



Report on consumer behaviour (1st edition)

Project deliverable D1.1



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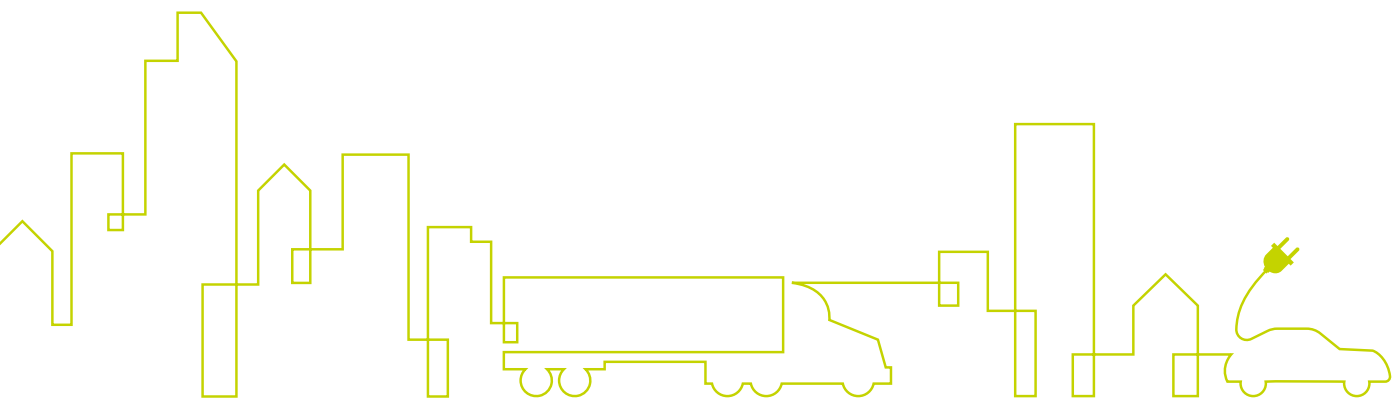
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SCALE Introduction

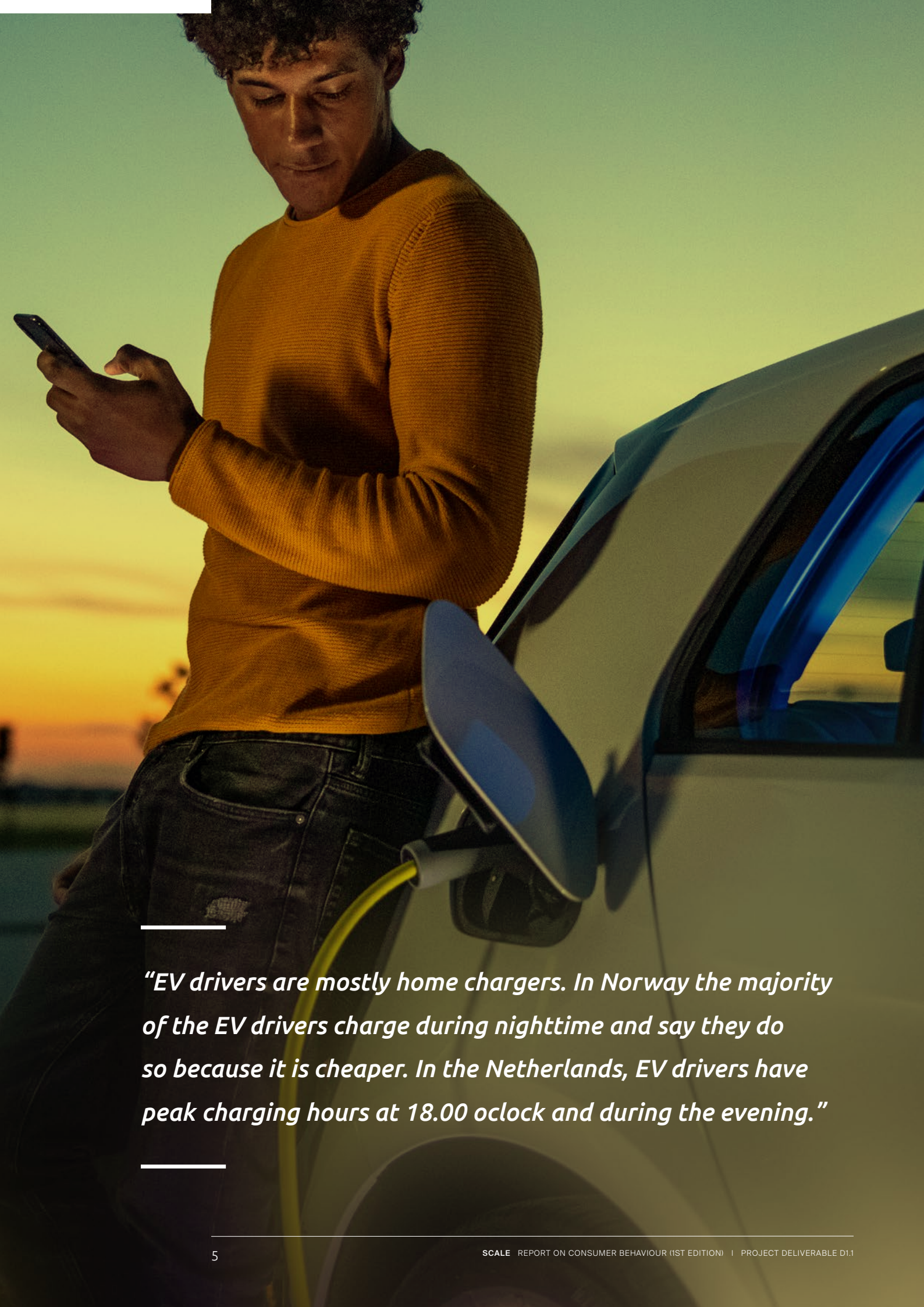
SCALE (Smart Charging Alignment for Europe) is a three-year Horizon Europe project that explores and tests smart charging solutions for electric vehicles. It aims to advance smart charging and Vehicle-2-Grid (V2G) ecosystems to shape a new energy system wherein the flexibility of EV batteries' is harnessed. The project will test and validate a variety of smart charging and V2X solutions and services in 13 use cases in real-life demonstrations in 7 European contexts: Oslo (NO), Rotterdam/Utrecht (NL), Eindhoven (NL), Toulouse (FR), Greater Munich Area (GER), Budapest/Debrecen (HU) and Gothenburg (SE). Going further, project results, best practices, and lessons learned will be shared across EU cities, regions, and relevant e-mobility stakeholders. SCALE aims to create a system blueprint for usercentric smart charging and V2X for European cities and regions.

SCALE's consortium comprises 29 cutting-edge European e-mobility actors covering the entire smart charging and V2X value chain (equipment and charging manufacturers, flexibility service providers, research and knowledge partners, public authorities, consumer associations, and so forth.) It is led by ElaadNL, one of the world's leading knowledge and innovation centres in smart charging and charging infrastructure.



List of abbreviations and acronyms

Acronym	Meaning
AC	Alternating current
EV	Electric vehicle
ICEV	Internal combustion engine vehicle
PHEV	Plug-in electric vehicle
OEM	Original equipment manufacturer
V2H	Vehicle to home
V2G	Vehicle to grid
V2L	Vehicle to load
V2X	Vehicle to anything
VER	The Dutch Electric Vehicle Drivers Organization



“EV drivers are mostly home chargers. In Norway the majority of the EV drivers charge during nighttime and say they do so because it is cheaper. In the Netherlands, EV drivers have peak charging hours at 18.00 oclock and during the evening.”

Report executive summary

Key words

Electric vehicles, EV drivers, smart charging, Vehicle-to-Anything

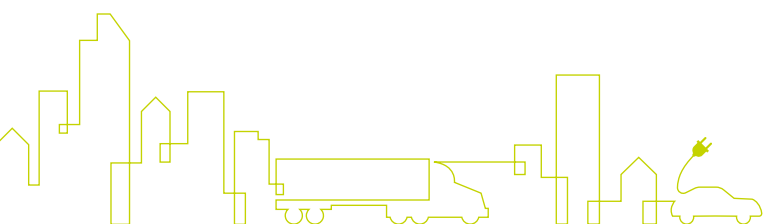
Summary

This report analyzes EV drivers' behavior, their needs and challenges. This report uses results from research articles, reports and surveys conducted by both external parties and partners within the SCALE project. In this first edition of the consumer behavior report, the purpose is to highlight EV drivers' charging behavior, smart charging habits and what considerations they have when they decide whether to adopt new charging technology.

The first edition of the consumer behavior report relies mainly on surveys through digital questionnaires already conducted in Norway, Netherland, Sweden, Denmark, Iceland and Finland by partner organizations in the SCALE project. The main results studied are from the Norwegian EV driver survey 2022 conducted by the Norwegian EV Association, and the Dutch National Charging Survey conducted by Elaad and VER (the Dutch Electric Vehicle Drivers Organization).

EV drivers are mostly home chargers. In Norway the majority of the EV drivers charge during nighttime, and say they do so because it is cheaper. In the Netherlands, EV drivers have peak charging hours at 18.00 o'clock and during the evening. The Dutch EV drivers seem less motivated to change charging behavior due to price levels, but this must be studied closer due to an ever changing energy situation in Europe as well as a possible correlation with households' present electricity contracts. Many EV drivers are already charging smart in Norway and the Netherlands. The potential to increase that amount and charge even smarter is also present, especially in the Netherlands where 68% of EV drivers own solar panels. In the Nordic countries, limited charging opportunity at home is an important barrier against getting an EV among consumers that do not already own an EV. This is important to be aware of going forward to a fully electric car market in Europe by 2035.

This report is the first of a series of reports on consumer behavior. The second edition of this report will include results from a SCALE specific survey, further studying consumers needs and challenges related to vehicle-to-anything technology and smart charging.



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Purpose of the deliverable

Attainment of the objectives and explanation of deviations

The objectives related to the first edition of this deliverable (consumer behavior report) have been achieved in full and as scheduled.

The purpose of this deliverable is to illustrate and analyze consumer needs and interests regarding smart charging of electric vehicles. Different studies and surveys show what EV drivers want when charging their car and assess their charging behavior. This report uses results from research articles, reports and surveys conducted by both external parties and partners within the SCALE project.

In this first edition of the consumer behavior report, the purpose is to highlight EV drivers' charging behavior, smart charging habits and what considerations they have when they decide whether to adopt new charging technology. The second edition of the report will provide a more thorough analysis of EV drivers' needs and motivations regarding smart charging and vehicle-to-everything technology.

Intended audience

- EV drivers/owners
- EV Fleet Managers
- Mobility Service Providers (MSPs)
- Site owners (building, parking, work-place, public)
- Organisations representing the above
- Charge Point Operators (CPOs)
- Distribution System Operators (DSOs)
- Transmission System Operators (TSOs)
- Original Equipment Manufacturers (OEMs)
- Consultants in EV deployment and energy market
- Balancing Service Providers (BSPs)
- Aggregators
- Policy-makers
- Standardisation bodies
- European Institutions (DG MOVE, DG ENER, DG CONNECT, DG GROW, EP, JRC)

Structure of the deliverable

This document is divided into 5 chapters, with relevant subchapters. The first chapter is an introduction to the consumer behavior report and offers relevant definitions and background to the topics discussed in later chapters. The following chapters assess EV drivers' charging behavior, with an in depth focus on home charging. Following that, there is a subchapter on EV drivers' perceptions and habits with regards to smart charging. Then a subchapter on vehicle-to-everything is included to analyze perspectives and attitudes toward a new and relatively unfamiliar technology to most EV drivers. The last subchapter before the conclusion looks at different surveys that have examined barriers toward becoming an EV driver among non-EV drivers. The conclusion summarizes the findings in this first edition of the consumer behavior report and elaborates what is needed in the next editions of the report.



“Many EV drivers are already charging smart in Norway and the Netherlands. The potential to increase that amount and charge even smarter is also present, especially in the Netherlands where 68% of EV drivers own solar panels.”

1 Context

While the uptake of EVs increases at high speed in Europe, the need to understand EV drivers' expectations, preferences and challenges grows. SCALE is aiming to achieve smart charging alignment for Europe, paving the way for achieving Europe's Fit for 55 ambitions.

This report assesses customer expectations, identifying EV-users' preferences and existing obstacles related to charging. The report will provide a broad insight into how EV drivers charge their cars, how they experience different types of charging, and what challenges they face. Furthermore, the report focuses on EV drivers' experiences with alternating current (AC) charging and especially smart charging. Smart charging is defined as "to control and optimize the time and speed of charging" (de Brey, Gardien & Hiep 2021).

The report will also discuss EV drivers' perception towards Vehicle-to-X (V2X), which can be explained as using the storage capacity of the EV battery for non-mobility purposes. Moreover, V2X can be referred to as Vehicle-to-everything and is a term that describes using the power stored in the EV to power for example a home (V2H), a neighborhood and so forth (de Brey, Gardien & Hiep 2021). Another part of V2X is called Vehicle-to-Grid (V2G). This means to have your car act as a power supply that can deliver energy back to the power grid. This can also be referred to as "bidirectional charging" or "power recycling" (de Brey, Gardien & Hiep 2021).

There are few studies that have researched this topic, especially with survey data (Sharp, R., Delmonte, E., & Jenkins, R. 2019; de Brey, Gardien & Hiep 2021; Grøndahl et.al. 2019). Particularly studies about EV drivers' perceptions of V2X are uncommon. The few studies that investigate EV drivers' behavior are often done in countries with relatively high EV uptake (e.g. European Nordic countries, the Netherlands, the US).

One of the goals in SCALE is to research potential barriers and experiences related to smart charging and V2X in other countries with lower EV uptake. The results from such countries might differ from results from countries with high EV uptake. Therefore, new editions of this report aim to include survey data from countries that are previously not studied at a high extent.

Updated versions of task 1.1

This report will be updated in a second version during the fall of 2023 (month 16), and a third version in month 32 of the SCALE project. We hereby openly invite any organization wishing to send input on what they deem relevant to include in the second version of the report.

1.1 EV adoption in Norway and the Netherlands

The EV share of new car sales in Norway in Q3 2022 was 75% (OFV 2022). Furthermore, PHEV accounted for 11.5% of the sales. In total today there are 531.000 EVs on Norwegian roads (OFV 2022). This makes Norway a great place to study EV drivers' behaviours and opinions. The Norwegian EV drivers today do not only consist of "first movers" and many have had an EV for 5 years or more. The Norwegian parliament has set a target that says Norway shall have 100 percent zero-emission vehicle sales in 2025. This does not mean that the Norwegian parliament has adopted a ban on fossil fuel cars, only that the country is working towards a goal of 100 percent zero-emission vehicle sale in 2025.

In the Netherlands the EV share of new car sales in Q3 2022 was 23% (ACEA 2022a). This is high compared to Q3 2022 numbers for EU in total (11.9%). It is also a distinct increase from Q1 numbers the same year, where the EV share of new car sales was at 16% (ACEA 2022b). So far this year the BEV share in the Netherlands is at 21% (ACEA 2022a). In total today (September 2022) there are 478.000 electric passenger cars (EV) on Dutch roads (Netherlands Enterprise Agency 2022).

1.2 The European energy crisis

Europe is currently facing an energy crisis, with electricity prices increasing to highs never seen before. The increasing prices and the following media attention on the topic, might have affected EV drivers' charging behaviour the last year. It is natural to believe that EV drivers have become more price-conscious and have tried to avoid charging their car when prices peak. This will be studied further.

Furthermore, it is natural to assume that the type of electricity contract a household has, has mattered more the last year than before. Whether a household has a contract with fixed tariffs or tariffs that vary according to supply and demand, will probably have different effects on EV drivers' charging behaviour. Households with electricity contracts that have fixed tariffs will not have the same incentives to change behaviour and use of electricity. On the other hand, EV drivers who have an electricity contract where price varies according to supply and demand, will have a larger incentive to change charging behaviour accordingly.

In Norway the most common is to have smart meters and electricity contracts with tariffs that vary according to supply and demand. In the Netherlands a fixed tariff is at the moment most common, although electricity contracts with flexible tariffs are also being introduced.

2 Methodology & approach

The first edition of the consumer behavior report relies mainly on surveys through digital questionnaires already conducted in Norway, Netherlands, Sweden, Denmark, Iceland and Finland by partner organizations in the SCALE project. The main results studied are from the Norwegian EV driver survey 2022 conducted by the Norwegian EV Association, and the Dutch National Charging Survey conducted by Elaad and VER (the Dutch Electric Vehicle Drivers Organization).

The respondents of the Norwegian EV driver survey are only EV drivers in Norway. The Dutch National Charging Survey has surveyed both EV and plug-in hybrid (PHEV) drivers. The survey in the Nordic countries of Norway, Sweden, Iceland, Finland and Denmark, is called The Nordic EV Barometer and is conducted by Opinion on behalf of the Norwegian EV Association and Nordic Energy Research. This is a representative population survey with a fixed group of 1000 respondents from each country. The respondents are eligible car owners in each country.

Not all respondents answered all questions, the correct number of respondents to a given question will therefore be shown by the letter “N”, and it will be specified whether the N consist of only EV drivers or other car owners.

Additionally, this report includes other relevant research and scientific studies of smart charging and Vehicle-to-X. This is to include a broad consumer perspective in the first edition of the consumer behavior report in SCALE, with relevant available data. Other research projects and scientific articles might have access to other databases and consumers than partners in SCALE do, therefore the report includes results from other sources where this is regarded as relevant or interesting.

2.1 The Norwegian EV driver survey

The Norwegian EV driver survey has been conducted by the Norwegian EV Association on an annual basis since 2012. The EV driver survey of 2022 was sent out to 120.000 possible respondents in April. Respondents were mainly acquired through the Norwegian EV Association’s list of newsletter contacts. The total number of respondents in 2022 is 16.581, which gives a response rate of 12%. The survey asked for information about the respondents’ last year as an EV driver. The population of the survey is EV owners living in Norway. The sample consists of both members and non-members of the Norwegian EV Association. A digital survey was sent to the respondents by e-mail, and the average response time was 22 minutes.

The size of the sample makes it fully representative of EV drivers in Norway. However, since the sample is not weighted on different background variables, it is probably skewed in comparison to the general population of car owners in Norway. The majority of the respondents own new EVs, which is not surprising since EVs are still a relatively new technology. Although, when we compare EV ownership in the survey results and total EV fleet numbers, we find that the top ten EV models from among the

respondents in the survey, largely correspond with the top ten EV models in the Norwegian fleet. This is an indication that the sample corresponds reasonably well with the total population of EV drivers and is an indication of the survey's representativeness.

76% of the respondents in the survey are male. This might seem like an overrepresentation in the sample, but a similar gender distribution can be found in other EV driver studies (Figenbaum & Nordbakke 2019; de Brey, Gardien & Hiep 2021).

2.2 The Dutch National Charging Survey

The National Charging Survey is an annual, large-scale survey among Dutch EV drivers. Respondents were recruited through various partners and media channels, such as newsletters and online media, with the aim of taking a sample that is as representative as possible. 2.957 respondents started the survey and 2.241 completed the survey. The survey was conducted from April 11th to June 1st 2022. The survey asked for information about the period April 2021 to March 2022.

A comparison of car ownership in the survey and in the fleet, shows that the top ten EV models from this survey largely corresponds with the top ten EV models in the Netherlands. This is an indication that the sample corresponds well with the total EV driver population and is also an indication of the survey's representativeness.

2.3 The future SCALE survey

As part of SCALE a new survey will be conducted in more European countries to map expectations and barriers towards smart charging and V2X in all of Europe. The survey aims to collect insights on motivations related to V2X adoption (financial, environmental, technological or social benefits). Furthermore, the survey will try to discover potential price barriers, for example how much an EV driver is willing to pay for a V2X system compared to a normal home-charging system. It is also highly relevant to map what EV drivers hope to gain from V2X, and which type of V2X they deem as relevant and attractive from their point of view, for example Vehicle-to-Home, Vehicle-to-Grid or other.

Furthermore, the survey aims to collect insights related to V2X barriers, like potential battery degradation impact from discharging the vehicle, fear that the vehicle won't be charged enough by time of leave, lack of being in full control of the charging process when external control is being applied, and so forth. Moreover, it would be relevant to try and map trust levels in terms of handing over control for optimizing charging and discharging cycles to a third party, like an original equipment manufacturer (OEM), energy supplier, grid operator, or charge point provider.

3 Who are the EV drivers?

As with internal combustion engine (ICE) cars, the majority of the EV drivers in Norway are male and between the age of 45-66 years (Fevang, Figenbaum, Fridstrøm, Halse, Hauge, Johansen & Raaum 2020). Most own their EV and have bought it new and not used. This is not surprising considering an EV can still be considered a relatively new technology. Only 5% of the respondents lease their EV. In contrast, in the Netherlands most EV drivers drive a leased car. New EV drivers are well represented in both the Norwegian EV driver survey and the Dutch National Charging survey. In the Norwegian survey the new EV driver (driving electric for one year or less) makes up a total of 36% of the respondents, compared to 43% in the Dutch survey.

In Norway, 73% live in detached homes and 26% live in appartement buildings. 97% of the respondents in the Norwegian survey have access to their own parking spot, and 83% have installed a home-charging box. In comparison 36% of the Dutch population live in apartment buildings (StatLine 2022). Furthermore, only 41% of the Dutch population have a private parking spot (ANWB 2021). Anyhow, 67% of the Dutch EV drivers have installed a home charger. This shows that Dutch EV drivers are not representative for the Dutch population in total. EV drivers in the Netherlands are wealthier compared to other groups, this might therefore explain the overrepresentation of EV drivers having their own parking spot and installed a home charger.

The Dutch EV drivers drive on average 18.500 kilometer per year (2021-2022). In comparison the majority of the Norwegian EV owners drive around 12-16.000 kilometers per year. These results might be affected by Covid 19 restrictions, that have impacted drivers' behaviors differently from country to country. These results are therefore not representative for a normal year, and other surveys might yield different results in terms of average kilometers driven throughout a year.

4 Charging habits and patterns

Estimations based on results from the Norwegian EV driver survey in 2021 show that Norwegian EV drivers do 80% of their charging at home. Furthermore, results from the survey in 2022 show that 23% of Norwegian EV drivers charge daily at home, 31% charge every 2-3 days and 25% charge weekly at home. Only 1% of Norwegian EV drivers use public normal charging stations daily, 3% use it every 2-3 days and 7 percent use it weekly. Lastly, 24% claim they never use it. It is quite clear that the Norwegian EV drivers mainly charge at home.

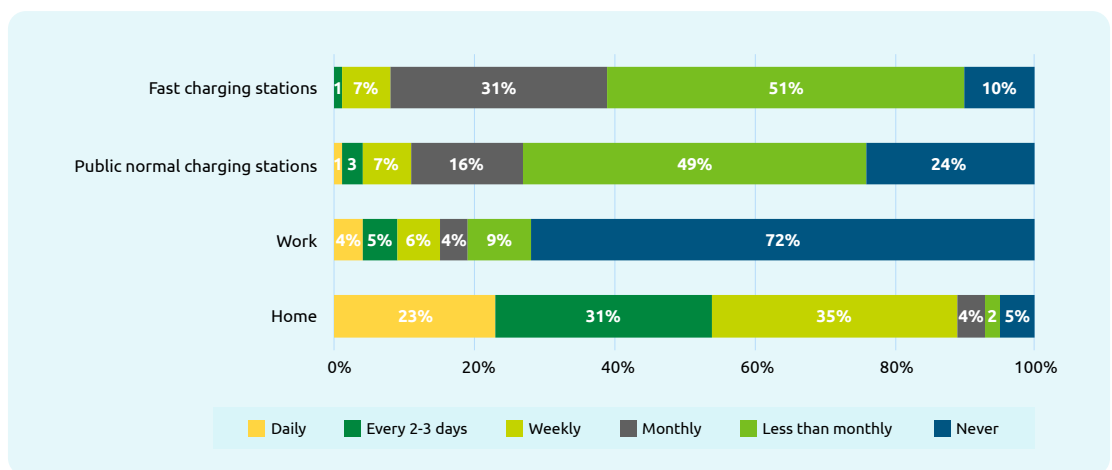


Figure 1: How often do you charge - The Norwegian EV driver survey 2022. N=15.076

The same goes for Dutch EV drivers. In the Dutch National Charging Survey, results show that 44% of the kilometers driven with an EV are charged at the private charging station at home, 7% at the normal electricity socket at home, 21% at the public charging station near home, 13% at the charging station at work, 9% at the fast charger, 7% at the public charging station elsewhere and 1% at a socket elsewhere.

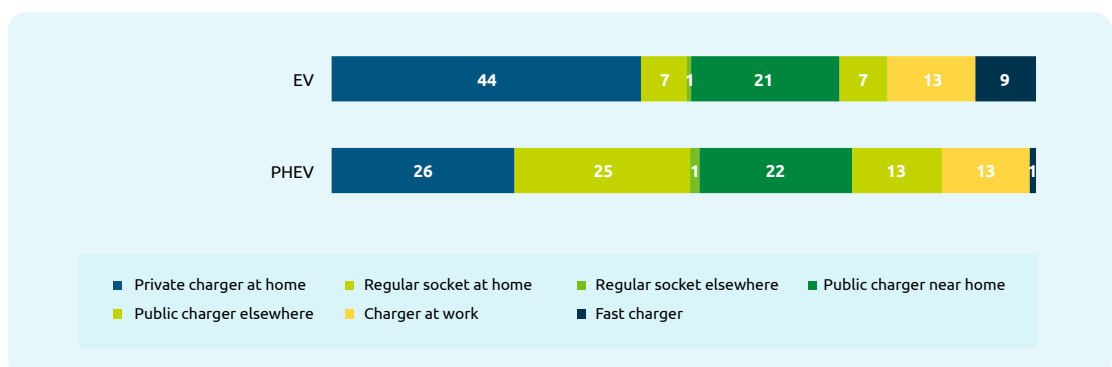


Figure 2: Percentage charged kms per charger type for PHEV and EV - The Dutch National Charging Survey. EV N= 2344, PHEV N=190.

When Dutch EV drivers are asked how often they charge on average per month at different charging facilities, the results show that on average the EV drivers charge two times a month at a fast-charging station, four times a month at a charging station at work, five times a month at public charging stations near home, and eleven times at the private charging station at home.

4.1 Charging at home

Most Dutch EV drivers (64%) charge at fixed times. There is a peak around 18.00, and at the start of the lower night-time electricity tariff in the Netherlands (21.00 in Brabant and Limburg and 23.00 in the rest of the country). Since 72% of Dutch charging sessions takes place at home, the EVs are usually removed from the charger in the morning. There is also a small peak of disconnected vehicles at the end of the working day, around 17.00.

In Norway, most EV drivers that charge at home do so during the night.

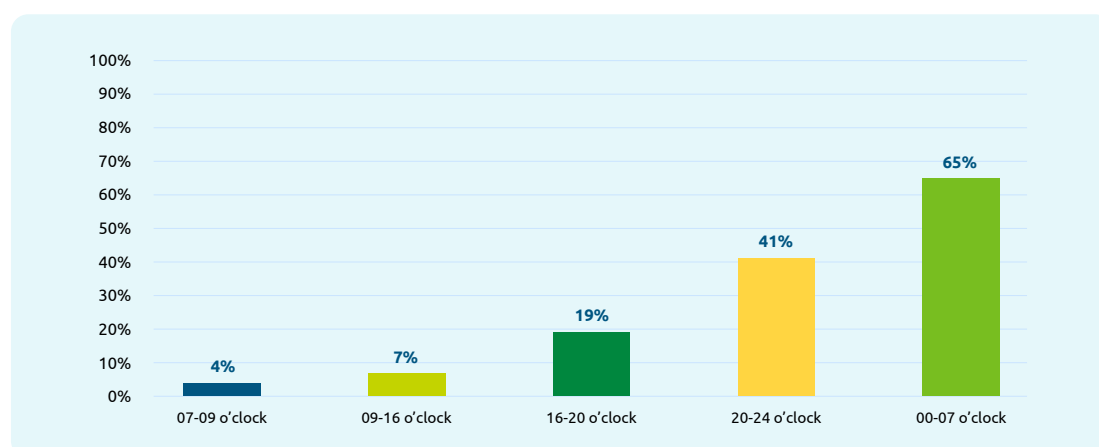


Figure 3: At what hours do you normally charge your EV? The Norwegian EV driver survey 2022. N=14,302

65% of Norwegian EV drivers say that they charge their car between midnight and 07.00. Consequently, Norwegian and Dutch EV drivers share one peak related to home charging (around 23.00-0.00 o'clock). Although, since there is a peak in the Netherlands at 18.00 o'clock and no such peak exists in Norway, the results show that Norwegian EV drivers charge during nighttime to a slightly higher extent than the Dutch EV drivers.

73% of Dutch EV drivers with a charging point at home charge on a 3-phase charger. In Norway, the most common charging solution among the EV drivers (35%) is a charging box with maximum effect of 7.4 kW. It is important to add that as much as 19% do not know the maximum effect of their charging box in Norway.

4.2 Does price affect charging behaviour?

Energy prices in Europe the last year have been at record highs during longer time periods. The explanations for why this is the case are complex and will not be discussed in this report. Anyway, Norwegian EV drivers for example, have experienced a 144 percent increase in electricity prices from

august 2021 to august 2022 (SSB 2022). This has had an effect on the EV drivers' behavior. When we ask Norwegian EV drivers that say they charge during the night why they charge at that time, 68 percent of them say they charge during nighttime because it is cheaper. 45% say they do so because it is more practical.

This is a complete shift in survey results compared to 2021. In 2021 the majority of the Norwegian EV drivers said they charged during nighttime because it is the most practical (55%), and 47% said they charged during nighttime because it is cheaper. In summary, the amount of EV drivers that charge during nighttime in 2021 and 2022 have stayed stable, but in 2022 the reasoning has changed among the majority of the EV drivers. Therefore, it is natural to assume that the prices on electricity and the attention that topic has received in the public, have had an effect on the consumers and made them change their explanation for their behavior.

On the other hand, 66% of Dutch EV drivers indicate that they will not change their charging behavior as a result of rising energy prices. The Dutch survey was conducted in May and the situation might therefore have changed since. Regardless, the results are completely different than in the Norwegian survey, which is interesting for the follow-up studies that will be done during the SCALE project. Even though 66% of Dutch EV drivers will not change charging behavior due to energy prices, there are 44% who will. Amongst them, 18% will look more closely at where charging costs are lowest, 11% will do less fast charging or simply drive less (5%).

When attempting to explain the differing results from the two surveys, several factors have to be addressed. Norwegian and Dutch households do not have the same type of electricity contract, and price level differ between the two countries. Furthermore, since the two surveys have formulated the questions regarding this topic differently, the wording might be one of the explanations. Regardless, this is a topic that the next edition of the consumer behavior report will study further. The SCALE consumer behavior survey must strive to examine whether there is in fact such a difference in adaption to rising energy prices among EV drivers in the two countries. If it is the case, the survey must also address and try to answer why that is.

4.3 Smart charging

Smart charging is achieved by aligning the time, speed, and charging method with the EV driver's preferences and prevailing market conditions (de Brey, Gardien & Hiep 2021).

When asked whether they are willing to charge smart, 82% of Dutch EV drivers say that they are. More than half of the Dutch EV drivers are familiar with smart charging (52%). 54% of Dutch EV drivers can smart charge at home and 22% are connected to a smart energy management system. They mainly see it as a smart use of the capacity of the electricity network and smart charge in particular at their charger at home, either by charging with their own solar energy or by charging at night outside peak hours. Furthermore, the survey shows that 68% of Dutch EV drivers have solar panels, and 95% of them would like to use solar power for charging or are already doing so. The adoption of solar panels among Dutch EV drivers is very high. This implies two things: 1) the potential to smart charge through using private solar power is also very high, 2) the high amount of private ownership of solar panels might decrease as larger groups of the population make a shift from a fossil fuelled car to an EV.

39% of Norwegian EV drivers control the charging of their car at home through the EV or the EV's app. 25% control it through the home charger or the home charger's app, and 10% control it through a different app/third party. Consequently, 74% of Norwegian EV drivers smart charge at home. This is a huge increase from last year's survey. In 2021 35% of the Norwegian EV drivers controlled the charging of their car at home through the EV or the EV's app, only 16% did it through the home charger or the home charger's app, and 7% did it through a different app/third party. Especially the share of smart charging through the charging box or the charging box's app have increased a lot in a year. Moreover, when we look at the respondents that replied that they control charging through the charging box or the charging box's app, we see that most of them are new EV drivers (34%). This might be an important explanation to the high increase in the results from last year.

Dutch EV drivers want smart charging to be "easy" (87%) and there is a need for insight in (76%) and control over (73%) the smart charging session. Paying less and charging faster at times of abundance of energy is classified as "acceptable". Paying more at moments of scarcity or other less optimal moments score in terms of acceptance between "neutral" and "agree". The main reason for smart charging is "Making optimum use of sustainable energy". The biggest barrier among Dutch EV drivers is the fear that the car is not charged as much as the driver would prefer.

In the UK, a study about smart charging has found that when EV and ICEV owners were to decide which smart charging options are or would be most suitable to them, participants were most likely to consider factors related to saving money and the environment (Sharp, R., Delmonte, E., & Jenkins, R. 2019). EV drivers in the study placed greater emphasis on being environmentally friendly than ICE vehicle drivers. Furthermore, convenience of use and the assurance of a minimum level of charge for upcoming journeys were also key considerations (Sharp, R., Delmonte, E., & Jenkins, R. 2019).

4.4 Vehicle-to-X (V2X)

The next step in Smart Charging is using the car for energy storage for purposes other than driving. This means that you not only use power as required by the car for driving, but that your car acts as a power supply. This technique is commonly referred to as V2G (Vehicle-to-grid) or V2X (Vehicle-to-everything). Others speak of bidirectional charging or “power recycling”. The power stored in your car can, for example, be used to power your own home, the neighborhood, or even fed back into the grid (de Brey, Gardien & Hiep 2021).

The Norwegian EV driver survey has so far not included any questions related to V2X. This will change in the updated version of the SCALE consumer behavior report in the fall of 2023.

The Dutch National Charging survey 2022 has addressed especially Vehicle-to-Grid. The respondents were presented with the formulation:

New technologies will make it possible in the future to store electricity generated (for example from our own solar panels) in car batteries and use it at another time in the house or supply it back to the power grid. In this way smart use can be made of the times of lower and higher electricity prices and fluctuations on the grid can be absorbed by solar or wind energy. This means that sustainable energy is used even more effectively. It can also make households more self-sufficient in their power consumption. This is called “Vehicle-to-Grid.”

The respondents were then asked to rate how important a set of reasons would be to participate in V2G on a scale of 1 (strongly disagree) to 5 (strongly agree). The results (see table 1) show that Dutch EV drivers find sustainability and self-sufficient power consumption at home the most important arguments for adoption of V2G. Contributing to a stable grid and financial advantage are rated as slightly less important. Furthermore, there is nothing in the results that show a difference in opinions between experienced and new EV drivers.

How important are the following reasons to participate in V2G?	Average on a scale from 1 to 5
Financial gain	3,7
Higher partition of durable energy usage	4
Contribute to a stable grid	3,9
More self-sufficient at home	4,1

Table 1: Importance of reasons to participate in V2G. The Dutch National Charging Survey 2022

Another interesting study was conducted by Shell Recharge Solutions in 2022. This study also asked a question about smart charging and V2G. It is unclear how the respondents in the survey were collected, but Shell states to have surveyed 14.991 current EV drivers in five countries: UK (2.853), France (1.587), Germany (6.272), Netherlands (4.145), and Belgium (134). These respondents might be exclusively customers of Shell Recharge’s charging solutions.

Results show that 79% of the respondents would be willing to schedule a charging session later in order to prevent a peak in the energy demand. Furthermore, 66% would be interested in receiving financial benefits to allow their EV's battery to be used to support renewable energy. 59% believe that smart charging would be a good way of encouraging more people to drive EVs. Additionally, 57% would be willing to accept slower charging in order to help maximize national renewable energy usage. Lastly, only 41% would be willing to pay a bit more for a charge point when this delivers smart services. Especially the results to the last statement must be taken with a pinch of salt if all respondents are customers of Shell Recharge's charging solutions.

Statements	Percentage agreement with each statement
Would be willing to schedule a charging session later in order to prevent a peak in the energy demand	79%
Would be interested in receiving financial benefits to allow my EV's battery to be used to support renewable energy	66%
Believe that smart charging would be a good way of encouraging more people to drive EVs	59%
Would be willing to accept slower charging in order to help maximize national renewable energy usage	57%
Would be willing to pay a bit more for a charge point when this delivers smart services	41%

Table 2: Statements from Shell Recharge solutions EV driver report 2022

Additionally, a study conducted on 4000 electric energy consumers in Spain, France, Italy and Denmark, examined motivations towards using V2G (Bohdanowicz, Z.; Kowalski, J.; Biele, C. 2022). The results demonstrate differences in the effects of additional remuneration for using vehicle-to-grid stations, depending on users' reasons for saving electricity. Consumers with financial motivations are sensitive to economic incentives; the higher the remuneration for using V2G, the more willingness they show.

On the other hand, consumers with intrinsic and ecological motivations also show willingness to use V2G, but the researchers find no relationship between the size of the rewards and consumers' willingness to use the technology. That group is similarly encouraged by low (and extra 2.5% of energy for free) and high (an extra 20%) rewards (Bohdanowicz, Z.; Kowalski, J.; Biele, C. 2022). In contrast, consumers who show intrinsic general modesty (willingness to not waste things), the results show that motivations might even be discouraged. The researchers find that the higher the reward, the less interest they demonstrate in V2G. The article illustrates how different types of motivation can affect users' interest in the innovative V2G (Bohdanowicz, Z.; Kowalski, J.; Biele, C. 2022).

4.5 Different charging behaviour related to gender?

In the Norwegian EV driver survey 2022, there are only two relevant questions that can be aggregated on gender level and analyzed in a useful manner. "When do you charge your EV" and the follow-up question to the drivers that charge during nighttime "Why do you charge during night?". More men charge their EV during nighttime (0.00-07.00); 68% compared to 55% of women. When asked why they charge during

nighttime, 7% more of the men say their app controls their charging to this time (18%). Furthermore, 7% more of the men say they do not want to strain the power grid during daytime (31%). 6% more of women say they do it because it is most practical for them to charge during night (50%). Lastly the same amount of men and women say they charge during nighttime because it is cheaper (68%).

In the Dutch survey, only 9% of the respondents identified as female. No cross relations between the answers of the respondents, based on their gender, have been listed in the survey report.

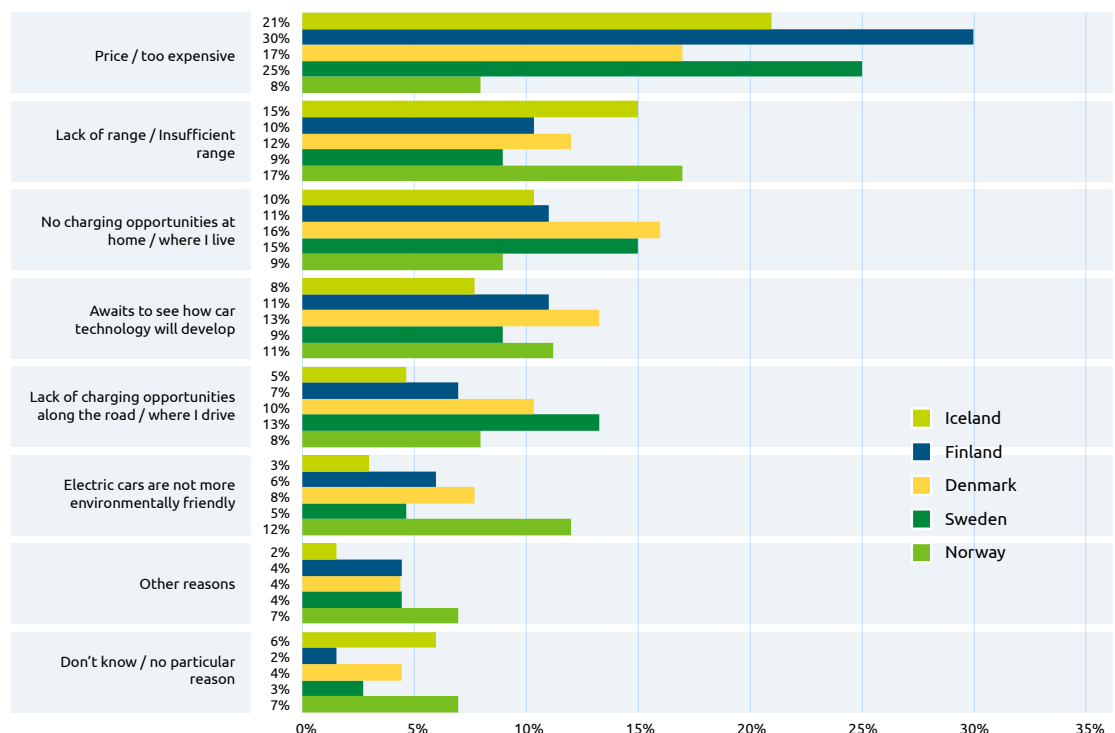
In the SCALE survey it will be relevant to ask where people would prefer that the smart charging is being controlled from. Whether they would like to do it through an app, that the charging box just takes care of smart charging, that the car charges smart and so forth. Such a question could be relevant to study on gender level because men and women might have different preferences in relation to smart charging and vehicle-to-everything (V2X).

4.6 Charging is a barrier among non-EV drivers

The Nordic EV barometer is a survey conducted in the Nordic countries of Norway, Sweden, Iceland, Finland, and Denmark. It is a representative population survey with 1000 respondents from each country. The respondents are eligible car owners in each country.

In this survey the respondents are asked what their next car will be. Many say EV, but those who do not answer EV get a follow-up question of why that is. Here we find interesting results. A majority of the respondents say it is due to the price of the car, but “no charging opportunities at home/where I live” is the second highest rated barrier in Sweden and Denmark. In Iceland and Finland, it is rated as the third barrier, and in Norway it’s the fourth barrier. When we look at all the Nordic countries put together, the average rating ranks “no charging opportunities at home/where I live” as the third barrier towards buying an EV.

Figure 4: Barriers toward buying an EV. Iceland, N=519. Finland, N=647. Denmark, N=506. Sweden, N=567. Norway, N=391.



Furthermore “Lack of charging opportunities along the road/where I Drive” is ranked as the fifth barrier towards buying an EV in the Nordic countries. This is especially regarded as an important barrier amongst respondents in Finland and Sweden.

Another relevant population survey is conducted by ANWB in the Netherland (ANWB 2021). The survey is called Electric Driving Monitor 2021 and has been conducted the last five years. The results from 2021 show that “too few charging stations” is listed as the fourth most important reason not to buy an EV. Furthermore, the sixth reason not to buy an EV is “no possibility to recharge”. Another interesting result from the Electric Driving Monitor 2021 is that people without a private parking space regard the charging infrastructure as a bigger barrier than people with a private parking space. Although this might not be shocking, it is still important to make note of since we know from chapter 3 in this report that Dutch EV drivers with a private parking spot are overrepresented, and therefore it is likely that the part of the Dutch population that are not yet EV drivers are to a higher extent people without a private parking spot.

These surveys show that lack of charging opportunities can be regarded as an important barrier to overcome in the Netherlands and the Nordic countries, as Europe strives to reach 100 percent share of electric vehicles in new car sales, from 2035 in the EU with more ambitious goals for Norway (2025) and Netherlands (2030).



“When EV drivers’ wants and needs regarding V2X technology are analyzed, the results seem to show that financial incentives are important among a majority. Many are also motivated by a renewable energy mix and self-sufficiency.”

5 Conclusions

EV drivers mostly charge at home, but the timing of their charging differed among the studied countries. In the Netherlands, peak hours for charging at home was at 18.00 and in the evening (21.00-23.00). In Norway most EV drivers charge during the night. Furthermore, it appears as though Norwegian EV drivers are more likely to change charging behaviour dependent on price levels when we compare with Dutch EV drivers' charging habits. One explanation might be different electricity contracts and the timing of the surveys that were analyzed in this report. Consequently, this will have to be analyzed further in the second edition of this report.

Both in Norway and in the Netherlands many EV drivers already utilize smart charging technology and are consequently charging smart. This is done either through a smart home charging box, through the EV's app, or through another app/third party. In the Netherlands 82% of EV drivers are willing to smart charge, while 54% are doing so today. 22% of EV drivers are connected to a smart energy management system. Furthermore, the possibility to charge even smarter seems high when the results from the Dutch charging survey are analyzed. With 68% EV drivers owning solar panels, there are opportunities for Dutch EV drivers to charge even smarter.

When EV drivers' wants and needs regarding V2X technology are analyzed, the results seem to show that financial incentives are important among a majority. Many are also motivated by a renewable energy mix and self-sufficiency.

Furthermore, consumers in many Nordic countries list "no charging opportunities at home/where I live" as one of the top barriers for them to overcome before buying an EV. These results are important to make note of. If a majority of consumers who are not yet EV drivers does not have an opportunity to install a home charger, this can affect their ability to adopt smart charging and V2X technology. When the goal of the SCALE project is to achieve smart charging alignment for Europe, this is important to take into account when assessing future needs and paving the way towards high uptake of smart charging and V2G.

References

-
- ACEA (2022a).** Fuel types of new cars. 3 November 2022. Available online: <https://www.acea.auto/fuel-pc/fuel-types-of-new-cars-battery-electric-11-9-hybrid-22-6-and-petrol-37-8-market-share-in-q3-2022/>
-
- ACEA (2022b).** Fuel types of new cars. 5 May 2022. Available online: <https://www.acea.auto/fuel-pc/fuel-types-of-new-cars-battery-electric-10-0-hybrid-25-1-and-petrol-36-0-market-share-in-q1-2022/>
-
- ANWB (2021).** The Driving Electric Monitor. URL: <https://www.anwb.nl/belangenbehartiging/duurzaam/elektrisch-rijden-monitor-2021>
-
- Bohdanowicz, Z.; Kowalski, J.; Biele, C. (2022).** Intentions to Charge Electric Vehicles Using Vehicle-to-Grid Technology among People with Different Motivations to Save Energy. *Sustainability*, 14, 12681. <https://doi.org/10.3390/su14191268>
-
- de Brey, B.; Gardien, L.; Hiep, E. (2021).** "Smart Charging Needs, Wants and Demands; Charging Experiences and Opinions of EV Drivers". *World Electric. Veh. J.* 12, 168. <https://doi.org/10.3390/wevj12040168>
-
- Fevang, E., Figenbaum, E., Fridstrøm, L., Halse, A., Hauge, K., Johansen, B. & Raaum, O. (2020).** Who goes electric? Characteristics of electric car ownership in Norway 2011-2017. TØI Report: 1780/2020. Available online: <https://www.toi.no/publikasjoner/hvem-velger-elbil-kjennetegn-ved-norske-elbileiere-2011-2017-article36389-8.html>
-
- Figenbaum, E. & Nordbakke, S. (2019).** Battery electric vehicle user experiences in Norway's maturing market. TØI Report: 1719/2019. Available online: <https://www.toi.no/publikasjoner/elbil-brukererfaringer-i-et-marked-under-modningjar-article35708-8.html>
-
- Grøndahl S., Lorentzen, E. & Haugneland P. (2019).** Experiences from Norwegian EV owners – Using the EV for all purposes. EVS32 Symposium Lyon, France.
-
- OFV (2022).** Opplysningsrådet for veitrafikken. <https://ofv.no/>
-
- RVO (2022).** Statistics Electric Vehicles and Charging in The Netherlands. Available online: <https://www.rvo.nl/onderwerpen/elektrisch-rijden/cijfers>
-
- Shell Recharge Solutions (2022).** The EV Driver Survey Report 2022. Available online: <https://shellrecharge.com/en-gb/solutions/knowledge-centre/reports-and-case-studies/ev-driver-survey-report>
-
- Sharp, R., Delmonte, E., & Jenkins, R. (2019).** Smart electric vehicle charging: what do drivers and businesses find acceptable? PUBLISHED PROJECT REPORT PPR903.
-
- SSB (2022).** Electricity prices. URL: <https://www.ssb.no/en/energi-og-industri/energi/statistikk/elektrisitetspriser>
-
- StatLine (2022).** Woningvoorraad; woningtype op 1 januari, regio. 21 September 2022. Available online: <https://opendata.cbs.nl/statline/#/CBS/nl/dataset/85035NED/table?ts=1667479856425>

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