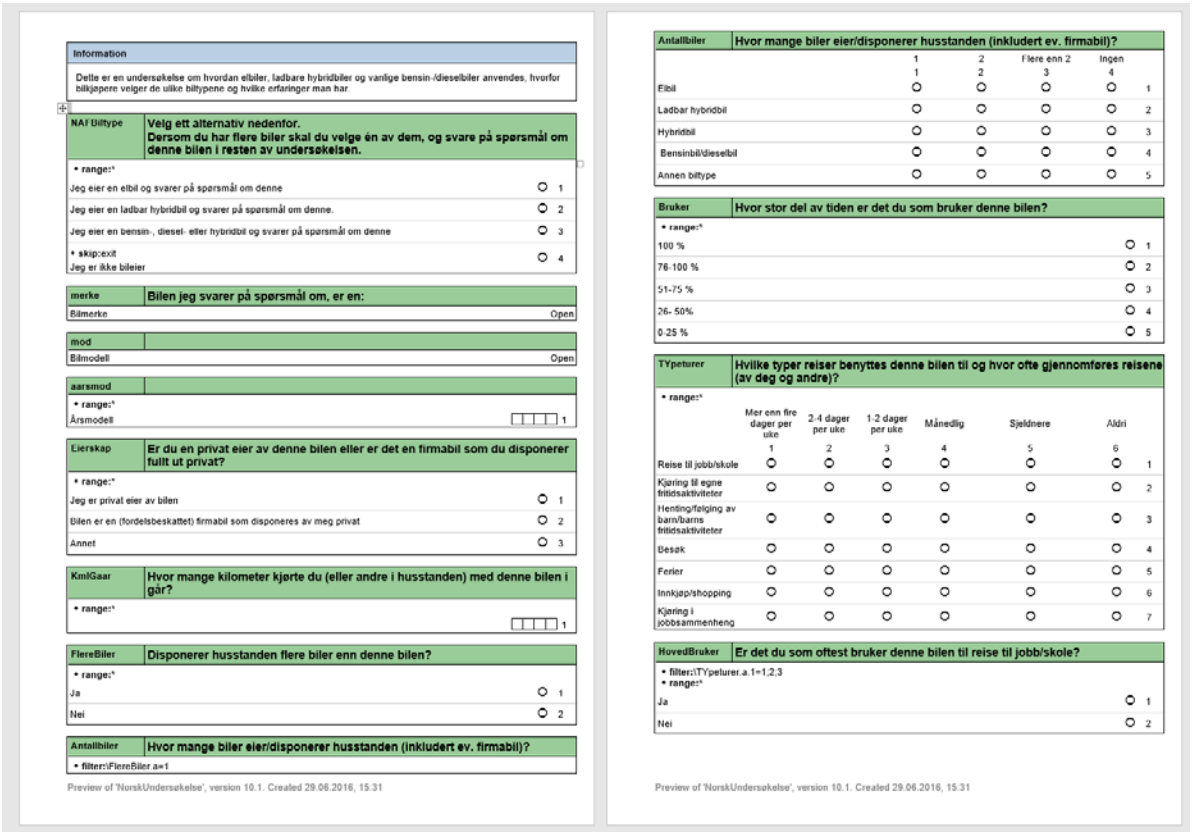
Questions to all respondents:

- What are the advantages and disadvantages of BEVs?
- What is the importance of the following factors (longer range, more fast chargers, too keep incentives) in increasing the share of BEVs?
- How long must the winter range minimum be for BEVs to appeal to more people?
- What is the importance of the following factors (longer EV mode range, competitive price, free parking and charging, reduced rate on toll roads/ferries) in making PHEVs interesting for more people?
- How long must the winter range in EV mode minimum be for PHEVs to appeal to more people?
- What is the importance of the following factors (better model selection, more public charging, work place charging, higher price on polluting vehicle, can drive when other vehicles not allowed to due to pollution incidents) in increasing the share of BEVs and PHEVs?

Questions to all respondents:

- Have you experienced dangerous situations because pedestrians, cyclist or children could not hear the vehicle?
- Sociodemographic:
    - Gender
    - Age
    - Education
    - Occupational status
    - Number of persons in the household
    - Number of persons below 18 years age in the household
    - Number of persons in the household possessing driver license.
    - The households annual gross income
    - Living area (large city, city, community, rural)
    - Zip code
- Are you a member of an environmental NGO?
- How interested are you in vehicles?
- Odometer reading of the vehicle and the first time registration year and month

Annex 2 Survey questionnaire



Information

Dette er en undersøkelse om hvordan elbiler, ladbare hybridbiler og vanlige bensin-/dieselbiler anvendes, hvorfor bilkjøpere velger de ulike biltypene og hvilke erfaringer man har.

NAFBiltype — Velg ett alternativ nedenfor. Dersom du har flere biler skal du velge én av dem, og svare på spørsmål om denne bilen i resten av undersøkelsen.

- range:*

Jeg eier en elbil og svarer på spørsmål om denne — 1
Jeg eier en ladbar hybridbil og svarer på spørsmål om denne. — 2
Jeg eier en bensin-, diesel- eller hybridbil og svarer på spørsmål om denne — 3

- skip:exit

Jeg er ikke bileier — 4

merke — Bilen jeg svarer på spørsmål om, er en:

Bilmerke — Open

mod

Bilmodell — Open

aarsmod

- range:*

Årsmodell — ☐☐☐☐ 1

Eierskap — Er du en privat eier av denne bilen eller er det en firmabil som du disponerer fullt ut privat?

- range:*

Jeg er privat eier av bilen — 1
Bilen er en (fordelsbeskattet) firmabil som disponeres av meg privat — 2
Annet — 3

KmlGaar — Hvor mange kilometer kjørte du (eller andre i husstanden) med denne bilen i går?

- range:*

☐☐☐☐ 1

FlereBiler — Disponerer husstanden flere biler enn denne bilen?

- range:*

Ja — 1
Nei — 2

Antallbiler — Hvor mange biler eier/disponerer husstanden (inkludert ev. firmabil)?

- filter:\FlereBiler.a=1

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

Antallbiler — Hvor mange biler eier/disponerer husstanden (inkludert ev. firmabil)?

	1	2	Flere enn 2	Ingen	
	1	2	3	4	
Elbil	○	○	○	○	1
Ladbar hybridbil	○	○	○	○	2
Hybridbil	○	○	○	○	3
Bensinbil/dieselbil	○	○	○	○	4
Annen biltype	○	○	○	○	5

Bruker — Hvor stor del av tiden er det du som bruker denne bilen?

- range:*

100 % — 1
76-100 % — 2
51-75 % — 3
26- 50% — 4
0-25 % — 5

TYpeturer — Hvilke typer reiser benyttes denne bilen til og hvor ofte gjennomføres reisene (av deg og andre)?

- range:*

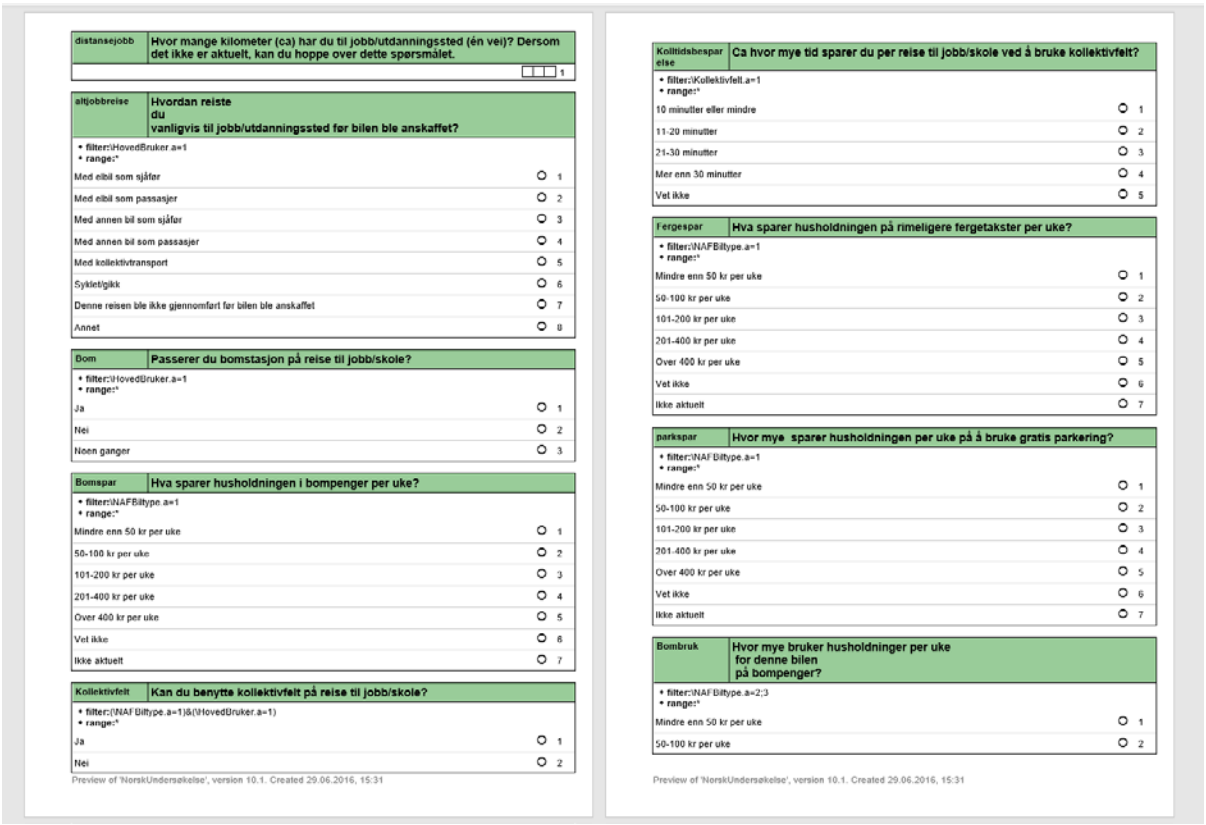
	Mer enn fire dager per uke	2-4 dager per uke	1-2 dager per uke	Månedlig	Sjeldnere	Aldri	
	1	2	3	4	5	6	
Reise til jobb/skole	○	○	○	○	○	○	1
Kjøring til egne fritidsaktiviteter	○	○	○	○	○	○	2
Henting/følging av barn/barns fritidsaktiviteter	○	○	○	○	○	○	3
Besøk	○	○	○	○	○	○	4
Ferier	○	○	○	○	○	○	5
Innkjøp/shopping	○	○	○	○	○	○	6
Kjøring i jobbsammenheng	○	○	○	○	○	○	7

HovedBruker — Er det du som oftest bruker denne bilen til reise til jobb/skole?

- filter:\TYpeturer.a.1=1;2;3
- range:*

Ja — 1
Nei — 2

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31



distansejobb — Hvor mange kilometer (ca) har du til jobb/utdanningssted (én vei)? Dersom det ikke er aktuelt, kan du hoppe over dette spørsmålet.

☐☐☐ 1

altjobbreise — Hvordan reiste du vanligvis til jobb/utdanningssted før bilen ble anskaffet?

- filter:\HovedBruker.a=1
- range:*

Med elbil som sjåfør — 1
Med elbil som passasjer — 2
Med annen bil som sjåfør — 3
Med annen bil som passasjer — 4
Med kollektivtransport — 5
Syklet/gikk — 6
Denne reisen ble ikke gjennomført før bilen ble anskaffet — 7
Annet — 8

Dom — Passerer du bomstasjon på reise til jobb/skole?

- filter:\HovedBruker.a=1
- range:*

Ja — 1
Nei — 2
Noen ganger — 3

Bomspar — Hva sparer husholdningen i bompenger per uke?

- filter:\NAFBiltype.a=1
- range:*

Mindre enn 50 kr per uke — 1
50-100 kr per uke — 2
101-200 kr per uke — 3
201-400 kr per uke — 4
Over 400 kr per uke — 5
Vet ikke — 6
Ikke aktuelt — 7

Kollektivfelt — Kan du benytte kollektivfelt på reise til jobb/skole?

- filter:(\NAFBiltype.a=1)&(\HovedBruker.a=1)
- range:*

Ja — 1
Nei — 2

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

Kolltidsbesparelse — Ca hvor mye tid sparer du per reise til jobb/skole ved å bruke kollektivfelt?

- filter:\Kollektivfelt.a=1
- range:*

10 minutter eller mindre — 1
11-20 minutter — 2
21-30 minutter — 3
Mer enn 30 minutter — 4
Vet ikke — 5

Fergespar — Hva sparer husholdningen på rimeligere fergetakster per uke?

- filter:\NAFBiltype.a=1
- range:*

Mindre enn 50 kr per uke — 1
50-100 kr per uke — 2
101-200 kr per uke — 3
201-400 kr per uke — 4
Over 400 kr per uke — 5
Vet ikke — 6
Ikke aktuelt — 7

parkspar — Hvor mye sparer husholdningen per uke på å bruke gratis parkering?

- filter:\NAFBiltype.a=1
- range:*

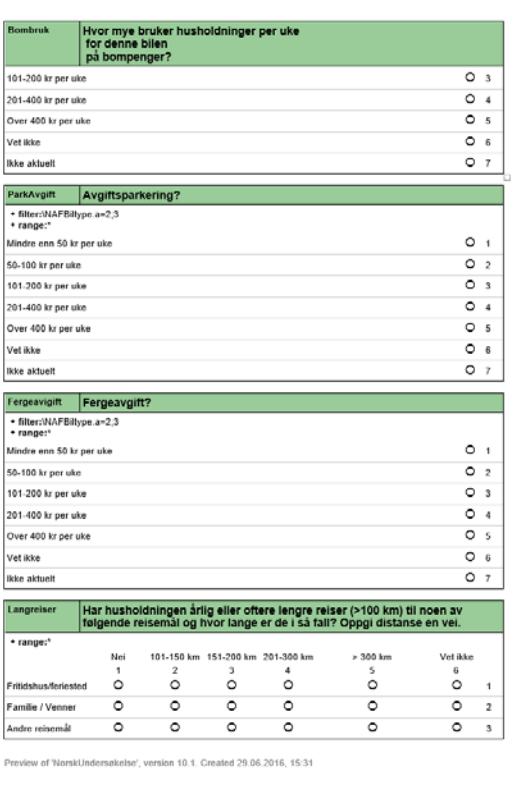
Mindre enn 50 kr per uke — 1
50-100 kr per uke — 2
101-200 kr per uke — 3
201-400 kr per uke — 4
Over 400 kr per uke — 5
Vet ikke — 6
Ikke aktuelt — 7

Bombruk — Hvor mye bruker husholdninger per uke for denne bilen på bompenger?

- filter:\NAFBiltype.a=2;3
- range:*

Mindre enn 50 kr per uke — 1
50-100 kr per uke — 2

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31



Bombruk — Hvor mye bruker husholdninger per uke for denne bilen på bompenger?

101-200 kr per uke	3
201-400 kr per uke	4
Over 400 kr per uke	5
Vet ikke	6
Ikke aktuelt	7

ParkAvgift — Avgiftsparkering?

• filter:\NAFBiltype.a=2;3
• range:*

Mindre enn 50 kr per uke	1
50-100 kr per uke	2
101-200 kr per uke	3
201-400 kr per uke	4
Over 400 kr per uke	5
Vet ikke	6
Ikke aktuelt	7

Fergeavgift — Fergeavgift?

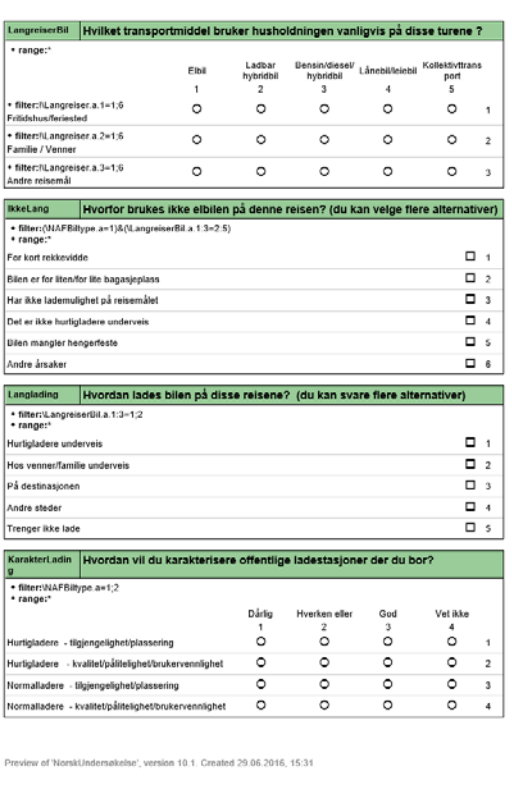
• filter:\NAFBiltype.a=2;3
• range:*

Mindre enn 50 kr per uke	1
50-100 kr per uke	2
101-200 kr per uke	3
201-400 kr per uke	4
Over 400 kr per uke	5
Vet ikke	6
Ikke aktuelt	7

Langreiser — Har husholdningen årlig eller oftere lengre reiser (>100 km) til noen av følgende reisemål og hvor lange er de i så fall? Oppgi distanse en vei.

• range:*

	Nei (1)	101-150 km (2)	151-200 km (3)	201-300 km (4)	> 300 km (5)	Vet ikke (6)	
Fritidshus/feriested	○	○	○	○	○	○	1
Familie / Venner	○	○	○	○	○	○	2
Andre reisemål	○	○	○	○	○	○	3



LangreiserBil — Hvilket transportmiddel bruker husholdningen vanligvis på disse turene ?

• range:*

	Elbil (1)	Ladbar hybridbil (2)	Bensin/diesel/ hybridbil (3)	Lånebil/leiebil (4)	Kollektivtrafikk (5)	
• filter:!(Langreiser.a.1=1;6) Fritidshus/feriested	○	○	○	○	○	1
• filter:!(Langreiser.a.2=1;6) Familie / Venner	○	○	○	○	○	2
• filter:!(Langreiser.a.3=1;6) Andre reisemål	○	○	○	○	○	3

IkkeLang — Hvorfor brukes ikke elbilen på denne reisen? (du kan velge flere alternativer)

• filter:(\NAFBiltype.a=1)&(\LangreiserBil.a.1:3=2;5)
• range:*

For kort rekkevidde	1
Bilen er for liten/for lite bagasjeplass	2
Har ikke lademulighet på reisemålet	3
Det er ikke hurtigladere underveis	4
Bilen mangler hengerfeste	5
Andre årsaker	6

Langlading — Hvordan lades bilen på disse reisene? (du kan svare flere alternativer)

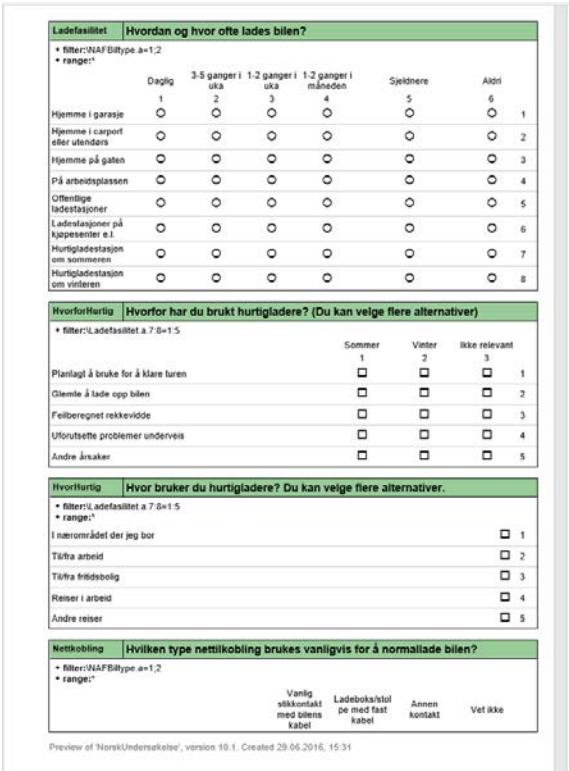
• filter:\LangreiserBil.a.1:3=1;2
• range:*

Hurtigladere underveis	1
Hos venner/familie underveis	2
På destinasjonen	3
Andre steder	4
Trenger ikke lade	5

KarakterLading — Hvordan vil du karakterisere offentlige ladestasjoner der du bor?

• filter:\NAFBiltype.a=1;2
• range:*

	Dårlig (1)	Hverken eller (2)	God (3)	Vet ikke (4)	
Hurtigladere - tilgjengelighet/plassering	○	○	○	○	1
Hurtigladere - kvalitet/pålitelighet/brukervennlighet	○	○	○	○	2
Normalladere - tilgjengelighet/plassering	○	○	○	○	3
Normalladere - kvalitet/pålitelighet/brukervennlighet	○	○	○	○	4



Ladefasilitet — Hvordan og hvor ofte lades bilen?

• filter:\NAFBiltype.a=1;2
• range:*

	Daglig (1)	3-5 ganger i uka (2)	1-2 ganger i uka (3)	1-2 ganger i måneden (4)	Sjeldnere (5)	Aldri (6)	
Hjemme i garasje	○	○	○	○	○	○	1
Hjemme i carport eller utenders	○	○	○	○	○	○	2
Hjemme på gaten	○	○	○	○	○	○	3
På arbeidsplassen	○	○	○	○	○	○	4
Offentlige ladestasjoner	○	○	○	○	○	○	5
Ladestasjoner på kjøpesenter e.l.	○	○	○	○	○	○	6
Hurtigladestasjon om sommeren	○	○	○	○	○	○	7
Hurtigladestasjon om vinteren	○	○	○	○	○	○	8

HvorforHurtig — Hvorfor har du brukt hurtigladere? (Du kan velge flere alternativer)

• filter:\Ladefasilitet.a.7:8=1:5

	Sommer (1)	Vinter (2)	Ikke relevant (3)	
Planlagt å bruke for å klare turen	☐	☐	☐	1
Glemte å lade opp bilen	☐	☐	☐	2
Feilberegnet rekkevidde	☐	☐	☐	3
Uforutsette problemer underveis	☐	☐	☐	4
Andre årsaker	☐	☐	☐	5

HvorHurtig — Hvor bruker du hurtigladere? Du kan velge flere alternativer.

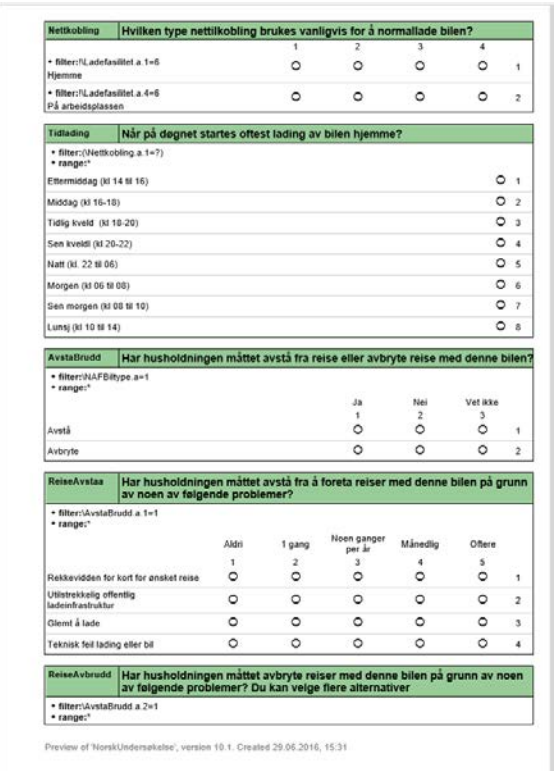
• filter:\Ladefasilitet.a.7:8=1:5
• range:*

I nærområdet der jeg bor	1
Til/fra arbeid	2
Til/fra fritidsbolig	3
Reiser i arbeid	4
Andre reiser	5

Nettkobling — Hvilken type nettilkobling brukes vanligvis for å normallade bilen?

• filter:\NAFBiltype.a=1;2
• range:*

	Vanlig stikkontakt med bilens kabel	Ladeboks/stolpe med fast kabel	Annen kontakt	Vet ikke



Nettkobling — Hvilken type nettilkobling brukes vanligvis for å normallade bilen?

	1	2	3	4	
• filter:!\Ladefasilitet.a.1=6 Hjemme	○	○	○	○	1
• filter:!\Ladefasilitet.a.4=6 På arbeidsplassen	○	○	○	○	2

Tidlading — Når på døgnet startes oftest lading av bilen hjemme?

• filter:(Nettkobling.a.1=?)
• range:*

Ettermiddag (kl 14 til 16)	1
Middag (kl 16-18)	2
Tidlig kveld (kl 18-20)	3
Sen kveldi (kl 20-22)	4
Natt (kl. 22 til 06)	5
Morgen (kl 06 til 08)	6
Sen morgen (kl 08 til 10)	7
Lunsj (kl 10 til 14)	8

AvstaBrudd — Har husholdningen måttet avstå fra reise eller avbryte reise med denne bilen?

• filter:\NAFBiltype.a=1
• range:*

	Ja (1)	Nei (2)	Vet ikke (3)	
Avstå	○	○	○	1
Avbryte	○	○	○	2

ReiseAvstaa — Har husholdningen måttet avstå fra å foreta reiser med denne bilen på grunn av noen av følgende problemer?

• filter:\AvstaBrudd.a.1=1
• range:*

	Aldri (1)	1 gang (2)	Noen ganger per år (3)	Månedlig (4)	Oftere (5)	
Rekkevidden for kort for ønsket reise	○	○	○	○	○	1
Utilstrekkelig offentlig ladeinfrastruktur	○	○	○	○	○	2
Glemt å lade	○	○	○	○	○	3
Teknisk feil lading eller bil	○	○	○	○	○	4

ReiseAvbrudd — Har husholdningen måttet avbryte reiser med denne bilen på grunn av noen av følgende problemer? Du kan velge flere alternativer

• filter:\AvstaBrudd.a.2=1
• range:*

ReiseAvbrudd — **Har husholdningen måttet avbryte reiser med denne bilen på grunn av noen av følgende problemer? Du kan velge flere alternativer**

	Aldri	1 gang	Noen ganger per år	Månedlig	Oftere	
	1	2	3	4	5	
Feilberegnet rekkevidde	○	○	○	○	○	1
Varmeapparatet brukte uventet mye energi	○	○	○	○	○	2
Glemte å sjekke tilgang på ladestasjoner	○	○	○	○	○	3
Glemte å sjekke ladetilstand på bilen ved turstart	○	○	○	○	○	4
Teknisk feil ladeinfrastruktur	○	○	○	○	○	5
Teknisk feil bil	○	○	○	○	○	6
Fikk ikke ladet pga. betalingsproblem	○	○	○	○	○	7

NoeProblem — **Har husholdningen opplevd tekniske eller andre problemer forbundet med ladingen?**

- **filter:**\NAFBiltype.a=1;2
- **range:***

Ja	○	1
Nei	○	2
Vet ikke/ikke aktuelt	○	3

Ladeproblem — **Har husholdningen noen gang opplevd følgende problemer?**

- **filter:**\NoeProblem.a=1
- **range:***

	Strømløs	Brent ladekontakt	Ødelagt ladeuttak	Bilens ladekabel skadet	Ladekabel stjålet eller ramponert	Ingen problemer	
	1	2	3	4	5	6	
Hjemme	☐	☐	☐	☐	☐	☐	1
På arbeidsplass/skole	☐	☐	☐	☐	☐	☐	2
På offentlige ladestasjoner, kjøpesentre, e.l.	☐	☐	☐	☐	☐	☐	3
På reisedestinasjon	☐	☐	☐	☐	☐	☐	4

Information

Vi vil nå stille noen spørsmål om hvordan og hvorfor du valgte å kjøpe bilen.

Nybrukt — **Kjøpte husholdningen denne bilen ny eller brukt?**

- **range:***

Ny hos bilforhandler	○	1

Nybrukt — **Kjøpte husholdningen denne bilen ny eller brukt?**

Brukt hos merkeforhandler	○	2
Brukt hos annen forhandler	○	3
Brukt av privatperson	○	4
Andre	○	5

HVorlengeel — **Hvor lenge har du brukt elbil/ladbar hybridbil?**

- **filter:**\NAFBiltype.a=1;2
- **range:***

0-1 år	○	1
1-2 år	○	2
2-5 år	○	3
5-10 år	○	4
> 10 år	○	5

Informasjon — **Hvor fikk husholdningen først informasjon som gjorde at dere vurderte å kjøpe denne typen bil? Det er mulig å velge flere alternativer.**

- **range:***

Media	☐	1
Jobb	☐	2
Bilforhandler	☐	3
Reklamemateriell eller magasin fra forhandler eller bilmerke	☐	4
Bekjente/familie/kolleger	☐	5
Organisasjon	☐	6
Annet	Open	

HVilkenorg — **Hvilken organisasjon fikk husholfningen informasjonen fra?**

- **filter:**\Informasjon.a=6

Elbilforeningen	○	1
NAF	○	2
Miljøorganisasjon	○	3
Politiske organisasjoner	○	4
Annet	Open	

UtnyttelsesInfo — **Hvor får husholdningen informasjon om hvordan bilen kan utnyttes bedre? Du kan svare flere alternativer**

- **filter:**\NAFBiltype.a=1
- **range:***

Bilforhandler, importør	☐	1

UtnyttelsesInfo — **Hvor får husholdningen informasjon om hvordan bilen kan utnyttes bedre? Du kan svare flere alternativer**

Blogger, facebook og øvrige sosiale media	☐	2
Media	☐	3
Kolleger, venner, familie med samme type bil	☐	4
Elbilforeningen, Elbilforum	☐	5
NAF, magasinet Motor	☐	6
Miljøorganisasjoner	☐	7
Andre	Open	

Faktorerforkjop — **Hvilke faktorer var avgjørende for at bilen ble kjøpt?**

- **range:***

	Ingen betydning	En del betydning	Stor betydning	Vet ikke	
	1	2	3	4	
Bilens trafikksikkerhet	○	○	○	○	1
Bilens miljøegenskaper	○	○	○	○	2
Bilens akselerasjonsegenskaper	○	○	○	○	3
Bilens kjørekomfort	○	○	○	○	4
Bilens driftssikkerhet	○	○	○	○	5
Mye for pengene	○	○	○	○	6
Lave drivstoffkostnader	○	○	○	○	7
Lave service- og vedlikeholdskostnader	○	○	○	○	8
Det var beste bil for mitt behov	○	○	○	○	9
filter:\NAFBiltype.a=1 Lavere årsavgift	○	○	○	○	10
filter:\NAFBiltype.a=1 Redusert fordelsbeskatning	○	○	○	○	11
filter:\NAFBiltype.a=1 Gratis parkering/lading på offentlige parkeringsplasser	○	○	○	○	12
filter:\NAFBiltype.a=1 Tilgang til lading på arbeidsplass/utdanningssted	○	○	○	○	13
filter:\NAFBiltype.a=1 Mitt foretrukne bilmerke fører ladbare biler	○	○	○	○	14
filter:\NAFBiltype.a=1 Gratis bompassering	○	○	○	○	15
filter:\NAFBiltype.a=1 Adgang til å kjøre i kollektivfelt	○	○	○	○	16
filter:\NAFBiltype.a=1 Billigere ferge	○	○	○	○	17

Faktorerforkjop — **Hvilke faktorer var avgjørende for at bilen ble kjøpt?**

filter:\NAFBiltype.a=1 Ingen vil kjøpe brukt diesel/bensinbil i framtiden	○	○	○	○	18
filter:\NAFBiltype.a=2 Kan kjøre lange turer på drivstoff og korte turer på elektrisitet	○	○	○	○	19
Andre faktorer	○	○	○	○	20

andrefaktorer — **Hvilke andre faktorer var det snakk om?**

- **filter:**(\Faktorerforkjop.a.20=2;3)

Open

avgjorelse — **Hadde husholdningen bestemt seg for å kjøpe denne typen bil før bilforhandler ble oppsøkt?**

- **range:***

Ja	○	1
Nei	○	2
Vet ikke	○	3

Hybridigjen — **Vil du kjøpe ladbar hybridbil igjen?**

- **filter:**\NAFBiltype.a=2
- **range:***

Ja	○	1
Nei	○	2
skip:nextsection Vet ikke	○	3

Elbiligjen — **Vil du kjøpe elbil igjen?**

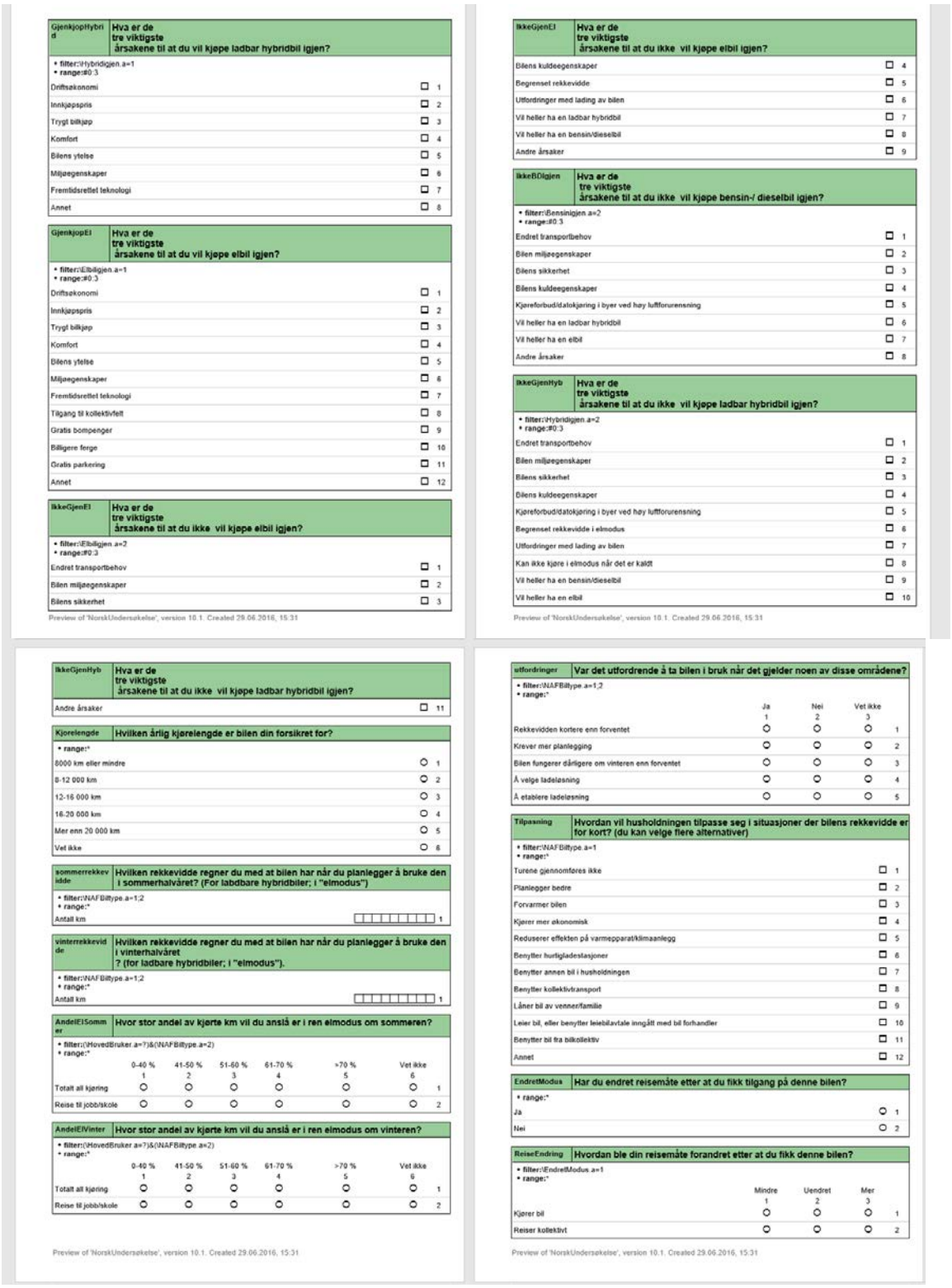
- **filter:**\NAFBiltype.a=1
- **range:***

Ja	○	1
Nei	○	2
skip:nextsection Vet ikke	○	3

Bensinigjen — **Vil du kjøpe bensin-/dieselbil igjen?**

- **filter:**\NAFBiltype.a=3
- **range:***

Ja	○	1
Nei	○	2
skip:nextsection Vet ikke	○	3



GjenkjopHybrid	Hva er de tre viktigste årsakene til at du vil kjøpe ladbar hybridbil igjen?
• filter:\Hybridigjen.a=1 • range:#0:3	
Driftsøkonomi	☐ 1
Innkjøpspris	☐ 2
Trygt bilkjøp	☐ 3
Komfort	☐ 4
Bilens ytelse	☐ 5
Miljøegenskaper	☐ 6
Fremtidsrettet teknologi	☐ 7
Annet	☐ 8

GjenkjopEl	Hva er de tre viktigste årsakene til at du vil kjøpe elbil igjen?
• filter:\Elbiligjen.a=1 • range:#0:3	
Driftsøkonomi	☐ 1
Innkjøpspris	☐ 2
Trygt bilkjøp	☐ 3
Komfort	☐ 4
Bilens ytelse	☐ 5
Miljøegenskaper	☐ 6
Fremtidsrettet teknologi	☐ 7
Tilgang til kollektivfelt	☐ 8
Gratis bompenger	☐ 9
Billigere ferge	☐ 10
Gratis parkering	☐ 11
Annet	☐ 12

IkkeGjenEl	Hva er de tre viktigste årsakene til at du ikke vil kjøpe elbil igjen?
• filter:\Elbiligjen.a=2 • range:#0:3	
Endret transportbehov	☐ 1
Bilen miljøegenskaper	☐ 2
Bilens sikkerhet	☐ 3

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

IkkeGjenEl	Hva er de tre viktigste årsakene til at du ikke vil kjøpe elbil igjen?
Bilens kuldeegenskaper	☐ 4
Begrenset rekkevidde	☐ 5
Utfordringer med lading av bilen	☐ 6
Vil heller ha en ladbar hybridbil	☐ 7
Vil heller ha en bensin/dieselbil	☐ 8
Andre årsaker	☐ 9

IkkeBDigjen	Hva er de tre viktigste årsakene til at du ikke vil kjøpe bensin-/ dieselbil igjen?
• filter:\Bensinigjen.a=2 • range:#0:3	
Endret transportbehov	☐ 1
Bilen miljøegenskaper	☐ 2
Bilens sikkerhet	☐ 3
Bilens kuldeegenskaper	☐ 4
Kjøreforbud/datokjøring i byer ved høy luftforurensning	☐ 5
Vil heller ha en ladbar hybridbil	☐ 6
Vil heller ha en elbil	☐ 7
Andre årsaker	☐ 8

IkkeGjenHyb	Hva er de tre viktigste årsakene til at du ikke vil kjøpe ladbar hybridbil igjen?
• filter:\Hybridigjen.a=2 • range:#0:3	
Endret transportbehov	☐ 1
Bilen miljøegenskaper	☐ 2
Bilens sikkerhet	☐ 3
Bilens kuldeegenskaper	☐ 4
Kjøreforbud/datokjøring i byer ved høy luftforurensning	☐ 5
Begrenset rekkevidde i elmodus	☐ 6
Utfordringer med lading av bilen	☐ 7
Kan ikke kjøre i elmodus når det er kaldt	☐ 8
Vil heller ha en bensin/dieselbil	☐ 9
Vil heller ha en elbil	☐ 10

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

IkkeGjenHyb	Hva er de tre viktigste årsakene til at du ikke vil kjøpe ladbar hybridbil igjen?
Andre årsaker	☐ 11

Kjorelengde	Hvilken årlig kjørelengde er bilen din forsikret for?
• range:*	
8000 km eller mindre	○ 1
8-12 000 km	○ 2
12-16 000 km	○ 3
16-20 000 km	○ 4
Mer enn 20 000 km	○ 5
Vet ikke	○ 6

sommerrekkevidde	Hvilken rekkevidde regner du med at bilen har når du planlegger å bruke den i sommerhalvåret? (For labdbare hybridbiler; i "elmodus")
• filter:\NAFBiltype.a=1;2 • range:*	
Antall km	☐☐☐☐☐☐☐ 1

vinterrekkevidde	Hvilken rekkevidde regner du med at bilen har når du planlegger å bruke den i vinterhalvåret ? (for ladbare hybridbiler; i "elmodus").
• filter:\NAFBiltype.a=1;2 • range:*	
Antall km	☐☐☐☐☐☐☐ 1

AndelElSommer	Hvor stor andel av kjørte km vil du anslå er i ren elmodus om sommeren?						
• filter:(\HovedBruker.a=7)&(\NAFBiltype.a=2) • range:*							
	0-40 % 1	41-50 % 2	51-60 % 3	61-70 % 4	>70 % 5	Vet ikke 6	
Totalt all kjøring	○	○	○	○	○	○	1
Reise til jobb/skole	○	○	○	○	○	○	2

AndelElVinter	Hvor stor andel av kjørte km vil du anslå er i ren elmodus om vinteren?						
• filter:(\HovedBruker.a=7)&(\NAFBiltype.a=2) • range:*							
	0-40 % 1	41-50 % 2	51-60 % 3	61-70 % 4	>70 % 5	Vet ikke 6	
Totalt all kjøring	○	○	○	○	○	○	1
Reise til jobb/skole	○	○	○	○	○	○	2

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

utfordringer	Var det utfordrende å ta bilen i bruk når det gjelder noen av disse områdene?			
• filter:\NAFBiltype.a=1;2 • range:*				
	Ja 1	Nei 2	Vet ikke 3	
Rekkevidden kortere enn forventet	○	○	○	1
Krever mer planlegging	○	○	○	2
Bilen fungerer dårligere om vinteren enn forventet	○	○	○	3
Å velge ladeløsning	○	○	○	4
Å etablere ladeløsning	○	○	○	5

Tilpasning	Hvordan vil husholdningen tilpasse seg i situasjoner der bilens rekkevidde er for kort? (du kan velge flere alternativer)
• filter:\NAFBiltype.a=1 • range:*	
Turene gjennomføres ikke	☐ 1
Planlegger bedre	☐ 2
Forvarmer bilen	☐ 3
Kjører mer økonomisk	☐ 4
Reduserer effekten på varmepparat/klimaanlegg	☐ 5
Benytter hurtigladestasjoner	☐ 6
Benytter annen bil i husholdningen	☐ 7
Benytter kollektivtransport	☐ 8
Låner bil av venner/familie	☐ 9
Leier bil, eller benytter leiebilavtale inngått med bil forhandler	☐ 10
Benytter bil fra bilkollektiv	☐ 11
Annet	☐ 12

EndretModus	Har du endret reisemåte etter at du fikk tilgang på denne bilen?
• range:*	
Ja	○ 1
Nei	○ 2

ReiseEndring	Hvordan ble din reisemåte forandret etter at du fikk denne bilen?			
• filter:\EndretModus.a=1 • range:*				
	Mindre 1	Uendret 2	Mer 3	
Kjører bil	○	○	○	1
Reiser kollektivt	○	○	○	2

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

ReiseEndring	Hvordan ble din reisemåte forandret etter at du fikk denne bilen?			
Sykler/går	○	○	○	3
Sitter på med andre	○	○	○	4

erstatning	Erstattet denne bilen en annen bil?	
⋆ range:*		
Nei, husholdningen fikk én bil ekstra	○	1
Den erstattet en bensin-/dieselbil	○	2
Den erstattet en hybridbil	○	3
Den erstattet en ladbar hybridbil	○	4
Den erstattet en elbil	○	5
Den erstattet flere enn en bil	○	6
Vet ikke	○	7

Paavirkning	Ble bilkjøpet påvirket av noen av disse årsakene? Du kan svare mer enn ett alternativ.	
⋆ filter:\erstatning.a=1 ⋆ range:*		
Husholdningen byttet bolig	☐	1
En person i husholdningen byttet arbeidssted	☐	2
Flere personer med førerkort i husholdningen	☐	3
Det har blitt flere personer i husholdningen	☐	4
Endret omsorgsreisebehov, for eksempel barn i barnehage/skole/fritidsaktiviteter	☐	5
Ønsket mer tid til familien	☐	6
Ønsket å bruke annen bil i husholdningen mindre	☐	7
Offentlig transport er for dårlig mht. frekvens eller komfort	☐	8
Annet	☐	9

endretforsikring	Har husholdningen endret samlet årlig kjørelengde i bilforsikringene etter at dere skaffet denne bilen?	
⋆ range:*		
Nei, har samme kjørelengde som før	○	1
Ja, har økt kjørelengden	○	2
Ja, har kuttet ned på kjørelengden	○	3
Har hatt bilen mindre enn ett år	○	4
Vet ikke	○	5

vennerfamilie	Har du venner eller familie som har kjøpt eller vurderer å kjøpe elbil som følge av at du har fortalt dem om dine erfaringer?					
⋆ filter:\NAFBiltype.a=1 ⋆ range:*						
	Nei	1-2	3-5	>5	Vet ikke	
	1	2	3	4	5	
Ja, som har kjøpt	○	○	○	○	○	1
Ja, som vurderer å kjøpe	○	○	○	○	○	2

FarligSits_1	Har du opplevd farlige situasjoner som følge av at fotgjengere, syklister eller barn ikke hører bilen?	
⋆ range:*		
Aldri	○	1
Har skjedd én gang	○	2
Har skjedd flere ganger	○	3
Skjer flere ganger i året	○	4

Information
Vi vil nå stille deg noen spørsmål om hva du mener om henholdsvis elbiler og ladbare hybridbiler (også kalt Plug-In Hybridbil).

fordelerulemper	Hva mener du er fordeler eller ulemper ved elbiler?					
⋆ range:*						
	Stor ulempe	Liten ulempe	Hverken fordel eller ulempe	Liten fordel	Stor fordel	
	1	2	3	4	5	
Bilens størrelse	○	○	○	○	○	1
Bilens rekkevidde	○	○	○	○	○	2
Bilens kjørekomfort	○	○	○	○	○	3
Bilens sikkerhet	○	○	○	○	○	4
Akselerasjonsegenskaper	○	○	○	○	○	5
Bilens varmeapparat	○	○	○	○	○	6
Design og image	○	○	○	○	○	7
Bilens miljøegenskaper	○	○	○	○	○	8
Å kunne lade hjemme	○	○	○	○	○	9
Tiden det tar å lade batteriet	○	○	○	○	○	10
Håndtering ledninger/ladekabel	○	○	○	○	○	11
Anskaffelsespris	○	○	○	○	○	12
Driftskostnader	○	○	○	○	○	13

fordelerulemper	Hva mener du er fordeler eller ulemper ved elbiler?					
Bruktbilverdi	○	○	○	○	○	14

FaktorBetydning_1	Hvilken betydning mener du disse faktorene har for å øke andelen elbiler?					
⋆ range:*						
	Ingen	Liten	Hverken eller/middels	Stor	Avgjørende	
	1	2	3	4	5	
Lenger rekkevidde	○	○	○	○	○	1
Bedre tilgang til hurtiglading	○	○	○	○	○	2
Beholde fritak for kjøpsavgifter	○	○	○	○	○	3
Beholde gratis bompenger	○	○	○	○	○	4
Beholde gratis parkering	○	○	○	○	○	5
Beholde tilgang kollektivfelt	○	○	○	○	○	6
Beholde rimeligere ferge	○	○	○	○	○	7

MinRekkevidde	Hvor lang mener du rekkevidden minimum må være om vinteren for at elbiler skal bli aktuelt for flere?	
⋆ filter:\FaktorBetydning_1.a.2=4;5 ⋆ range:*		
Antall kilometer	☐☐☐☐	1

FaktorBetydningLH	Hvilken betydning mener du disse faktorene har for å øke andelen ladbare hybridbiler?					
⋆ range:*						
	Ingen	Liten	Hverken eller/middels	Stor	Avgjørende	
	1	2	3	4	5	
Lenger rekkevidde i elmodus	○	○	○	○	○	1
Konkuransedyktig innkjøpspris	○	○	○	○	○	2
Gratis parkering og lading som for elbiler	○	○	○	○	○	3
Lavere sats i bomringer og på ferger	○	○	○	○	○	4

HybridMin	Hvor lang må rekkevidden i elmodus om vinteren minimum være for at ladbare hybridbiler skal bli aktuelt for flere?	
⋆ filter:\FaktorBetydningLH.a.1=4;5 ⋆ range:*		
Antall kilometer	☐☐☐☐	1

FaktorBetydning	Hvilken betydning mener du disse faktorene har for å øke andelen elbiler og ladbare hybridbiler?
⋆ range:*	

FaktorBetydning	Hvilken betydning mener du disse faktorene har for å øke andelen elbiler og ladbare hybridbiler?					
	Ingen	Liten	Hverken eller/middels	Stor	Avgjørende	
	1	2	3	4	5	
Bedre utvalg av biler hos bilforhandlere	○	○	○	○	○	1
Offentlige ladestasjoner på flere steder	○	○	○	○	○	2
Arbeidsplasslading	○	○	○	○	○	3
Høyere pris på biler som forurenser	○	○	○	○	○	4
Kan kjøre når det er kjøreforbud for andre biler i by	○	○	○	○	○	5

FarligSits	Har du opplevd farlige situasjoner som følge av at fotgjengere, syklister eller barn ikke hører bilen?	
⋆ range:*		
Aldri	○	1
Har skjedd én gang	○	2
Har skjedd flere ganger	○	3
Skjer flere ganger i året	○	4

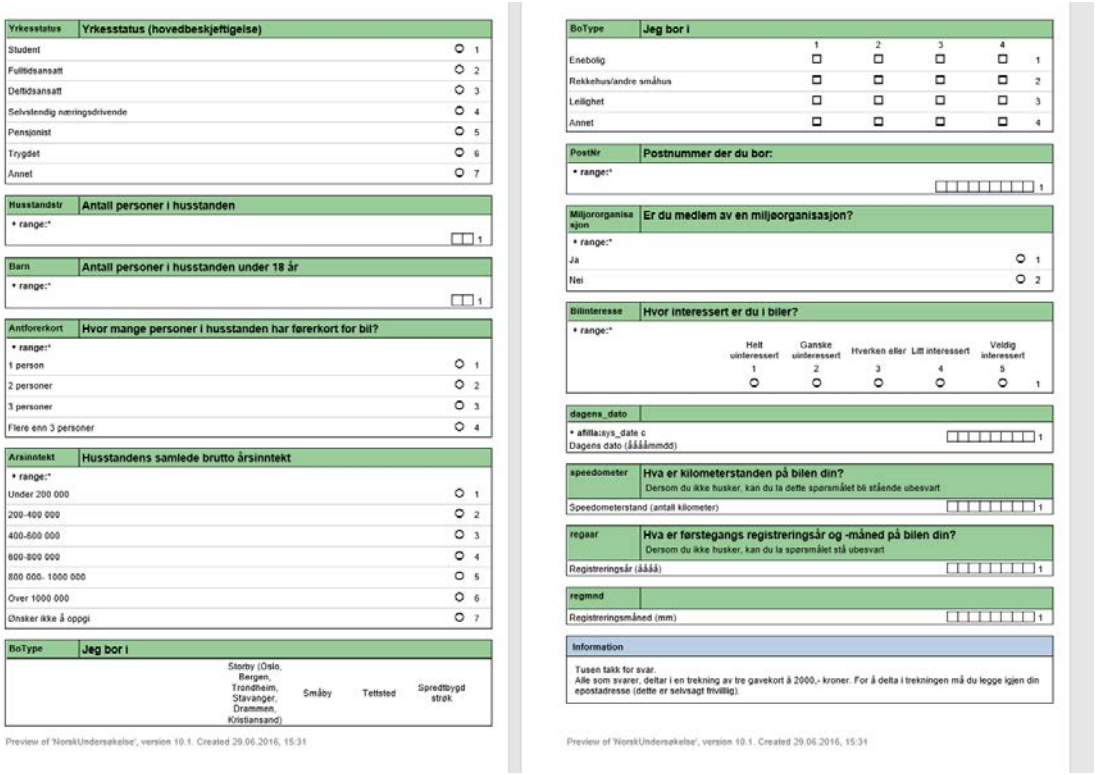
Information
Til slutt vil vi stille noen spørsmål om deg selv, for å kunne sammenligne eierne av ulike typer biler.

Kjonn	Kjønn	
⋆ range:*		
Kvinne	○	1
Mann	○	2

Alder	Alder	
⋆ range:*		
	☐☐	1

Utd	Høyeste fullførte utdannelse	
⋆ range:*		
Grunnskole	○	1
Videregående skole	○	2
Høyere utdanning av inntil fire års lengde	○	3
Høyere utdanning over fire års lengde	○	4

Yrkesstatus	Yrkesstatus (hovedbeskjeftigelse)
⋆ range:*	



Yrkesstatus	Yrkesstatus (hovedbeskjeftigelse)	
Student		1
Fulltidsansatt		2
Deltidsansatt		3
Selvstendig næringsdrivende		4
Pensjonist		5
Trygdet		6
Annet		7

Husstandstr	Antall personer i husstanden
* range:*	
	1

Barn	Antall personer i husstanden under 18 år
* range:*	
	1

Antforerkort	Hvor mange personer i husstanden har førerkort for bil?	
* range:*		
1 person		1
2 personer		2
3 personer		3
Flere enn 3 personer		4

Arsinntekt	Husstandens samlede brutto årsinntekt	
* range:*		
Under 200 000		1
200-400 000		2
400-600 000		3
600-800 000		4
800 000- 1000 000		5
Over 1000 000		6
Ønsker ikke å oppgi		7

BoType	Jeg bor i				
	Storby (Oslo, Bergen, Trondheim, Stavanger, Drammen, Kristiansand)	Småby	Tettsted	Spredtbygd strøk	

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

BoType	Jeg bor i				
	1	2	3	4	
Enebolig	☐	☐	☐	☐	1
Rekkehus/andre småhus	☐	☐	☐	☐	2
Leilighet	☐	☐	☐	☐	3
Annet	☐	☐	☐	☐	4

PostNr	Postnummer der du bor:
* range:*	
	1

Miljoorganisasjon	Er du medlem av en miljøorganisasjon?	
* range:*		
Ja		1
Nei		2

Bilinteresse	Hvor interessert er du i biler?					
* range:*	Helt uinteressert	Ganske uinteressert	Hverken eller	Litt interessert	Veldig interessert	
	1	2	3	4	5	
						1

dagens_dato	
* afilla:sys_date c Dagens dato (åååå mmdd)	1

speedometer	Hva er kilometerstanden på bilen din? Dersom du ikke husker, kan du la dette spørsmålet bli stående ubesvart
Speedometerstand (antall kilometer)	1

regaar	Hva er førstegangs registreringsår og -måned på bilen din? Dersom du ikke husker, kan du la spørsmålet stå ubesvart
Registreringsår (åååå)	1

regmnd	
Registreringsmåned (mm)	1

Information
Tusen takk for svar. Alle som svarer, deltar i en trekning av tre gavekort à 2000,- kroner. For å delta i trekningen må du legge igjen din epostadresse (dette er selvsagt frivillig).

Preview of 'NorskUndersøkelse', version 10.1. Created 29.06.2016, 15:31

Annex 3 Overview of incentives

Table 9.1 BEV incentives

Incentives	Introduced	Benefits for buyers of passenger vehicles, influence on relative advantage	Future of the incentive[2]
Fiscal incentives Reduction of purchase price/yearly cost gives competitive prices			
Exemption from registration tax	1990/1996	The tax is based on emission, engine power and weight and makes ICEVS more expensive. Example of ICEV taxes: VW Up 3000 €. VW Golf: 6000-9000 €,	Continued until 2020. Future revisions of the incentive will be evaluated against the Norwegian climate policy goals for 2020 and 2030. For ICEVs the registration tax will be tuned further to reduce emissions.
VAT exemption	2001	Vehicles competing with BEVs are levied a VAT of 25% on sales price minus registration tax.	Unchanged through the end of 2017. Will consider replacing it with a subsidy scheme, initially at the level of the VAT exemption and slowly ramped down.
Reduced annual vehicle license fee	1996/2004	BEVs and hydrogen vehicles 52 € (2014-figures). Diesel rate: 360-420 € with/without particulate filter.	Half rate of ICE vehicles to be introduced 01.01.2018 and full rate from 2020.
Reduced company car tax	2000	The company-car tax is lower but BEVs are mostly not company cars.	This incentive may be removed from 2018
Economic incentives			
Free toll roads	1997	In the Oslo-area the saved costs are 600-1 000 € per year for commuters. Some places exceeds 2 500 €/year	The government will appraise the environmental effects of introducing differentiated fees for toll roads (main roads and toll rings around cities) and ferries based on the environmental characteristics of vehicles as well as a low rate for BEVs and FCEVs. In June 2016, it was agreed that BEV owners will have to pay a low rate in the toll ring around Oslo, but the cost for ICEVs increases even more.
Reduced fares on ferries	2009	Similar to toll roads saving money for those using car ferries.	
Financial support for charging stations	2009	Reduce the economic risk for investors in charging stations, reduce range anxiety and expand usage options.	
Financial support for fast charge stations	2011	More fast-charging stations become available, increases BEV miles driven & market.	
Practical incentives			
Access to bus lanes	2003/2005	BEV users save time driving to work in the bus lane during rush hours. High value to user in regions with large rush-hour delays.	Local authorities can introduce restrictions in their jurisdictional district if zero emission vehicles hinder busses' ability to navigate the bus lanes.
Free parking	1999	Users get a parking space where these are scarce or expensive and save time looking for a space.	Local authorities will be given the authority to decide whether this incentive is to continue in their jurisdictional district
Free charging		Not regulated in national laws, but is often bundled with free parking	Local authorities will be given the authority to decide whether this incentive is to continue

PHEVs have a reduced registration tax, for compact PHEVs it is typically zero. They have access to public charging stations but not free parking, and may thus have to pay for parking when charging if the charging station is in an area where you have to pay for parking.

[2] As presented in the governments revised budget for 2015 (may 2015) and subsequent decision in the parliament.

Institute of Transport Economics (TØI)
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.

A private, non-profit foundation, TØI receives basic funding from the Research Council of Norway. However, the greater part of its revenue is generated through contract research. An important part of its activity is international research cooperation, mostly in the form of projects under the Framework Programmes of the European Commission.

TØI participates in the Oslo Centre for Interdisciplinary Environmental and Social Research (CIENS) located near the University of Oslo. See www.ciens.no

TØI covers all modes of transport and virtually all topics in transportation, including road safety, public transport, climate change and the environment, travel behaviour, tourism, land use and urban planning, decision-making processes, freight and travel demand, as well as general transport economics.

Claiming copyright to its products, TØI acts independently of its clients in matters of scientific approach, professional judgment and evaluation. TØI reports are generally downloadable for free at www.toi.no.

Visiting and postal address:
Institute of Transport Economics
Gaustadalléen 21
NO-0349 Oslo

+ 47 22 57 38 00
toi@toi.no
www.toi.no