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EV Users' Needs and Concerns - Preliminary Report

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Disclaimer

This document has been produced in the context of the EV4EU[1] project. Views and opinions expressed in this document are however those of the authors only and do not necessarily reflect those of the European Union or the European Climate, Infrastructure and Environment Executive Agency (CINEA). Neither the European Union nor the grating authority can be held responsible for them.

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[1] https://ev4eu.eu/

Executive Summary

The deliverable *EV Users' Needs and Concerns - Preliminary Report* collects information regarding the preliminary models concerning the different roles, needs, and behaviours of EV users.

The objective of this deliverable is to report what was uncovered during the research planned for task 3.1 of the EV4EU project, which included for all participating countries: one-on-one semi-structured interviews with key stakeholders to identify the different roles, needs, and behaviours; quantitative surveys; EV users "shadowing" to better understand the context of EV use, and evaluate the interaction with the city and other types of users.

Table of Contents

List of Figures

List of Tables

Acronyms

BEV	Battery Electric Vehicle[2]
DEMS	Društvo E-Mobilnost Slovenija (E-mobility society for Slovenia)
DSO	Distribution System Operator
EV	Electric Vehicle[3]
EV4EU	Electric Vehicles Management for Carbon Neutrality in Europe
ICEV	Internal Combustion Engine Vehicle
PHEV	Plugin Hybrid Electric Vehicle
ROI	Return on investment
TSO	Transmission System Operator
VPP	Virtual Power Plant
V2G	Vehicle-to-Grid
V2V	Vehicle-to-Vehicle
V2X	Vehicle-to-Everything

[2] Fully electric vehicles
[3] BEVs and PHEVs

1 Introduction

The Electric Vehicles Management for Carbon Neutrality in Europe (EV4EU) project proposes and implements user-centric Vehicle-to-Everything (V2X) management strategies that set the stage for mass deployment of electric vehicles (EVs).

Large-scale adoption of EVs can be successful if there's a better understanding of users' needs and concerns, and cater to them in the project. This deliverable intends to identify the different roles, needs, and behaviours of EV users across the countries included in this project and afterwards relate these results to the outcomes of the tests being implemented in each demonstrator for EV4EU.

1.1 Scope and Objectives

In this document, the results obtained by applying different methods of collecting data regarding users' needs and concerns about EV use in four different countries are presented, namely Denmark, Greece, Portugal and Slovenia.

1.2 Structure

This deliverable is divided into two parts. In the first chapters (from 4 to 7), the data collected from each country is presented, and main insights are identified. Chapters 8 and 9 aim to cross-reference all information gathered from different countries, to make a transversal analysis and identify points of interest to be developed in the following EV4EU tasks, namely Task 3.2.

1.3 Relationship with other deliverables

This deliverable will provide valuable information to the work being developed in task 3.2: *User-Centric Design Tools and APPs*, in task 3.6: *High-Level Design of V2X Management Strategies Coordination*, and in task 5.7*: Integration Between User Interfaces and Open V2X Management Platform.*

2 Methodology

The defined research protocol assumed the following methodology:

- **Literature review**, to highlight main topics to address when talking about EV adoption and V2X scenarios. These insights informed how to prepare the following steps of the methodology described;
- **City research template** from each demonstrator geography, to understand possible contextual barriers, as well as identify key stakeholders to consider in EV4EU project. City research template is available in APPENDIX A: City Research Template;
- **Interviews with identified subject experts**[4] (stakeholders' contacts collected through the city research template and other referrals), to characterize the current EV experience, possible needs and barriers from different players (energy providers, policy makers, etc.), and address V2X-related concerns. Script for the interview is available in APPENDIX B: Expert interview script;
- **Quantitative survey**, targeting EV users, with the goal of collecting information about EV daily uses, habits, needs and concerns, as well as exploring what a V2X scenario could entail, both in benefits and in concerns from the user's point of view. Questions asked are available in APPENDIX C: Survey questions;
- **Field research** in each country[5] (Ljubljana, Slovenia; Athens, Greece; São Miguel Island, Portugal), to immerse in contextual realities and debate possible specific approaches to tackle identified barriers, available in APPENDIX D: Field Trip Research Protocol. This included:
    - **EV user interviews**, where the main goal was to validate quantitative data collected with the online surveys, generate new insights, and better understand the context of driving an EV in different countries. By the end of each interview, participants were asked to show how they would charge their EV, from finding a charging station to connecting, and then disconnecting their car, which gave further clarification on how the charging infrastructure works in each country.
    - **Service Safari** method (only for Greece and Portugal[6]), which is a way of experiencing first-person a certain service or experience. In this case, the research team went through the task of renting and driving an EV around Athens and São Miguel Island, having the goal to find and charge in as many chargers as possible.
    - **Workshop with partners**, to present, discuss and validate collected insights, as well as ideate about possible solutions to tackle raised issues in each country.

Conclusions regarding gender and age-related behaviors and preferences were not possible to reach, since sample sizes are not big enough to have representative results. A wider sample should be tested, to include such tendencies.

[4] People considered having expertise in the field of EVs and Energy, as identified in each expert interview chapter.

[5] A field trip to Copenhagen, Denmark was also planned, but due to recruitment difficulties, we opted to postpone the trip and validate insights after D3.1 preliminary delivery date. New insights from the Danish field trip will be reflected on the final report.

[6] This methodology was only used in two countries due to an adaptation to the initial plan that was required, as explained in the chapters detailing each country's analysis.

3 Literature Review

To start understanding users' needs and concerns regarding EVs, the current EV context was first researched, as well as studies that already identify some known barriers and concerns.

Range anxiety is described as the main barrier to EV adoption, especially when talking about rural contexts. The needs for public charging vary significantly between urban and rural areas, since in the former area users can charge closer to home, while in the latter users need to move further away to assure charging availability. That means that relying only on highway infrastructure might not answer to all needs [1]. To mitigate this situation, probabilistic models can be created, according to [2], to predict where to place fast charging stations, but slow chargers have not been considered as part of these models, since there is a perception that this infrastructure is not as adequate for urban space.

Studies also demonstrate how EV adoption in public services can improve urban contexts. In this example, considering exchanging waste collection vehicles (garbage trucks) to electric ones can bring a more efficient and economical alternative, as well as reducing noise pollution at night [3]. Nevertheless, EV charging is seen as a major challenge for the electric grid, and studies show the need to push for daytime charging, to make the most out of day-time renewable sources [4].

Finally, EVs are associated with a plethora of digital platforms, that simply weren't part of the equation before. This digitalization of the driving experience can bring multiple benefits, but for now it seems to be uncoordinated, ending up causing constraints to users, rather than simplifying their lives [5].

From these findings, coupled with key impacting factors listed in [6] and the research team's own experience, it was seen that there are some assumptions regarding EV adoption that should be used as a starting point for the research efforts, such as:

- Main motivations and barriers for EV adoption, where the decision to have an EV can depend on economic, environmental, technological, cultural and even bureaucratic factors;
- Concerns associated to costs and return on investment (ROI), heightened by vehicle-to-grid (V2G) scenarios, especially battery degradation and a sense of fairness in energy exchange values;
- Energy and digital literacy levels, considering the assumption that people with higher literacy will be more prone to opt for an EV;
- The current charging infrastructure that can have a role in triggering both pricing and security uncertainties;
- The existence of different user profiles, which can require different needs-to-be-met.

4 EV user experience and interaction with the city in Slovenia

Slovenia is a European country with a population of 2 108 732 inhabitants, of which 1 732 182 are 18 years old or older, which means that around 82% of the population is old enough to drive [7].

At the end of year 2021, Slovenia had registered 1 189 457 passenger cars, of which 5413 were battery electric vehicles (BEVs) (0.45%) and 16 045 were hybrid (1.35%) [7].

4.1 Quantitative research

For the Slovenian quantitative study, the team shared the survey through the Prolific[7] platform, as well as on social media and through stakeholders' contacts. From these sources, 25 responses were gathered from people living in Slovenia, distributed by age and gender as seen in Figure 1.

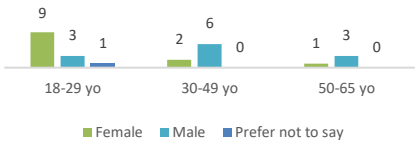

Figure 1: Gender and age group distribution of Slovenian respondents to quantitative survey.

To assess energy literacy, respondents were asked about different topics, including household related issues (topics 1 to 3 in Figure 2), equipment's electricity consumption (topics 4 and 5 in Figure 2), energy sources and generic technical concepts (topics 6 to 11 in Figure 2).

In Slovenia, population seems to have a good energy literacy overall, noting that the topics that raised more doubts amongst respondents were the more technical ones.

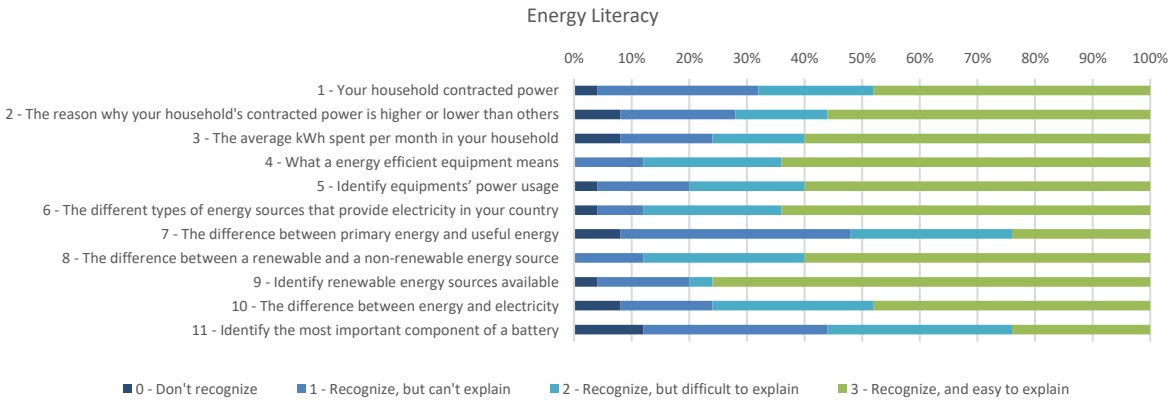

Figure 2: Perceptions of Slovenian quantitative survey respondents regarding several energy literacy related topics.

[7] https://www.prolific.co/ - online platform to recruit participants for quantitative surveys

As to how the population perceives EVs, they seem to be considered a better option than internal combustion engine vehicles (ICEVs) in most categories, as we see in Figure 3, except for easiness to “refuel”, indicating a clear concern with the charging availability.

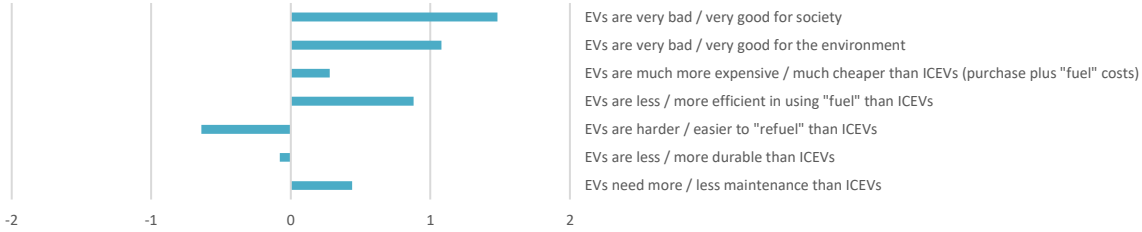

Figure 3: Perception of EVs in Slovenia, when compared with ICEVs (first adjective towards the negative numbers, and second adjective towards the positive number).

The concern about charging was reinforced by the question about what changed in their lives, before and after owning an EV, since the topic that surfaced the most was the need for increased planning for EV charging. This question also received a lot of positive feedback regarding increased comfort and convenience, enjoying driving more, economic savings and even time saved (perception that avoiding the gas station means saving time with that extra trip).

When asked about main motivations for acquiring an EV, Slovenian respondents’ motivators seem to be closely related with environmental and economic issues. The top motivators selected were:

- “Better for the environment, due to low CO2 footprint” (77%);
- “Cheaper ‘fuel’” (68%);
- “Less noise” (41%);
- “State incentives / benefits / discounts for electric vehicles” (41%).

EV users in Slovenia would appreciate assuring more and better fiscal benefits (fewer taxes) during the first 3 years of owning a new EV, as well as a compensation for exchanging their ICEV for an EV. Also, some respondents mentioned it would be interesting to provide free parking and free charging in public infrastructure in moments when the electricity consumption is lower than the production capacity.

In Slovenia, 19 out of 25 respondents (76%) would buy used EVs, mainly because they’re cheaper, and there’s a perception of being as reliable as buying a second-hand ICEV. They mentioned being concerned about battery status, and if the previous owner took good care of the car. But if they felt that the car is in good conditions, then a used EV would be a good option.

Finally, regarding charging habits, Figure 4 plots the correlation between the type of area where participants live in, the average distance they make each time they use their car, and the place they go more often to charge their EV. As seen in Figure 4, majority of participants travel between 20 and 50 kms

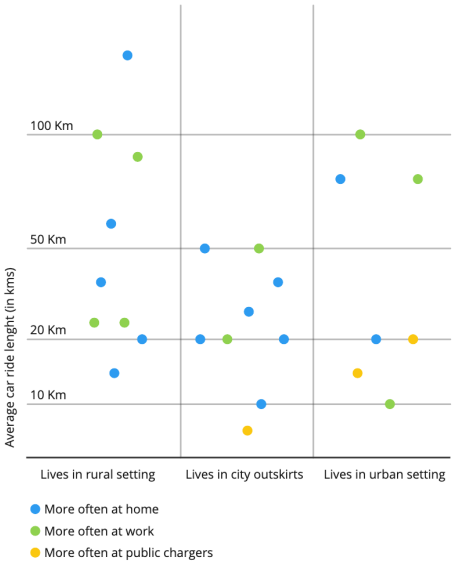

Figure 4: Correlation between type of residence area, average distance for each trip, where EV charges more often, in Slovenia.

for each trip, and tend to charge more at home, especially the ones living in the city outskirts or rural areas. Public chargers are mainly used by people that travel shorter distances.

4.2 Field research

To prepare for the field research, four different local stakeholders were inquired. They provided key insights about Slovenia's reality, mainly from an industry and academic point of view. After collecting those insights and analyzing data gathered from the quantitative surveys so far, EV users that lived in Slovenia, were recruited and interviewed. Finally, a workshop was conducted to validate collected insights with project partners.

4.2.1 Expert interviews

Four stakeholders were interviewed from the Electrotechnical department of the University of Ljubljana[8], Elektro Celje[9], Gen-I[10] and from Društvo E-Mobilnost Slovenija (DEMS)[11].

It was noted during the interviews that the perception that economic concerns are what weigh the most when considering acquiring an EV, and that ends up being the main barrier for its adoption. Following this, the reported lack of charging infrastructure and the perceived "lack of range" associated with EVs also constitute barriers, leading to a mentioned assumption that BEVs are only good for "within the city" travel, whilst plugin hybrid electric vehicles (PHEVs) are a safer option for longer distances. Besides that, there is also the perception that EV owners have the possibility to charge at home (house with a garage), otherwise having an EV is not feasible.

Related to this concern, in Slovenia, even though there are laws approved defending the "right to charge", this only applies to new buildings, and thus in older condominiums can be a hassle to push chargers' installation in common areas (requiring 90% approval rate of the condominium). Therefore, there is a perception that the EV owners, not only need to have a garage space, but it needs to be in his house, otherwise it still does not meet EV charging needs.

When looking to the public charging infrastructure, it can be seen that big energy companies are investing in expanding this network in Slovenia. Nevertheless, the investment is not only needed in the charging infrastructure itself, but there's also a need to improve the electricity grid.

From stakeholders' point of view, EV users can be classified as either very invested and curious about everything related to EVs (Group 1), or they see it as just another car (Group 2). According to survey results, participants that know more about EV-related technology (like V2G and V2X) also have higher energy literacy[12], thus can be concluded that Group 1 has higher energy and

[8] Slovenian University - https://www.uni-lj.si/university/
[9] Electric distribution system operator (DSO) from Slovenia - https://www.elektro-celje.si/si/
[10] Virtual Power Plant (VPP) from Slovenia - https://gen-i.si/en/
[11] E-mobility society for Slovenia (DEMS) - https://dems.si/
[12] When asked if they knew about V2G and V2X technologies, respondents that had an average energy literacy above 2.5 (scale of 0 to 3) mostly knew about them, while respondents below 2.5 average energy literacy (most of them having lower than 2) weren't familiar with these concepts.

digital literacy than Group 2. To help EV owners learn more, associations like DEMS organize events and seminars to help increase knowledge and promote EV adoption across Slovenia.

Finally, the perception surrounding the use of existing public charging infrastructure was looked at. In Ljubljana's city center, there is an imposed time limit of 3-hours charging during day hours. Some of the charging places charge by energy consumed and some charge both the energy and the parking time. Still, on DEMS' view there is a sense of paying more for parking than charging, and this is seen as positive, since it ends up being an incentive for people to bring their EVs to the city center to charge. Although this might be seen as an advantage for EVs, charging in these stations can be complex and unpredictable, since different charging networks lead to different pricing and payment methods. An interesting comparison is made between EVs and ICEVs, when talking about "fuelling": both need to be equally simple. It's straightforward to fuel an ICEV, charging an EV should be the same.

4.2.2 EV users' interviews

Eight EV drivers were interviewed, from which 5 were male (1 below 30 years old, and the others between 40 and 55 years old) and 3 were female (all between 30 and 40 years old). For these participants, the two main motivators for purchasing an EV were ecological and economic factors, the first aligned with what we saw in the surveys about having lower carbon footprint than ICEVs (lower to no emissions, possible to charge with "green" electricity) and a reduction in noise pollution, and the second aligned with the perception of EV adoption current main barrier, which is the cost of purchasing and charging an EV.

State incentives are still available in Slovenia, supporting new EV purchases. These incentives have been decreasing each year and are perceived as something meant for early adopters. This trend leads people to think that incentives will be discontinued in the long term. Even though people believe economic benefits are a great way to massify EV adoption, there are still people that perceive them as "an extra bonus", since they would buy an EV anyway (EVs seen as cheaper than ICEVs, both in electricity costs versus fuel, and maintenance costs). Another incentive, road tax exemption, also has a role in pushing EV adoption.

In Slovenia, charging was free in public charging stations until 1st November 2022[13]. Now, it is paid, and due to the current energy crisis, prices have been rising, and are unpredictable. This situation prompts people to place EV charging costs at the same level as ICEV refueling costs, thus, losing their economic advantage, and so EVs are no longer seen as cheaper. This perception from users is confirmed in Figure 3, where the comparison between EVs and ICEVs overall costs show a value very close to neutral, indicating that, even though they believe EVs are cheaper than ICEVs (accounting for purchase and "fuel" costs), it's not significant.

People also mentioned this concern regarding varying prices, not only throughout the country, but especially when travelling abroad, where charging in public network can become even more complicated due to different charging processes. Exception was one of the interviewees, who mentioned he only used Tesla chargers when travelling abroad, since he has a bank account linked to his Tesla, and payments are seamless.

[13] In November, they started paying around 0.28€/kWh. Prices were updated in January, and they're now paying around 0.38€/kWh. Plus, some chargers have an "unlocking fee" (the user must pay 0.50€ just to start the charge), and that gives a perception of some brands being more expensive than others. There's also a 3-hour charging limit during the day, so if the user charges for over 3 hours, the rate changes from €/kWh to €/min. This is perceived as a "free parking" for 3 hours, and the user starts paying for the parking after that time limit.

Besides pricing, public charging availability is also a big concern. Besides Ljubljana, where infrastructure is considered adequate, when going outside of the capital, public chargers are scarce, and adding that to possible malfunctions of the system, charging an EV can be a stressful task.

Interviewees mention an "always charging" preference, mainly due to range anxiety. This could mean high plug-in rates, but it also brings concerns to users, since they are aware that charging processes affect battery life (some were told about this by the car dealer, and some found out online or through talking to friends), and some even mention having limits defined in the car to charge only until 80%, while other state they only charge with lower power chargers (also referred to as "slow-chargers"). This seems to be considered "common knowledge" amongst EV owners, but almost no one could explain why. It is also mentioned that the time it takes for EVs to charge can be a hassle, and increased planning is required to assure enough range.

EV users seem to assume that batteries should last 10 to 15 years, and they will have decreased range as time passes and more charging cycles are done. They expect to change cars when batteries degrade, instead of just switching the battery. The fact that technology is always evolving endorses this, since people expect batteries to increase their available range in the future. Besides this, some mentioned it would be interesting to have the possibility to repurpose batteries as a household energy storage (second-life application).

V2G and V2X technologies bring both hopeful expectations and great concerns to EV drivers. On one hand, people see these technologies as potentially having financial and ecological benefits, and even mention the possibility of V2G helping to balance the electricity grid. On the other hand, concerns regarding increasing battery degradation, and the fear of not being in control of this system, raises questions, and sometimes even lack of trust on this type of technology. To be able to trust V2G technology, people assume they would need to:

- have some type of warranty to cover battery costs, so that if it degrades faster than expected, they will get a replacement;
- regulations should be in place, to define how this exchange should work;
- get notified every time the grid uses power from their batteries (even if it does not specify for which purpose the energy will be used);
- be able to set limits for discharging, to assure enough range for their own needs;
- be financially compensated for the energy being taken from their batteries.

People imagine the future of electric vehicles with faster charging, bigger ranges, and more chargers spread around the country. Some mention the possibility of induction charging in parking spaces, and even on roads. Others assume that maybe many chargers could negatively impact urban space and suggest vehicle-to-vehicle (V2V) charging to suppress some infrastructure needs.

4.2.3 Workshop with partners

During the Slovenian workshop[14], a better understanding was gained regarding some of the previous findings, namely:

- The terrain where Ljubljana is located was once a swamp, and that means it is not possible to build underground in most of the city. That is why it is very difficult to have garages, leading to public parking spaces being scarce;

[14] Besides the EV4EU Slovenian partners, this workshop counted with the participation of the Slovenian Government and Porsche Slovenia.

- Since **private charging is so difficult to assure inside the city, EV users need to rely on public infrastructure, and end up paying a lot to charge their EV**;
- There seems to be a lot of misleading, or even lack of information regarding chargers available;
- A great part of the population seems to live outside of the city, in family houses, some of them traveling 100 km a day to get to work. This need to travel long distances daily, together with the fact that weekends are usually spent at second houses (in rural areas) or even in neighboring countries (like Croatia, Austria, and Italy) end up exacerbating range anxiety feelings. A possible way to overcome this could be to **extend charging infrastructure, with strategic optimization of charging stations' locations** (also taking into account ease of renewable energy use in those stations);
- For Slovenians, **a car seems to be a status symbol, and it should be big enough to accommodate constant travelling and even moving from house to house**. This means that people seem to prefer cars that end up consuming more energy;
- According to car sellers, people are not willing to buy a car without testing it first, and EVs are not always available for a test-drive in car dealerships;
- Finally, to push EV adoption, partners mentioned two possible strategies to increase EV perception and long-term use. To convince more people to adopt EVs, partners believe that "if more companies and public entities have EV fleets, that can 'spread the word' about EVs". Another strategy to promote a better experience would be to create an "EV driving license", where people would learn about specific characteristics of EVs, as well as some energy concepts and habits that can help them make better and more efficient use of their EV.

4.3 Key insights from Slovenia

Considering results from the Slovenian research and observation, key insights gathered were as follows:

Table 1: Key insights gathered from Slovenia

Primary insights:	We observed that:	Secondary insights:
Insight 1: Good average energy literacy, but very different levels amongst EV users.	Range anxiety is real. Apprehension regarding vehicle range, especially when it goes beneath a certain threshold.	Data confirms relation between energy literacy and a good battery maintenance.
	Disparate knowledge, disparate attitudes. Energy literacy and EV charging habits and battery maintenance seems to correlate.	
Insight 2: Low EV adoption in Slovenia as consumers still don't feel safe enough with the technology.	Motivations are grounded on a paradox of future savings and need for initial investment.	The paradoxical reality must be tackled by creating more offer overall (public charging infrastructure), but also by reinforcing that EV's are becoming the right economical choice.
	EV sales are increasing in Slovenia (65% from 2020 to 2021) [6] but they are just 9.69% of all the new vehicles registration in 2021[15], although there's a low EV adoption perception.	
Insight 3: Price and emotion constitute a powerful blocker.	Main concerns regarding EV's and V2X are correlated, not only they need to be accessible, but people need to trust the technology.	Lack of charging infrastructure is reinforcing "range anxiety" feelings, and people are sharing a
	EV batteries are seen as a red flag because they are expensive, and their degradation is a stress factor.	

[15] www.eea.europa.eu/ims/new-registrations-of-electric-vehicles

	Car choice is not only based on daily routine, but conditioned by leisure and occasional longer trips, so the choice of vehicle is conditioned.	feeling of being emotionally conditioned to make decisions.
Insight 4: Narratives on EVs are rooted on the long-term price benefits, but initial investment is still very high for most.	EVs are seen as a cheaper option than ICEVs on the long term, as well as better for the environment and society, and more efficient.	Ecological concerns are top-of-mind, but economic factors are key, and users seem to expect increasing support from authorities and policy makers.
	Ecological and financial concerns are top of mind topics when talking about EVs. State incentives are considered insufficient.	
	Preference seems to be subsidising directly EV purchase, and some people refer incentives have been reducing over time.	
Insight 5: Street charging versus parking concerns.	In Ljubljana, chargers are available "on every other street", but availability is not certain (free spot, working charging station, and accessible prices).	In Slovenia, parking "for all" seems to be crucial, and charging is "quite easy" when comparing to finding a place to park.
	Charging stations are associated to a possible problem, since they reduce parking spaces for non-charging vehicles (EVs and ICEVs).	
Insight 6: EV charging complexity brings concerns to users.	EVs are harder to refuel. Different providers, increasing prices and unlocking fees contribute to this feeling.	Seamless charging experience seems to play an important role in EV adoption. It needs to be "as easy as going to a gas station".
	People seem to be mostly comfortable leaving their car in a public charger overnight, as security is not an issue.	
Insight 7: V2X arises interest, but also a lot of doubts from users. Trust will lie on a seamless experience with monetary gains.	Perceived V2X benefits include energy savings, security, and the advantages of having a battery system for the house.	Benefits from V2X do not seem to be clear for all users, and this could become a barrier to V2X adoption. The good of the community is not enough.
	Some people assume there are no benefits for the user individually.	
	Expectation is to get monetary compensation in V2X scenario, even though the perception of "greater good" was mentioned.	
	Main concern raised regarding V2X was control. People need to feel that they are in control of their energy availability.	
	Futuristic scenarios mentioned an increased charging infrastructure, including induction charging in parking spots and "on-the-road".	
	Battery degradation concerns do not appear for every person, depending on the energy literacy level.	

5 EV user experience and interaction with the city in Greece

Greece is a European country with a population of 10 482 487 inhabitants [8]. In 2011 census [9], around 80% of the population was over 19 years old, and thus old enough to drive.

In 2021, Greece had around 3300 BEVs registered, and 7000 PHEVs. Both together amounted to around 0.2% of registered vehicles in the country that year [10]. From the countries included in this study, Greece was the one with lower EV penetration in its car stock.

5.1 Quantitative research

For the Greek quantitative study, the survey was shared using the Prolific platform, as well as in a group for EV enthusiasts. From these sources, 52 responses were gathered from people living in Greece, distributed by age and gender as seen in Figure 5.

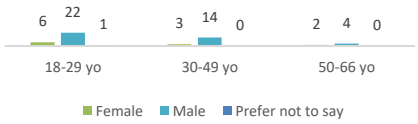

Figure 5: Gender and age group distribution of Greek respondents to quantitative survey.

To assess energy literacy, the respondents were asked about different topics, including household related issues (topics 1 to 3 in Figure 6), equipment's consumption (topics 4 and 5 in Figure 6), energy sources and generic technical concepts (topics 6 to 11 in Figure 6).

In Greece, population seems to have a very good energy literacy overall, noting that the subjects that bring more difficulties are also the more technical ones. We also noted that EV enthusiasts (the ones who seem to dedicate more time exploring how to better use their cars) have an average energy literacy of 2.74 (on a scale of 0 to 3), while respondents gathered with Prolific platform have an average of 2.23.

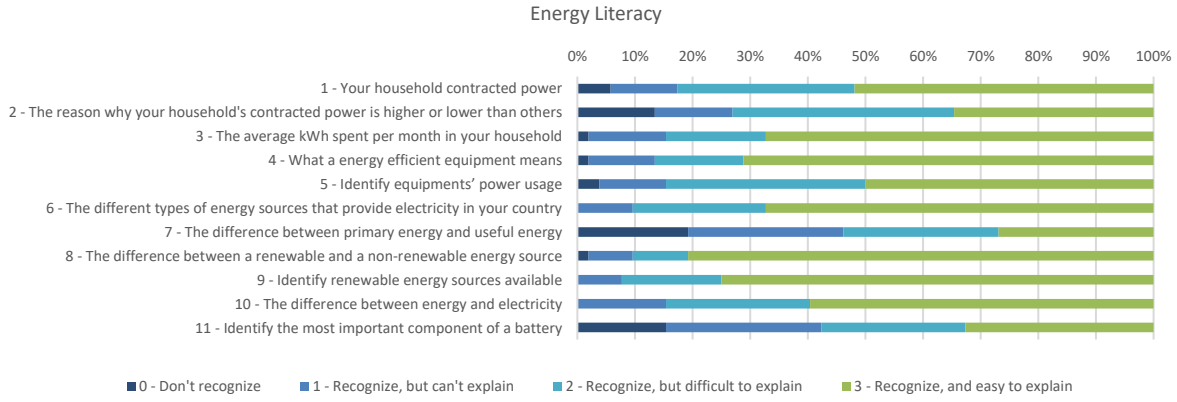

Figure 6: Perceptions of Greek quantitative survey respondents regarding several energy literacy related topics.

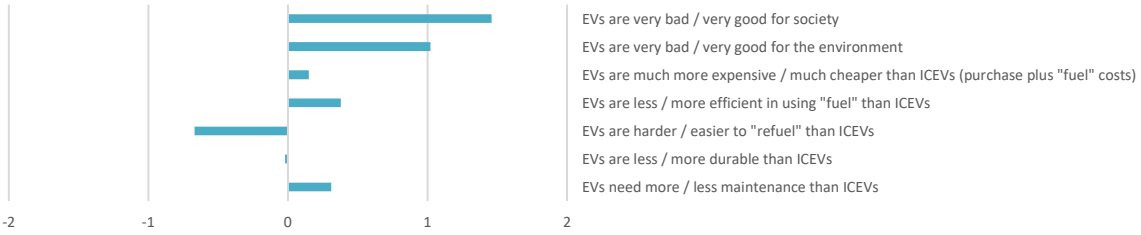

Figure 7: Perception of EVs in Greece, when compared with ICEVs (first adjective towards the negative numbers, and second adjective towards the positive number).

As to how the population perceives EVs, they seem to be considered a better option than ICEVs in most categories, as we see in Figure 7, except for easiness to "refuel", indicating a clear concern with the charging availability. Also, durability is seen as similar to ICEVs.
When asked about what changed in their lives, before and after owning an EV, the topic that surfaced the most was the economic savings related to owning an EV, as well as a sense of contributing to a more sustainable future, with less carbon footprint and less noise. Also, respondents mentioned an increased comfort and convenience, and enjoying driving more.

When asked about main motivations for acquiring an EV, Greek respondents' motivators seem to be closely related with environmental and economic issues, as well as technology. The top motivators selected were:

- "Better for the environment, due to low CO2 footprint" (76%);
- "Cheaper 'fuel'" (55%);
- "The technology associated with electric vehicles" (45%).

EV users in Greece would appreciate assuring better compensations for exchanging their ICEV for an EV. Also, some participants mentioned it would be interesting to provide support in acquiring charging equipment, exchanging battery, and increase the charging network in the country.

In Greece, 35 out of 52 respondents (67.3%) would buy used EVs, mainly because they are cheaper, and there is a perception of being the same as buying a used ICEV, and a more environmentally friendly option.

Finally, regarding charging habits, the correlation between the type of area where participants live in, the average distance they make each time they use their car, and the place they go more often to charge their EV were plotted.

As seen in Figure 8, majority of participants travel less than 50 km for each trip and live in urban areas. Field research suggested that lack of public infrastructure outside of city centers might be the cause of this.

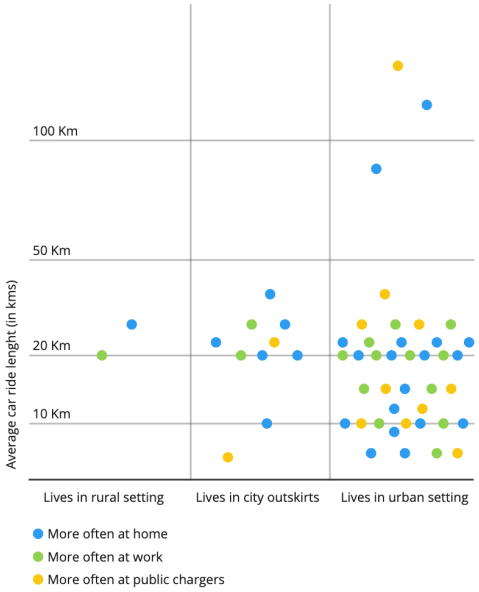

Figure 8: Correlation between type of residence area, average distance for each trip, where EV charges more often, in Greece.

5.2 Field Research

To prepare for the field research, different local stakeholders were talked to. They provided key insights about Greece's reality, mainly from an energy distribution and policy point of view. After collecting those insights and analyzing data gathered from the quantitative surveys so far, recruiting EV users that lived in Greece was attempted. This proved rather difficult, since participants were reached through an e-mobility Facebook group which had little interest in participating. To have more thorough insights, it was decided to include a Service Safari method

in this field trip. Finally, a workshop was conducted to validate collected insights with project partners.

5.2.1 Expert interviews

Three stakeholders were interviewed from the Ministry of Energy[16], from HEDNO[17] and from the Independent Power Transmission Operator[18].

During these interviews, it was found that economical concerns appear to be the main issue surrounding EV adoption, and a lower cost of use (in comparison with ICEVs) may be a good incentive. Moreover, in Athens there is an extra incentive regarding circulation in the city center[19].

When talking about energy literacy, it was mentioned that people probably became more conscious about electricity use and consumption after having an EV. This assumption is supported, as seen above, by the fact that EV enthusiasts appear to have higher energy literacy levels than other EV drivers.

There were also mentions of very low public transportation usage in Greece, specifically in Athens, which supported suspicions that car use might be overwhelming in the city, and users could be very concerned about parking availability. From the surveys, comes a generalized perception that people do not respect EV charging places. According to the Ministry of Energy, they are considering implementing technical solutions to better regulate this issue.

In these interviews, it was mentioned that most Greek population lives in apartments, inside urban areas. The assumption was made that parking and public charging availability close to home and place of work is a big concern. Charging in condominiums has some regulations to incentivise it[20], but public network is perceived as not being enough to supress charging needs, mainly outside of Athens.

V2G technologies brought up the discussion on very important concerns: system operators believe that the current electric grid is not prepared and will not support a mass EV adoption, possibly bringing capacity and degradation issues into play.

5.2.2 EV users' interviews

Four EV drivers were interviewed, all male (2 were between 30 and 49 years old, and 2 were between 50 and 66 years old). In these interviews, people mentioned they believed there is a lot of misinformation from the media. Still, they stated there was a rise in sales because of

[16] https://ypen.gov.gr/
[17] DSO from Greece - https://deddie.gr/en/
[18] Transmission System Operator (TSO) from Greece - https://www.admie.gr/en
[19] The rule applied to Athens Low Emission Zone, also known as "Athens' ring", states that, in the center of the city, cars are only allowed to circulate depending on the day of the month and the last digit of their license plate. If it's an even date, only plates ending in even numbers can enter this area, and vice versa. Electric and hybrid vehicles are excluded from this restriction.
[20] If someone wants to install an EV charger in their garage spot (in a condominium), the law states they are free to do so. The condominium can only prohibit it if a specialized electrician proves the charger would constitute a potential danger to the building.

incentives, and there is an increased attempt of raising awareness and promoting EVs in the mobility media channels and through two existing annual conventions.
Participants said that, in Greece, even though there is monetary help to purchase an EV (applicable to cars, motorbikes and bikes), the values are not enough, and an EV is still too expensive. Moreover, these incentives do not apply to second-hand cars.
Some people see EVs as a more ecological option, especially when talking about air and noise pollution, but others disagree, since electricity sources might not be renewable, and a person mentioned battery recycling is "not trustworthy". Some participants mentioned they would like to be able to keep their old batteries, to use them as a "house power bank", thus giving them a second use after they are no longer suitable for their cars.
Even though it is expensive to buy, daily use of an EV ends up being cheaper than having an ICEV (charging costs are lower than petrol prices, and EVs have lower maintenance costs). Nevertheless, economic concerns still arise, since needing a new battery can be very expensive. One participant reported that "they ask 100€ to inspect the car and 'blackmail' the customer by stating they will lose the battery warranty if this inspection isn't made. And most of the time, there's no need for this inspection".
There seems to be a perception that charging at home is more convenient and cheaper, and if charging periods are selected according to the electricity prices, it is possible to save money. On the other hand, public infrastructure is too scarce, especially outside of Athens. Main issue for participants interviewed was working with the charger itself, since connections sometimes fail, and it is very troublesome to have so many apps: "We should have one app that worked for every charger".
In Athens, parking is free for 3 hours in charging places, so citizens only pay for the electricity charged into their EV. Still, the main challenge is to find an available charging station (as verified during the Service Safari, mentioned below).
The main concern that comes to mind when talking about V2X is battery degradation, and participants stated they would need more information and further research to understand what kind of impacts this technology could have on their batteries. On the other hand, they recognize V2G exchanges could bring interesting economic benefits, e.g., making it possible to sell energy back to the grid. Still, to agree to this technology, participants mention they would require some level of control over the system, like defining limits of how much energy the grid can take, or even opting out in certain moments.

5.2.3 Service Safari

During the Service Safari conducted, very interesting insights were discovered and confirmed:

- The message that car rentals give customers renting an EV is that "it's exactly like any other automatic car, so it's very easy to drive". If asked for any more details, they would not know, not even where the cable was stored;
- Different styles of charging truly affect range available, and that can be hard to control in cities with a lot of traffic like Athens;
- Charging stations are very poorly identified in Athens. They were easily missed in the beginning, because signaling was not clear, only a "stopping and parking prohibited" sign is in place, with a message written in Greek that states the exception for charging EVs (Figure 9). Sometimes, there is also a yellow line painted on the pavement. APPs to find charging stations did not always show the right location, which increased the difficulty in finding them;

- Some charging stations were unavailable, since non-EVs were parked there, occupying the parking spot. In one place, even though the station had two charging points, there was only one place marked in the ground (occupied by two ICEVs), and the others were occupied with trash containers (Figure 10).

Figure 9: Sign in Athens, identifying charging station.

Figure 10: Charging station in Athens, with two charging points, but only one parking space marked, and ICEVs occupying it. On the other side, trash bins make it impossible to park a larger vehicle.

5.2.4 Workshop with partners

Some findings were better understood during the workshop with the Greek partners, namely:

- There is a perception that **Greek people are not as concerned with battery degradation as in other countries, because that is considered "a problem for the future",** while assuring enough range is "a problem of the present", and was stated that Greeks tend to concern themselves more with the immediate rather than the long term effects;
- **Incentives in place are difficult to apply to, there is a lot of bureaucracy involved**. It was also mentioned that freelancers have an increased benefit, since they can also get money back from leasing an EV by deducting it as business expenses;
- There is a perception of a low level of concern towards other people's property, stating they believe **owners of expensive cars (like EVs) are not comfortable leaving their car parked in a public area, since they are afraid someone will damage it;**
- Even though there are laws to facilitate installing a charger in a condominium (as seen in the experts' interviews), this is not easily applicable in Athens. Since the city has a lot of historic monuments, building underground is not something very easy to do, and so, condominiums' garages are usually on the ground floor, and outdoors. This way, parking spaces are not usually allocated to a specific person, and instead they are shared amongst every resident. This means that installing a charger goes back to being something that needs condominium approval (at least 50%), since it is not being installed in a private parking spot, but rather a shared one;
- It was made clear that there is a **need to define a regulatory framework for how V2X technology should work, and how to manage energy exchange between the grid and the consumers.** Nevertheless, policy makers seem to expect this framework to originate in energy providers (as stated during the experts' interviews), and energy providers believe policy makers should have a prominent role in leading this definition;
- Some suggestions were shared regarding possible incentives to promote, not only EV adoption, but V2X acceptance and participation, such as an incentive that considers possible extra spendings from battery degradation, but also considers the energy that the user can sell to the grid. Another suggestion was a gamification exercise of

incentivizing EV users to provide energy to the electricity grid, thus reducing the need to maintain non-renewable power sources to keep the grid working;

- It was mentioned that there is the need for more information about V2X incentives, so that better business models can be designed. The lack of legislation regarding selling energy to the grid, makes it difficult to assess V2X integration;
- Partners pointed out that V2X implies communication and energy exchange, and that "first the energy exchange should be implemented, the comms come second".

5.3 Key insights from Greece

Considering what was researched and observed in the Greek studies, key insights gathered were as follows:

Table 2: Key insights gathered from Greece

Primary insights:	We observed that:	Secondary insights:
Insight 1: Good energy literacy, but differing according to interest in EV technology.	People that engage in e-mobility groups display higher energy literacy levels, not only regarding EVs, but other electricity topics as well.	After having an EV, people become more conscious about electricity use and consumption.
Insight 2: Endorsing EV adoption goes beyond economical support.	People can have support in purchasing or leasing an EV, and in buying a home charger. Free road tax is also an economic benefit.	Even though economical support is still the most valued incentive to push EV adoption, other benefits are seen as valuable.
	It is difficult to apply to incentives, it involves a lot of bureaucracy.	
	Incentives missing when talking about second-hand EVs. They are seen as cheaper and more eco-friendly. Main concerns related with how driving and charging habits affect battery life.	
	Besides economic support, EV owners also have the possibility of freely accessing the city center in Athens.	
	Government is supporting the possibility of installing chargers in condominium's garages.	
Insight 3: Environmental motivations seem to surpass economic factors.	EV adoption motivated by environmental concerns and economic factors, although contradicted by partners during workshop, saying "people want to appear more eco-friendly, but their main driver is always the economic one".	Sustainability appears as a driver that can promote EV adoption. The word "investment" might be creating the wrong expectations. EVs are not an "investment", but a "good value for money".
	Reducing noise pollution appears as an advantage of EVs, as well as the perception of lower maintenance needs.	
Insight 4: Parking and charging issues related, and both raise big concerns.	Having an EV is seen as challenging if the owner cannot charge at home or at work.	To reinforce EV adoption, we should look at public space availability and planning, to promote charging for all.
	Low public transportation use, traffic congestion and poor urban planning arise EV parking concerns.	
	Fairness and equality concerns about increasing public charging network, due to difficulties with parking space availability for all.	
	Population parks in EV chargers, even without charging, and new systems might help regulate this issue.	
	Public charging network appears to be insufficient to allow for a mass EV adoption.	
Insight 5: Security concerns increase when referring to EVs.	Security seems to be an issue, as cars might get vandalised, and the perception that EVs are expensive seems to exacerbate that.	Concerns with security are intrinsically related with local culture, and decreasing ownership perception might be interesting.
	Leasing an EV is perceived as better, since the user doesn't need to care about the car's condition.	
Insight 6: Private charging is key in Greece.	People prefer private charging, and public network is for emergency charges or to take advantage of dedicated EV parking.	EV adoption, depends on the need to define how chargers can be installed in condominiums.
	In Athens, most condominiums' parking areas are outdoors, with no designated place, so they still need to get approval.	

Insight 7: Battery concerns appear to be only related to range anxiety in majority of cases.	More worries with range availability rather than battery life. Greeks seem not to care as much about battery degradation ("problem of the future"), but about range ("problem now").	Battery degradation isn't currently a blocker for V2X adoption.
	EV enthusiasts display increased concern with battery health and maintenance, due to high value perception of a new battery.	
Insight 8: V2X brings concerns mainly regarding energy availability and cost.	EV users' main concerns surrounding V2X relate to electricity availability, costs, and availability of public charging network.	Perceived mistrust in public charging infrastructure expansion. Communicate how V2X can contribute to energy availability, instead of increasing demands.
	Battery degradation concerns come second, showing that this is not top of mind for these users.	
Insight 9: V2X perceived benefits in traffic optimisation and energy efficiency.	EV enthusiasts are "big ambassadors" for EVs and V2X related technology.	To drive V2X adoption, the message should highlight its potential to reduce traffic congestion and increase grid capacity.
	Main V2X benefits regarding daily commuting, traffic information and optimisation. Safety is also something worth mentioning.	
	EV enthusiasts see V2X benefits more related to energy issues, mainly the possibility of having a battery system for their homes.	
	Users agree in either receiving a discount in their electricity bill or getting money back from electricity used from their batteries.	
	Partners alert that V2X implies communication and energy exchange. First implement energy exchange, comms come second.	
Insight 10: V2X regulatory framework is crucial.	System operators assume EVs and V2G technologies might pose a big issue regarding grid capacity and degradation.	Different expectations from entities about who should define the much-needed regulatory frameworks regarding V2X.
	There is a lack of legislation regarding selling energy to the grid, which is necessary for V2X integration.	
	Without clear rules and procedures, both policy makers and energy providers doubt V2X can become a reality. But both look at each other expecting those frameworks.	

6 EV user experience and interaction with the city in Denmark

Denmark is a European country with a population of 5 932 654 inhabitants, of which 4 776 816 have 18 years old or more, which means that around 80.5% of the population is old enough to drive [11].

In February 2023, Denmark had registered 2 799 016 passenger cars, of which 119 214 were BEVs (4.26%) and 106 720 were PHEVs (3.81%) [11], which means a total of around 8% of total car stock in Denmark is an EV. In 2021, electric stock share (BEV+PHEV) was around 5.2% [10].

6.1 Quantitative research

For the Danish quantitative study, the survey was shared using the recruitment platform Prolific, as well as on social media and through stakeholders' contacts. 23 responses were gathered from people living in Denmark, distributed by age and gender as seen in Figure 11.

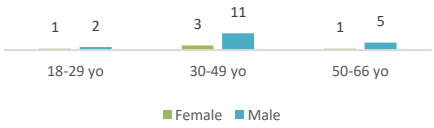

Figure 11: Gender and age group distribution of Danish respondents to quantitative survey.

To assess energy literacy, respondents were asked about different topics, including household related issues (topics 1 to 3 in Figure 12), equipment's consumption (topics 4 and 5 in Figure 12), energy sources and generic technical concepts (topics 6 to 11 in Figure 12).

In Denmark, population seems to have the highest energy literacy of the countries surveyed, even in the more technical subjects.

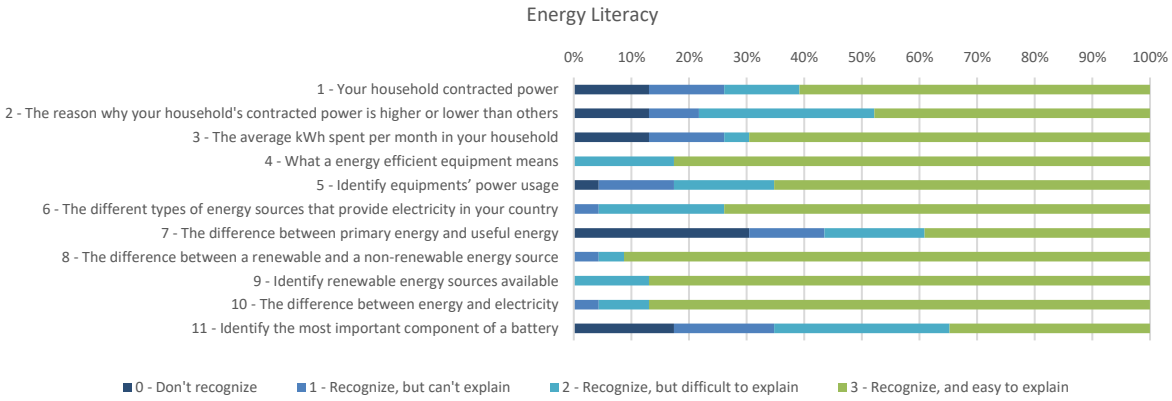

Figure 12: Perceptions of Danish quantitative survey respondents regarding several energy literacy related topics.

As to how the population perceives EVs, they seem to be considered a better option than ICEVs in most categories, as it is possible to see in Figure 13, except for easiness to "refuel", indicating

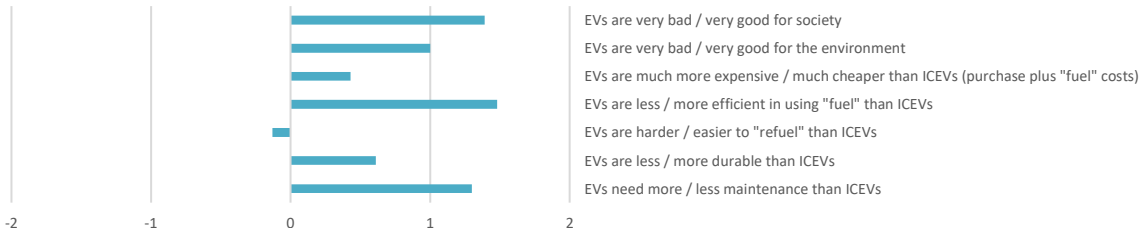

Figure 13: Perception of EVs in Denmark, when compared with ICEVs (first adjective towards the negative numbers, and second adjective towards the positive number).

a concern with charging availability. This concern was reinforced by the question about what changed in their lives, before and after owning an EV, since the topic that surfaced the most was the need for increased planning for EV charging. This question also received a lot of positive feedback regarding increased comfort and convenience of having an EV and enjoying driving more.

When asked about main motivations for acquiring an EV, Danish respondents' motivators seem to be closely related with environmental issues, as well as technology. The top motivators selected were:

- "Better for the environment, due to low CO2 footprint" (82%);
- "The technology associated with electric vehicles" (50%);
- "Less noise" (41%).

EV users in Denmark would appreciate paying less for electricity during a fixed period, and some support if they exchange their ICEV for an EV. Also, some participants mentioned fixed electricity prices, or even no taxes on electricity and on EVs, as well as free parking and "fossil free" zones.

In Denmark, 15 out of 23 respondents (65.2%) would buy used EVs, mainly because they are cheaper, and it is a more environmentally friendly option.

Finally, regarding charging habits, it is plotted in Figure 14 the correlation between the type of area where participants live in, the average distance they make each time they use their car, and the place they go more often to charge their EV.

As seen in Figure 14, majority of participants travel less than 50 km for each trip and live in urban areas or city outskirts. The first ones tend to charge more at the office or in public chargers, while the latter charge more often at home.

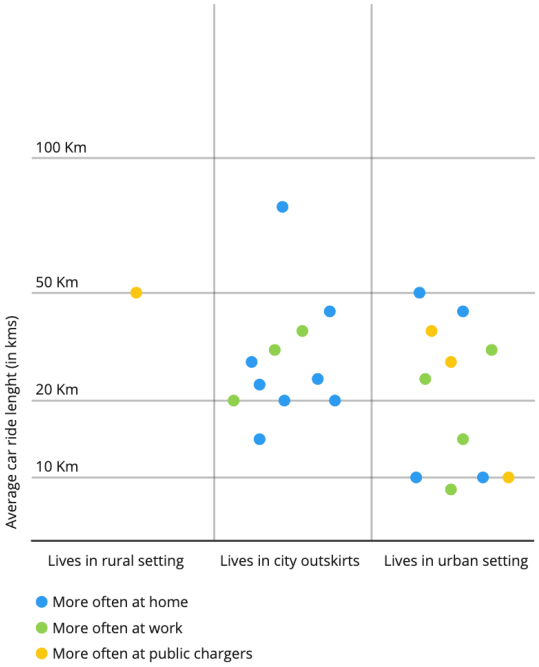

Figure 14: Correlation between type of residence area, average distance for each trip, where EV charges more often, in Denmark.

6.2 Field Research

To prepare for the field research, different local stakeholders were talked to. They provided key insights about Denmark's reality, mainly from an academic and energy distribution point of view. After collecting those insights and analyzing data gathered from the quantitative surveys so far, we recruited EV users that lived in Denmark for remote interviews.

6.2.1 Expert interviews

Two stakeholders were interviewed from Denmark's Technical University[21] and from Bornholms Energy[22]. During these interviews, it was realized that economic concerns are key in Denmark, since taxes on vehicles are very high, even though they are lower for EVs.

Possibility to charge with solar panels seems to be working as a motivation for people to buy EVs, and it was also reported that people can ask for a refund of the electricity tax corresponding to the energy used to charge their car.

The perception of an energy crisis is driving people to be more energy conscious, and therefore their literacy has been increasing in the last year. Nevertheless, economic reasons apparently tend to be more impactful in pushing EV adoption than energy consciousness.

One of the experts interviewed mentioned he does a lot of research and planning to choose the best times to charge his EV at home, not only checking electricity prices in each moment, but also looking at wind predictions for following days (since more wind usually means a drop in energy price). This might not be realistic for most of the population to replicate, but could be an opportunity for something to develop, in order to facilitate EV user lives, and even promote further EV adoption.

It was also mentioned that Danish people are not very attached to their cars, when comparing to other cultures. Besides, there is a perception that most people rely on public transportation and bicycles, except when living further away from the city.

When talking about batteries' impact, the need to recycle them is something pointed as lacking investment. This will not drive mass EV adoption but will be crucial when majority of cars are electrical.

Finally, there is a belief that people in Denmark will trust V2X technologies, but only if they can understand the benefits associated. To make people trust V2X, addressing the need of mindset shift regarding EVs is a priority. People expect vehicles to have greater ranges, thus reducing their range anxiety, and are very concerned about battery degradation. By analysing daily commuting, need for greater ranges is questionable, and increased planning might solve mobility needs. Even for longer trips, a re-evaluation of destination choices (travel somewhere closer), or even means of traveling could be the answer. Owning a car means it will be parked most of the time, and by having an EV at home, people can benefit from a very valuable asset: "an EV becomes a battery for your home, that can also take you places, rather than a car as a primary use".

From a more technical point of view, experts perceive that the main V2X barrier is the communication part of the connection. All the technology needed to make V2X work already exists, but there are no standards or protocols defined, which means that communication is not possible between components of different brands and manufacturers. Assuring interoperability will be key to make V2X work.

[21] https://www.dtu.dk/english/
[22] TSO, DSO and Retailer for the Bornholm island in Denmark - https://www.beof.dk/privat

6.2.2 EV users' interviews

Seven EV drivers were interviewed, from which 4 were male (ages ranging from 30 to 56 years old), and 3 were female (ages ranging between 40 and 53 years old). One of the economic advantages pointed out was the savings that come from using electricity to power their cars, especially with fuel prices on the rise. Additionally, some have been able to take advantage of "green loans", which offer extra benefits to those who purchase environmentally friendly vehicles.

Many EV owners mentioned having "green energy" contracts, which assure that all the energy used to charge the EV comes from renewable sources. For many, the motivation to own an EV is to contribute to the transition to more sustainable energy sources and reduce their environmental impact. Even if the specific contribution of one individual seems small, they can serve as an example for their neighbors and inspire them to make similar choices.

Despite the above-mentioned benefits, some participants noted that the high cost of purchasing a car in Denmark remains a significant barrier. Interviewees stated that the registration taxes on BEVs (up to 50%), although lower the ICEVs (up to 180%), are still quite heavy, signalling a missed opportunity to encourage more people to adopt EVs.

Others mentioned different incentives, such as free parking for EVs in Copenhagen, regardless of whether they are charging or not, but some also noted that ICEVs sometimes park in EV charging spots. Some suggestions included creating fuel-free zones in city centers to promote the mass adoption of EVs and address parking needs.

Regarding charging habits, and public charging network perception, some interviewees mentioned that it has become a habit to plug-in their vehicle whenever possible, however, some set the specific time to charge with the car app to get the best energy prices.

One person mentioned they were considering installing a charger at home, but they do not have a private parking space that allows them to comply with local regulations. They believe that collective chargers could be a good way to solve charging needs in places where houses cannot have a charger. For example, if a neighbour has a charger, regulations could allow them to share it with the neighborhood.

They also mentioned that the government should secure enough charging stations, as chargers are now in private companies' hands, and the network is lacking in small towns. That leads people to prefer charging at home. Some interesting suggestions regarding public charging network included having roaming-like capabilities, so charging is possible everywhere without having to install different APPs and pay extra costs (there are a lot of different companies, so people need to install a plethora of APPs).

Range anxiety is a significant concern but seems highly dependent on daily habits and if people have a PHEV or a BEV. One of the participants believed that faster charging would solve most range issues.

Battery degradation is also on EV owners' minds. Batteries have an 8-year warranty, which is a relief for some individuals, but they wonder what will happen after it expires. The fast-charging option is preferred by some individuals, while others are concerned about its impact on battery life.

Also, the perceived difficulty in recycling EV batteries causes further concerns, and battery recycling is seen as crucial for EV mass adoption, when end-of-life EV numbers rise. Some individuals think that longer-lasting batteries would be better and greener, reducing the impact

they have on the environment. While EVs are seen as better for the planet than ICEVs, the raw materials for batteries could be problematic.

When talking about V2X technologies, bureaucracy can be a significant obstacle to implementing them. While benefits of these technologies would be good for the environment, current laws in Denmark may prohibit them. For instance, a law requires immediate consumption of solar power, and excess energy must go to the grid. For V2G to work to its full capabilities, this law might need to change.

Charging infrastructure is another issue to consider. While having chargers everywhere would be ideal, it would also require a lot of investment in grid infrastructure. In some areas in Denmark, people may be able to use their own wind turbines or solar panels to charge their cars at home, but there is still a need for many charging stations. The chargers would need to be along roads, in every parking spot, and in every parking lot. However, there are also concerns about time limits on charging and whether people should only charge up to a certain percentage or amount of time at public chargers. Additionally, prices should be the same everywhere within the country, or even on a European level, like what happened with telephone roaming (before, prices changing from place to place, and now it is possible to use the cellphones with the same tariff anywhere within the European Economic Area). One participant mentioned that a possible alternative would be if society shifted away from personal car ownership, and more towards a sharing vision that also considers alternative means of transportation.

Assuring range is another challenge. Sharing energy with the grid is fine, but only if they can assure their needs are met. They would need to trust that, if they leave their car charging at night, they will have enough range the following morning for their daily routine.

Community is also an important factor. While sharing energy with a neighbour is not a problem, the system's design and algorithm would need to ensure everyone benefits from it. The sense of property could also be a problem, and people may not like the sharing economy that this technology implies. To address this, there could be more of a household or community-driven system that integrates small groups of people and responds to their needs.

6.2.3 Workshop with partners

The workshop with Partners will be held in July 2023, as the Team will be in Denmark for the Project General Assembly. The results for this activity will be included in the final version of this document.

6.3 Key insights from Denmark

Considering what was researched and observed in the Danish studies, key insights gathered were as follows:

Table 3: Key insights gathered from Denmark

Primary insights:	We observed that:	Secondary insights:
Insight 1: EV owners display highest energy literacy amongst countries evaluated.	Energy crisis is driving people to be more energy conscious, and therefore their literacy has been increasing in the last year.	Though energy literacy is higher, clarification regarding energy use in EVs and energetic advantages of V2G might be crucial.
	Having an EV seems to have an impact on energy literacy, as it tends to be higher than average.	
Insight 2:	Registration tax can reach 180%, which increases initial investment to purchase a vehicle, although EVs are taxed at lower rates.	Support in initial investment seems to be key in Denmark.

Economic barriers seem to be the main concern regarding EV adoption.	Some people suggested increased support to EV purchase, including a price reduction for exchanging an ICEV for an EV.	
	People can ask for a refund of the electricity tax corresponding to the energy used to charge their car.	
Insight 3: Ecological benefits are endorsing EV adoption, also because they also have economic advantages.	Ecological motivations seem to be main factor when adopting EVs.	Ecological arguments might be crucial to push V2X adoption, especially when paired with support in assuring more renewable energy sources.
	There is a lot of renewable energy production in Denmark, and people seem to value and prefer these types of energy sources.	
	Possibility to charge with solar panels or wind turbines work as a motivation for EV adoption, since charging gets even cheaper.	
	Most survey respondents (65.2%) would buy used EVs, considering both economic and ecological arguments for this decision.	
Insight 4: EVs could be transformed into a "battery for your home, that can also take you places".	Danish people are not as attached to their cars as other cultures.	Anchor message in benefits EVs can bring besides mobility, to further promote EV adoption.
	Mentality shift regarding mobility, as public transportation and bicycles respond to main needs.	
	Two mobility profiles in Denmark: - People in big cities prefer using public transports or bicycles; - People in small towns prefer having a car for their daily commute if it requires longer distances.	
Insight 5: EVs require increased planning, due to charging constrains.	EVs are perceived as a better option than ICEVs, except for the ease of refuelling, due to lack of charging stations availability.	Assuring increased charging network seems important to promote EV adoption. Electricity price predictions might be an opportunity to explore in V2G user platforms.
	Need for increased planning for EV charging, especially for longer trips where charging stations may be scarce.	
	Charging habits varied based on location and access to different types of charging infrastructure.	
	Some plan charging based on energy prices and wind predictions.	
	Improve public charging network by having "roaming-like" capabilities and more stations in small towns.	
	Faster charging seen as a potential solution for range anxiety.	
Insight 6: Battery recycling is a big concern for EV drivers.	Battery degradation not concerning most EV owners in Denmark.	Different battery uses and further investment in recycling might be crucial to assure people continue seeing EVs as a more environment-friendly option.
	Many wonder what might happen when battery warranties expire, and the impact batteries will have on the environment.	
	Longer-lasting batteries as possible greener solution.	
	Battery recycling concerns EV users, as it lacks investment. It will not drive mass EV adoption but will be crucial when it happens.	
Insight 7: V2X has bureaucratic barriers, as well as a need to assure benefits for all.	To trust in V2X technologies, people will need to first understand the benefits associated.	V2X seems to be highly related to community-driven approaches and will require policy makers investment to make it a reality.
	Communication might be a V2X barrier, since there are no protocols defined, and assuring interoperability will be key.	
	Bureaucracy can be a significant obstacle since some Danish laws might prevent V2G to work to its full capabilities.	
	Enabling privately owned renewable energy sources might help overcome potential grid investments.	
	People need to assure their own needs before sharing energy. Community-driven system should ensure benefits for everyone.	

7 EV user experience and interaction with the city in Portugal

Portugal is a European country with a population of 10 343 066 inhabitants, of which 8 483 688 are 20 years old or more, which means that around 82% of the population is old enough to drive [12].

In 2021, Portugal had 5 632 644 registered vehicles [12], of which around 38 000 are BEVs (0.67%) and around 41 000 are PHEVs (0.73%), that represent a combined stock share of 1.4% of Portugal's total passenger cars [10].

Specifically for Portugal, the EV4EU project demonstrator for this country is in the Azores Autonomous Region. For this region, comprised of 9 islands, the total population is of 236 413 inhabitants, of which 188 057 are 20 years old or more, which means that around 79.5% of the population is old enough to drive [12]. In 2022, there were 792 EVs in Azores [13].

7.1 Quantitative research

For the Portuguese quantitative study, the survey was shared using the recruitment platform Prolific. 50 responses were gathered from people living in Portugal (entire country was included in the survey), distributed by age and gender as seen in Figure 15.

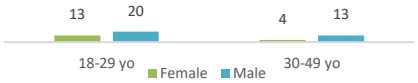

Figure 15: Gender and age group distribution of Portuguese respondents to quantitative survey.

To assess energy literacy, respondents were asked about different topics, including household related issues (topics 1 to 3 in Figure 16), equipment's consumption (topics 4 and 5 Figure 16),energy sources and generic technical concepts (topics 6 to 11 in Figure 16).

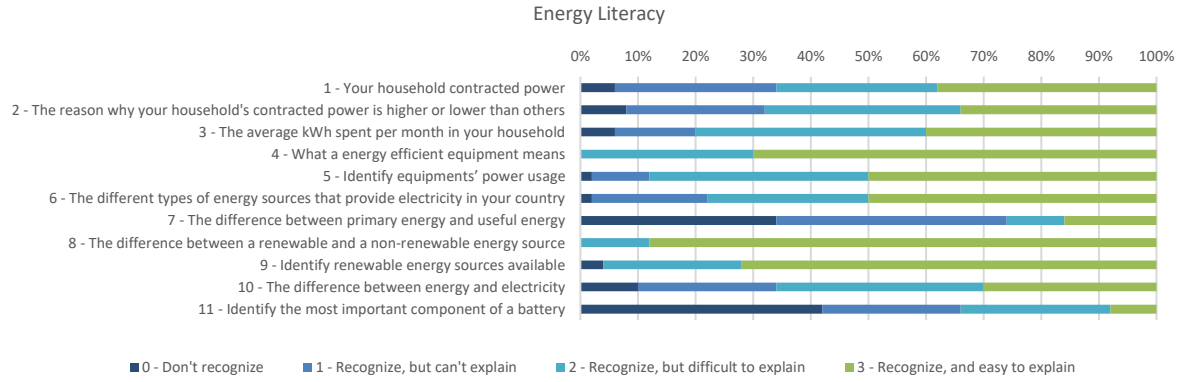

Figure 16: Perceptions of Portuguese quantitative survey respondents regarding several energy literacy related topics.

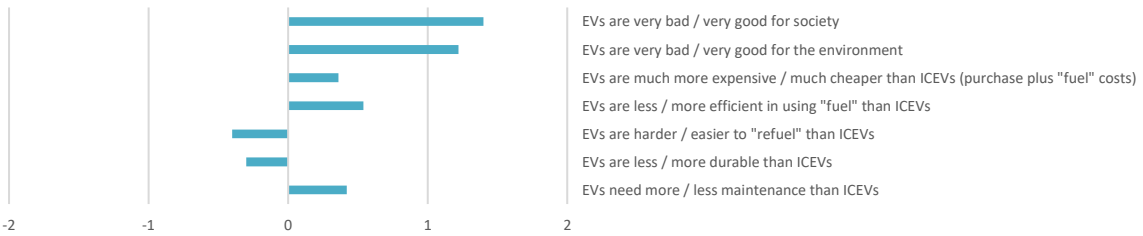

Figure 17: Perception of EVs in Portugal, when compared with ICEVs (first adjective towards the negative numbers, and second adjective towards the positive number)

In Portugal, population seems to have a good energy literacy overall, noting that the subjects that bring more difficulties are also the more technical ones.

As to how the population perceives EVs, they seem to be considered a better option than ICEVs in most categories, as we see in Figure 17, except for easiness to "refuel" and durability of the car. When asked about what changed in their lives, before and after owning an EV, the topic that surfaced the most was economic savings in fuel, as well as a greater sense of contributing to a more sustainable future.

When asked about main motivations for acquiring an EV, Portuguese respondents' motivators seem to be closely related with economic and environmental issues. The top motivators selected were:

- "Cheaper fuel" (86%);
- "Better for the environment, due to low CO2 footprint" (69%);
- "State incentives / benefits / discounts for electric vehicles" (43%).

EV users in Portugal would appreciate paying less electricity during a fixed period, and some support if they exchange their ICEV by an EV. Also, some participants mentioned discounts or exemption in taxes related to EVs, as well as support in buying home charging options and renewable energy self-production.

In Portugal, 33 out of 50 respondents (66%) would buy used EVs, mainly because they are cheaper. They mentioned being concerned about battery status, and if the previous owner took good care of the car, but if they feel that if the car is in a good condition, then a used EV would be a good option.

Finally, regarding charging habits, it is plotted in Figure 18 the correlation between the type of area where participants live in, the average distance they make each time they use their car, and the place they go more often to charge their EV.

As seen in Figure 18, majority of participants travel less than 50 km for each trip and live in urban areas or city outskirts. Regarding preference of charging place, public chargers and office ones seem to be more often used by people living in urban areas, whereas home chargers seem to be used by various profiles.

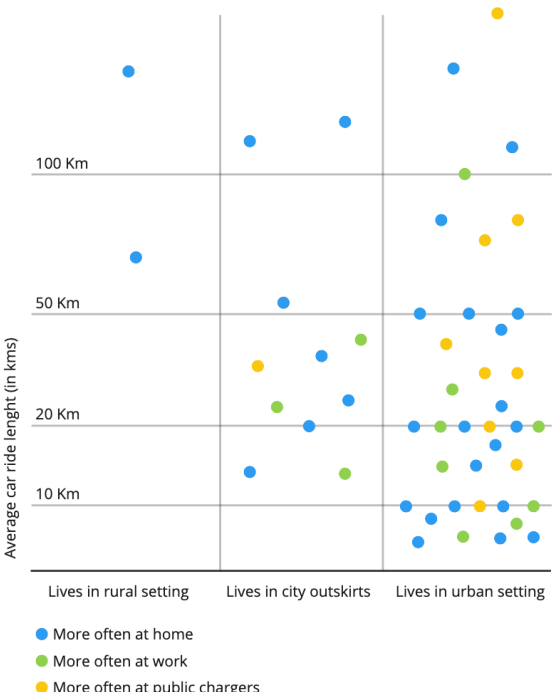

Figure 18: Correlation between type of residence area, average distance for each trip, where EV charges more often, in Portugal

7.2 Field Research

To prepare for the field research, different local stakeholders were talked to. They provided key insights about Portugal's reality, especially the Azores Autonomous Region, mainly from an energy distribution and policy point of view, but also including a car dealerships' perspective. After collecting those insights and analyzing data gathered from the quantitative surveys so far,

EV users that lived in Azores were recruited, specifically in São Miguel Island (where the project's demonstrator will be located). To have more thorough insights, it was decided to also include a Service Safari method in this field trip. Finally, a workshop was conducted to validate collected insights with project partners.

7.2.1 Expert interviews

Seven stakeholders were interviewed from Azores Regional Energy Department [23], Azores Electricity [24], from Angra do Heroísmo [25], Horta [26], Ribeira Grande [27] and Ponta Delgada [28] Municipalities, and from Stellantis&You Portugal[29].

During these interviews, it was realized that Portugal is making significant efforts to promote EV adoption, but challenges remain around infrastructure, regulation, and education.

The Portuguese government provides incentives for the purchase of EVs, and Azores Regional Government has an extra incentive available. These incentives are not only for private buyers, but also for companies and even leasing options. In Azores, they are considering expanding these incentives to taxis and rent-a-car companies, to further promote electric mobility.

The logistical and economical challenge of importing fuel into the islands versus generating clean electricity is seen as a motivating factor for local authorities to encourage EV usage.

Mobilizing population to adopt EVs can be challenging, and dealerships in Portugal appear to be doing little to assist with the application process for EV incentives. However, ensuring mobility is a significant factor in EV adoption, and on an island, this seems to have a "reassuring" effect on drivers who do not require as much range as they would in a larger region.

Although public transportation exists, it is underutilized in Azores due to a perception that it does not meet required needs, thus contributing to the levels of car ownership.

Public charging infrastructure faces several barriers, including high installation costs, lack of investment in certain areas, and slow licensing and certification processes. Adding to this, the population seems to perceive public network as very expensive, and its availability is surrounded with uncertainty. Thus, many assume charging at home is the only option, limiting the acquisition of EVs.

There is also a lack of public understanding about energy consumption impacts, which may lead to issues with energy supply in the future. Increasing energy literacy could help change behavior around energy consumption, although a significant overhaul of habits may be necessary. It might not have a direct impact on EV use, but could benefit overall management of the charging process. Digital literacy is also essential for understanding and troubleshooting potential issues with public charging stations.

[23] Direção Regional de Energia dos Açores, department from Azores regional government - https://portal.azores.gov.pt/web/dren
[24] Eletricidade dos Açores, TSO, DSO and Retailer from Azores - https://www.eda.pt/
[25] https://angradoheroismo.pt/
[26] https://www.cmhorta.pt/
[27] https://www.cm-ribeiragrande.pt/
[28] https://www.cm-pontadelgada.pt/
[29] Car dealership and brands' representative - https://www.stellantisandyou.com/pt/

It was mentioned that there is a need for greater regulation around EV usage, including V2G technology and battery disposal and recycling. This last one is especially concerning in Azores, since dangerous waste disposal implies added costs in shipping back to the mainland.

The electric grid operators mention that increasing EV penetration and implementing V2G technology would help to solve grid management difficulties and take better advantage of the available geothermal energy.

Battery degradation is a significant concern in Portugal, especially given the cost of a new battery, but monetary compensation may help to encourage the use of V2G. Still, V2G appears to be seen as an advantageous technology for private energy management (houses, condominiums, privately owned parking lots), but not as useful for public chargers, and trust in this system might highly depend on a better understanding of the technology involved, the benefits it brings, and how it can be controlled.

7.2.2 EV users' interviews

Five EV drivers were interviewed, from which 3 were male (ages from 30 to 60 years old) and 2 were female (ages from 30 to 60 years old). EVs were seen as expensive, when compared to ICEVs, by all participants. The initial purchase price of an EV can be higher than that of a similarly sized ICEV, which can deter many from making the switch. However, EVs are apparently seen as an investment by some, since they have the potential to save money over the lifetime of the vehicle through reduced taxes, fuel, and maintenance costs. Thus, many interviewees assume they are planning to recoup the upfront cost of their vehicle over time through these savings. However, even with state incentives available, some seem to still consider EVs out of reach, and would need a decrease in EV prices to buy one.

Despite being aware of the positive environmental impact of EVs during their use (less air and noise pollution), interviewees did not seem to prioritize sustainability in their purchasing decisions, some even mentioning that they do not consider EVs as a better option, since production and disposal impacts (mainly regarding batteries) are very significant. Specifically for batteries, some participants showed concerns about possibility of recycling them for EV reuse, while others would like to keep them after the warranty expires, to use as an energy storage at home.

Battery degradation is a pressing concern. All interviewees mentioned high battery prices and noticed their batteries are losing autonomy. Some link this to faster charging, while others are seemingly unaware of this correlation. One of the participants mentioned they drastically changed their driving habits, to promote a longer battery life.

As to charging preferences, participants do not seem to have a uniform opinion about what can be better for batteries, and assume they just charge according to what they feel better suits their needs and daily routines. Some charge at home and establish specific charging times (to make the most of cheaper electricity tariffs), others charge at work or even in the public network. However, it seems to be unanimous that the public infrastructure is not enough, reporting pricing uncertainty, a lack of chargers across the island, and misguiding information in APPs (some are not working, others are future installations and are not yet available). A participant even said that "if you cannot charge at home, owning an EV can be a drama". This was confirmed during the Service Safari, when chargers were found to be not working, others occupied by ICEVs, and some did not even exist.

Additionally, two participants mentioned another concerning situation: they had an employer provided contract with an energy operator for using public chargers, thinking it was free (it used

to be in the past), but in fact the energy operator was billing only on an annual basis. They felt overwhelmed by the value when receiving the bill and were not satisfied by how this was managed by the operator.

When it comes to V2G and V2X scenarios, Portuguese participants seem to be suspicious of these technologies, and would need the technology to mature and see if they would have benefits for themselves. Many assume V2G would only benefit the electricity grid and expect some economic compensation for this exchange. Besides, a few participants quickly mentioned big concerns for themselves, especially regarding battery degradation. They would expect further information about this, as well as some level of control about whether they would be required to participate in this technology.

It seemed the majority would like to have an overview of what these energy exchanges would be, being informed at the end of the month of how much they contributed to the grid. Besides, they also expect to be able to define some parameters of how much energy they allow the grid to take, even though they believe the system should be smart enough to know that, based on their car usage profile. They expect to plug-in their EV every time they park it (which means a need for a bigger charging network), and the system should decide when and how much to charge, "rationing" electricity amongst everyone.

7.2.3 Workshop with partners

Some findings were better understood during the Portuguese workshop[30], namely:

- EVs have **additional concerns when talking about an island context. For example, maintenance becomes more difficult**, since it depends on brand representatives in the island, otherwise people need to send their cars to the mainland;
- By living on an island, São Miguel's population seems to **suffer less from range anxiety, and that might be leading to less "consistent habits" in charging** (not setting as many routines, or easily forgetting to charge). This means there is less charging predictability, and that could be a concern to grid managers;
- Some ideas to tackle identified issues in Azores were:
    - Incentivizing energy literacy by not only including it in schools, but also promoting it through electricity bills, making them simpler and more transparent;
    - **Public chargers could become faster** (to promote higher turnover rates) and have dynamic tariffs;
    - **Identifying where chargers are is not enough, and the system could allow for a new layer of information that included the working state of each charger** (either by checking the charger status, or by allowing people to contribute to the platform and warn about possible issues);
    - EV charging tariffs could be separated from home contracts, since EVs are a more flexible asset to the grid;
    - **Energy sector could be paying for part of EVs and batteries' costs, to promote V2G adoption;**
    - With EV technology evolving, people might be refrained from buying a vehicle that could be outdated very soon;

[30] Besides the EV4EU Portuguese partners, this workshop counted with the participation of the Association of São Miguel island's Municipalities.

- Batteries could display only part of their total capacity to the user, so that people would not have to concern themselves about maintaining their batteries between 20% and 80%. Instead, the percentage shown to the user would be from 0% to 100%, but be equivalent to 20% to 80%, and that could lead to better battery maintenance without the stress related to this issue.

7.3 Key insights from Portugal

Considering what was researched and observed in our Portuguese studies, key insights gathered were as follows:

Table 4: Key insights gathered from Portugal

Primary insights:	We observed that:	Secondary insights:
Insight 1: Energy literacy in Portugal appears to be average, according to tested sample.	People do not understand impact of their energy consumption, and increasing energy literacy would require behavioural changes.	Increasing energy awareness can be done by incentivising energy literacy by including it in schools, and promoting it through electricity bills, making them simpler and more transparent.
	When applied to EVs, energy literacy is not necessary, but could facilitate its use and prolong batteries' lifespan.	
	Digital literacy is also important for EV use, especially when it comes to public chargers.	
Insight 2: Incentives in Portugal include tax reductions, exemption from road tax, and free parking.	Portuguese government provides incentives to purchase EVs, and Azores Regional Government adds to them to encourage adoption.	Envisioning a scenario where ICEV cars are no longer available, would these incentives still be in place? Or would this paradigm shift to a different reality?
	EV owners aware of other incentives, like tax reductions and road tax exemption, and free parking in some areas of the country.	
	Car dealerships do not assist with application process for incentives, they only inform if funds are still available that year.	
	Suggested incentives include support for home chargers and new batteries, free tolls, tax reductions, and free charging.	
Insight 3: Mobility needs are a main concern, and if they're met, EVs seem like a great option.	Public transportation is not meeting people's mobility needs, and that drove the population to get used to having their own car.	There's a need to assure mobility in an easy and seamless manner. Will a mindset shift and increased public transportation investment be the answer? How can EVs be a part of this new ecosystem?
	By driving in an island, range needs are apparently lower, and that seems to reassure EV drivers.	
	Shift in mobility needs and underlying habits might increase alternative transportation means, mainly in younger generations.	
Insight 4: EV adoption driven by economic factors, and environmental concerns come second.	Electricity being cheaper than fuel is creating "investment" perception, as people will "get their money back".	How can we boost EV adoption, having in mind that economic issues are what mainly drives Portuguese population?
	EVs seen as a good way to decarbonise mobility, but not the final solution, since battery production and discard brings concerns.	
Insight 5: Portuguese seem comfortable purchasing used EVs, mainly due to economic reasons.	The price of used EVs is significantly lower than that of new EVs, making them an attractive option for cost-conscious consumers.	Is second-hand market the answer to increase EV adoption in Portugal?
	People seem to trust in second-hand car market.	
	Batteries are main concern regarding used EVs, but accessing battery's current state details can help make informed decisions.	
Insight 6: Unless charging at home is available, people seem distrustful of the current charging network.	Mobility needs are easily met when people can charge at home.	Improving the charging network seen as too expensive and slow, even if it's considered the needed solution.
	Long times for charging make people uncomfortable, and there's a preference for faster charging when on the road.	
	Public infrastructure leads to "dramatic" views around EVs, due to uncertainty involved, namely cost and availability unpredictability.	
	Increasing public network is challenging, due to high costs, lack of investment, and slow certification and licensing processes.	
Insight 7: Parking concerns regarding fairness and equality for all.	Parking availability for all vehicles seems to be big concern.	How can we assure a fair solution for both EV and non-EV owners, as well as other city users?
	Making more spaces exclusive to EV charging needs to be done gradually, adapting to society's EV adoption.	

Insight 8: Concerns about running out of battery, degradation, and environmental impacts are pressing issues among EV drivers.	Range anxiety dictates when to charge, and some owners were advised to keep battery above 20% to avoid battery degradation.	Improving battery technology, increasing its lifespan and promoting reusability and recyclability could be crucial for further EV adoption in Portugal.
	Battery degradation concerns related with new batteries' costs.	
	Positive correlation between EV price and battery life, since more money spent leads to increased battery maintenance habits.	
	Environmental impact of batteries (production and disposal) is concerning and recycling them can improve EV adoption.	
Insight 9: Greater regulation seems to be fundamental to define future scenarios.	Further regulation regarding vehicle circulation might increase EV adoption and redefine population's mobility needs.	Regulations implemented need to assure both population's needs and authority's concerns are answered.
	V2G exchanges will only be possible with proper regulation, making benefits and rights of these new "prosumers" clear.	
Insight 10: Electric grid management can greatly improve with increased EV adoption.	Electric grid operators interested in massifying EVs in Azores, since V2G could resolve grid management difficulties.	Maximizing grid balancing could lead to different services and tariffs, according to flexibility needs for each context.
	Reducing diesel and gasoline importation needs is something Azores local authorities are very keen on.	
Insight 11: V2G seen as interesting technology, but people need to understand it and be compensated by participating in it.	V2G perceived as advantageous for energy management in private environments, but not for public chargers.	V2G and V2X benefits will need to be made clearer for individual users, otherwise its' adoption might be very low.
	Trust in V2G depends on information regarding economic benefits and costs involved, and possibility to control the technology.	
	Benefits related to energy efficiency, electricity prices reduction and increased security, but some believe "this would only benefit grid operators".	
Insight 12: Trusting V2X depends on regulations, transaction visibility and data privacy.	Trust in the V2X technology seems to be closely related to assuring that regulations regarding energy exchange are in place, energy transactions are visible to users, and data collected doesn't compromise privacy.	Energy exchange service needs to be designed in a way that gains trust from every player involved in the system.

8 Countries' cross-analysis

Each country showed us different perspectives and relevant insights into what EV contexts are across Slovenia, Greece, Denmark and Portugal. Having these insights in mind, this section addresses common characteristics and main differences between them, considering the assumptions identified as a starting point for our analysis, listed in the Literature Review, namely:

- Main motivations and barriers for EV adoption, where the decision to have an EV can depend on economic, environmental, technological, cultural and even bureaucratic factors;
- Concerns associated to costs and ROI, heightened by V2G scenarios, especially battery degradation and a sense of fairness in energy exchange values;
- Energy and digital literacy levels, considering the assumption that people with higher literacy will be more prone to opt for an EV;
- The current charging infrastructure can have a role in triggering both pricing and security uncertainties;
- The existence of different user profiles can require different needs-to-be-met.

Starting with main motivations for EV adoption, it is possible to identify a tendency in considering either economic or ecologic factors as main drivers. An interesting insight was that, from surveys, **clear majority identified ecologic reasons as main drivers, while during interviews economic factors were almost always identified as the most important motivators.** The only country where both surveys and interviews gave the same result was Portugal, where both identified economic drivers to be top-of-mind.

It was also noticed that Slovenia, Greece, and Portugal provide state incentives to support EV purchase, but all of them require some bureaucracy, and people need to apply to receive this support. On the other hand, **Denmark does not provide such support, and instead reduces the immediate tax applied to any vehicle purchase.** People in other countries suggested state incentives were given in the moment of purchase, and maybe what is being done in Denmark might be a possible solution for other countries: reduce taxation over EVs, to make them cheaper than ICEVs.

When talking about main barriers to EV adoption, it was verified that, besides economic struggles with initial investment, **the charging process is also something that greatly concerns people in Slovenia, Greece and Portugal, whereas in Denmark that concern doesn't seem to be as critical.** Both in Slovenia and Greece, charging problems are very closely related to the fact that private parking is scarce, and so people need to depend on public chargers more often, whereas in Azores people conveyed a "dramatic" scenario if there is the need to rely solely on public infrastructure.

As seen in different countries, energy literacy seems to have some correlation with EV adoption. Denmark, the country with the highest EV adoption percentage, is also the one displaying higher energy literacy. In Greece it was also noticed a difference in literacy between EV enthusiasts and "common users", allowing us to assume that the bigger the research a person does on having and using the full potential of an EV, the higher their energy literacy will become. Nevertheless, it doesn't seem to be impacting EV adoption.

Something that was pointed out in every country was the perceived lack of public charging infrastructures. **EV owners see the available network as insufficient, especially when travelling**

outside of big cities. All assume increased planning is the main routine change that comes with driving an EV, but are concerned with not having enough alternatives in emergency scenarios. This was more noticeable in Azores, since São Miguel Island has very few chargers, and people reported a lot of them not working, or not even being there.

In general, people seem to prefer having a way to charge at home, when that's possible to install, due to increased convenience and lower prices. Also, plug-in rates seem to be more dependent on whether people can charge at home or at work, or if they rely solely on public infrastructure. Many that charge at home mentioned having a setting in their car that defined how much, or at what time to charge, and if they feel secure that always plugging the car in won't degrade the battery faster, they might even prefer to do it.

There's a perception that owning a car is a symbol of status, and in all countries, people ended up admitting that might be happening in some more than others, but a common perception was that this was more important when talking about EVs, since the majority is priced higher than the equivalent ICEV. It was noticed people are aware mobility is shifting, and different ways of going from A to B are being considered. Nevertheless, the main perception is that this is already a reality in Denmark, but other countries still have a long way to go and are still highly dependent on private car for daily commuting.

9 Impact of V2X in the EV user experience

When talking about V2X, a common concern among users is “how will it work?” People are not aware of what this technology is, and what impacts it might have in their daily lives.

In general, people assume there could be benefits for them, but some struggle to identify them, mainly because they feel it will benefit the energy companies more than themselves. Nevertheless, there are 3 main topics that are the focus of almost all conversations, when V2X scenarios are discussed:

- What impact will it have on battery degradation?
- Will people get economic benefits for sharing energy they already paid for?
- Can people have some degree of control over the system, to assure their personal mobility needs aren’t jeopardised?

Battery degradation is recurringly the first concern people convey, when explained what V2X means. Many assume they do not understand the specifics of how a battery works, but believe that increasing the number of charging and discharging cycles (as would happen in V2G exchanges) will decrease the life-span of their batteries, and that makes them uncomfortable. From what we gathered, the main issue is not battery degradation per se, but the perception of extremely high prices on new batteries, costing “almost as much as a new car”.

That brings to the second point mentioned, where people expect to receive compensation for allowing a system that might make them have to buy a new battery sooner than planned. Therefore, economic advantages are expected, and almost seen as mandatory, when accepting V2G energy exchanges. People are divided between receiving direct adjustments for energy shared, or having discounts on electricity prices, but both seem to work, as long as people feel they are getting this monetary compensation.

Lastly, control over the system seems to be crucial for majority of users. They don’t feel the need to know exactly what’s happening, where the energy is going to. They need to assure that they have enough battery for their daily needs, and expect to be able to set limits, such as only allowing the grid to take a certain percentage per day, or even asking to assure a specific range at a specific time. Others also mentioned having the possibility of occasionally opting out in case they want to make longer trips and require a full battery. Besides assuring mobility needs, they also expect to be informed of how much energy was taken from their batteries, but they expect this to happen with a notification, or preferably included in their electricity monthly invoice.

It's worth mentioning that some people see V2G and V2X technologies as potentially something that could be a steppingstone to creating more community-driven scenarios, where energy would be shared among neighbours and energy needs assured for all.

10 Conclusions

This deliverable presents the results and insights gathered from quantitative and qualitative studies done with EV owners and experts across Denmark, Greece, Portugal and Slovenia.

These show us what's the current perception and context regarding EV ownership and daily use, namely identifying main needs and common concerns and struggles. It was noticed that, even though sustainability has a big role in this subject, population's main driver seems to be related with economic issues, both when considering initial investments for EV adoption, and economic gains perceived with using electricity instead of fuel to charge their cars.

Public charging networks are seen as the main issue to resolve across all countries, and this could have an impact in promoting (or preventing) mass EV adoption.

V2X seems to be perceived as an interesting technology, but people need assurances regarding impact on battery degradation, economic advantages, and ability to control the system, to assure personal mobility needs.

These insights were verified across the four countries studied. However, some contextual differences show that a wider characterization of the European reality may be required to identify common patterns and behaviours, so to answer the needs and concerns of European EV present and future drivers.

Finally, it would have been interesting to identify and address specific gender related needs and concerns. However, an analysis on a wider sample would be required, since the available one was not statistically representative to draw conclusions regarding demographics.

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APPENDIX A: City Research Template

City research template

How to fill-in the City research template.

In this template we would like you to write down information which will help us prepare the research for **Task 3.1** regarding Electrical Vehicles Users Needs and Concerns on the 4 cities: Ponta Delgada (PT), Krško (SI), Mesogia (GR), and Rønne (DK).

After filling-in the template, please rename it as **"'City name' research template for 3.1_ev4eu** before returning it.

State the city for which you will fill in the information.

(City name)

Indicate an estimation of EV users in this city and total nr. of inhabitants. Please explain how you calculated this number and cite the references you used.

(Nr. of EV Users in the City) (Formula) (References)

Indicate the name and contact details of who will be the key informant for your city.

A Key informant provides information about participants or situations where the participants are less able to provide the perspective themselves or where the researcher cannot themself know the research population in detail. This person should have the ability to speak and write fluently in both English and the local language.

(Name) (Job role) (Email) (Phone Nr.)

Indicate the name of a recruitment agency or multiple, that could help us recruit research subjects for the field research.

(Recruitment agency name) (Website) (Email)

List the main barriers to the adoption of V2X technology in your city/country.

Open question

Stakeholders map template

How to fill-in the stakeholders map template

Indicate who are the stakeholders that **have or should have a say on the European landscape and particularly that are meaningful for the EV4EU project in your city**.

We'll have some themes under which you can identify the stakeholders. You'll group them through numbering, on which the **number "1" is the one you consider the most important and so on.** You can add as many stakeholders to each theme as you want but never forget that the ones that appear on top are the most important.

You can also add other stakeholders that you consider important and, finally, you don't have to fill-in all the brackets. Just add the stakeholders that make sense from your perspective.

When available, **please provide de contact details of the person we can reach out to conduct a stakeholder interview**. **Let us know if this person speaks English, by writing EN** at the end.

Stakeholder themes:

Electricity Retailers
1. (Stakeholder), (Contact person name), (Email), (EN when applicable)
2.
3.
4.
5.

Policy makers
1.
2.
3.
4.
5.

Investors
1.
2.
3.
4.
5.

Authorities

1.
2.
3.
4.
5.

System Operators

1.
2.
3.
4.
5.

Universities

1.
2.
3.
4.
5.

NGO's

1.
2.
3.
4.
5.

Individual and collectives users[1]

1.
2.
3.
4.
5.

Individual and collectives users[1]

1.
2.
3.
4.
5.

[1]Individual EV users, Companies/ municipalities with private EVs fleets, Individual Self-Consumers with EV's, Energy Communities and Collective Self-Consumers with EVs, Electric buses fleet operators Companies, Electric freight fleet transportation Companies.

Other Relevant stakeholders

1.
2.
3.
4.
5.

Thank You

APPENDIX B: Expert interview script

To interview identified experts, the team used the following script structure:

1. Introduction
2. Questions in "General – EVs" topic
3. Questions in topic that applies to person being interviewed (according to type of entity they work in)
4. Questions in "General – V2X" topic
5. Final questions

Introduction

Welcome message, introducing interviewer. Ask interviewee to introduce themselves, explaining what's their role in the company they work with.

General - EVs

What's your position regarding electric vehicles (EVs)?
Do you own or have ever driven an EV? [if answer is "yes", include "EV Owners" topic]

EV Owners

What's your main motivation for acquiring an EV car?
If you had to order the following items by importance in your decision to have an EV car, how would that look like?

- Economical concerns
- Ecological thinking (concerns about CO2 footprint)
- Cultural or societal influence (if car is perceived as a status symbol, and owning an EV means something when positioning yourself before others)
- State incentives

Do you believe EV cars are better for the planet? Why, or why not?
Would you be willing to have an EV if there were no state incentives?
What kind of incentives do you believe would be useful to implement, to help with EV mass adoption?

What are your charging habits?

- How often do you charge your EV?
- Usually, how do you decide you need to charge your car? (battery percentage left, kms left, charge everyday to avoid having empty battery, other)
- Have you ever run out of charge, or got really close to it? How do you cope with that? (assess range anxiety)
- Do you prefer to use slow of fast chargers? Why?
- Where do you charge it? Why? Why not other places? How is that experience?
    - [if at work] → How does the charging system work? Everyone charges simultaneously? Or is it a "first in first out" (FIFO) system? What would you prefer?
    - [if in condominium] → Did you have to install a wall-box? Problems with condominium approval? How was the process? How is the electricity paid for?
- What's your opinion regarding public chargers?
    - Are there any public chargers close to you (home or work)?
    - Have you ever charged in a public charger? How is that experience?
- If you had problems charging your car, who would you contact for help? (for different types of chargers, but focusing on public ones)

Regarding batteries, this is a point of big concerns when talking about EVs, especially regarding battery degradation. What's your take in this subject?

- Were you advised to use certain types of charges more often than others? (example, prefer slow chargers rather than fast ones)
- What do you believe is the average duration of an EV battery?
- If batteries were recyclable, do you consider this would have an impact regarding mass adoption of EVs?

Energy Retailers

How is the energy market arrangement in your country? How does it work? (several players, one is bigger than the rest, monopoly...)
What's the role of the current energy market in EV adoption?
What are the plans regarding the future role of the energy market in EV adoption?

[now, skip to "General - V2X" topic, then ask the rest of the questions]
What role does the energy market expect/plan to have, regarding V2X technology?
What does the energy market need from a V2X system?
Could you talk about your offers regarding e-mobility and others?

System Operators

How many public chargers are there in your country / case-study municipality? How can we locate / identify them?
What are the current city constrains in your city / country?

- Are there public chargers? (are there enough?)
- Do people use them?
- Are they working?
- Who maintains them?
- Are there any barriers regarding the implementation of more chargers? (grid limit? potency limit?)
- Can you identify a typical user profile for those chargers, i.e., who is the typical person that chargers their EV in public chargers?
- Who defines where public chargers should be placed? With what criteria? (see if they take into account EV user needs, and non-EV user needs)

How would you classify the general population's energy literacy level? High, average or low?

- Do you believe there's a difference in energy literacy level between EV users and non-EV users?
- Do you think people need high energy literacy to adopt and use EVs?
- Is it important to take steps into increasing people's energy literacy? If it were up to you, what would you do?

What's the feeling surrounding all the new services and interfaces (that change from charger to charger, and other services related to EVs)?

- Does energy and digital literacy come into play in this scenario?

[now, skip to "General - V2X" topic, then ask the rest of the questions]
Are there any power consumption limits that can affect V2X technology?

Policy makers & Authorities

Do you have a perceived ratio of use of public transports versus private cars?
Do you believe road rules are followed by everyone? Or is there a perceived indifference to these rules?

- Specifically about EV chargers, what rules are there regarding their use?
- Do you feel people follow those rules (of using EV chargers)? Or are they often overlooked?

- Imagine a society where EV chargers' rules were not obeyed. How would you try to overcome that? Would you create any kind of "failsafe"?

What are the current city constrains in your city / country?

- Are there public chargers? (are there enough?)
- Do people use them?
- Are they working?
- Who maintains them?
- Are there any barriers regarding the implementation of more chargers? (grid limit? potency limit?)
- Who defines where public chargers should be placed? With what criteria? (see if they take into account EV user needs, and non-EV user needs)

What kind of rules and incentives are in place to push EV adoption?
What kind of rules and incentives were applied for EV adoption in the past, and what was the result? [Lessons learned, what worked, what didn't work]
Is there an expected future ban of internal combustion engine cars?
What kind of rules and incentives are in place regarding battery disposal?

[now, skip to "General - V2X" topic, then ask the rest of the questions]
Considering V2X technology, what local laws do we need to have in mind, that might be a barrier in the short-term?
What do city regulators need from a V2X system?
In a reality where a lot of charging vehicles and other equipments would be charging in a public space, what do you believe is the ideal way of managing and queueing charging criteria?

Investors
What would you identify as the main advantages of EVs?
What is the perceived main motivation for users to want an EV?
If you had to order the following items by importance in user's typical decision to have an EV, how would that look like?

- Economical concerns
- Ecological thinking (concerns about CO2 footprint)
- Cultural or societal influence (if car is perceived as a status symbol, and owning an EV means something when positioning yourself before others)
- State incentives

Do you believe different literacy levels can have an impact in this?
Regarding batteries, this is a point of big concerns when talking about EVs, especially regarding battery degradation. What's your take in this subject?

- Do you believe battery recycling will be possible in a near future, in large scale? Why, or why not?
- Do you consider this will have an impact regarding mass adoption of EVs?

Where do you believe it would be useful to invest, to promote EV adoption?
What makes you invest/what makes you proud in investing on the ev ecosystem?
What are the main shortcomings of this technology that still need to be overcome in order to gain mass adoption?
What do you think can be done to reduce the time spent on charging an EV and do you believe this has an impact on adoption or even on the perception of cars as symbols of personal "freedom"?

[now, skip to "General - V2X" topic, then ask the rest of the questions]
What would you identify as the main advantages of V2X technology? And the main barriers?
How do you envision the future of mobility to be like?

- What do we still need to develop to achieve that future?
- And what kinds of regulations, incentives and behaviours would need to change or be implemented, in order to allow that future?

Universities

What would you identify as the main advantages of EVs?
What is the perceived main motivation for users to want an EV?
If you had to order the following items by importance in user's typical decision to have an EV, how would that look like?

- Economical concerns
- Ecological thinking (concerns about CO2 footprint)
- Cultural or societal influence (if car is perceived as a status symbol, and owning an EV means something when positioning yourself before others)
- State incentives

Do you believe different literacy levels can have an impact in this?
How would you classify the general population's energy literacy level? High, average or low?

- Do you believe there's a difference in energy literacy level between EV users and non-EV users?
- Do you think people need high energy literacy to adopt and use EVs?
- Is it important to take steps into increasing people's energy literacy? If it were up to you, what would you do?

What's the feeling surrounding all the new services and interfaces (that change from charger to charger, and other services related to EVs)?

- Does energy and digital literacy come into play in this scenario?

Regarding batteries, this is a point of big concerns when talking about EVs, especially regarding battery degradation. What's your take in this subject?

- Do you believe battery recycling will be possible in a near future, in large scale? Why, or why not?
- Do you consider this will have an impact regarding mass adoption of EVs?

[now, skip to "General - V2X" topic, then ask the rest of the questions]
What would you identify as the main advantages of V2X technology? And the main barriers?
How do you envision the future of mobility to be like?

- What do we still need to develop to achieve that future?
- And what kinds of regulations, incentives and behaviours would need to change or be implemented, in order to allow that future?

In a reality where a lot of charging vehicles and other equipments would be charging in a public space, what do you believe is the ideal way of managing and queueing charging criteria?

- Have you tested with different systems? What went well, and what failed? What are the main lessons learned?

Car manufacturers

What is the perceived main motivation for users to want an EV?
If you had to order the following items by importance in user's typical decision to have an EV fleet, how would that look like?

- Economical concerns
- Ecological thinking (concerns about CO2 footprint)
- Cultural or societal influence (if car is perceived as a status symbol, and owning an EV means something when positioning yourself before others)
- State incentives

Do you believe different literacy levels can have an impact in this?

Do you believe EV cars are better for the planet? Why, or why not?
What kind of incentives do you believe would be useful to implement, to help with EV mass adoption?
Inside your company, do you have any kind of incentive in place for your workers to have an electric vehicle?
Do you provide chargers at the office, for your workers? How is the queueing management made? "First in first out" (FIFO) system? Simultaneous charging? Other? Why did you implement that system?
How would you classify the general population's energy literacy level? High, average or low?

- Do you believe there's a difference in energy literacy level between EV users and non-EV users?
- Do you think people need high energy literacy to adopt and use EVs?
- It is important to take steps into increasing people's energy literacy? If it were up to you, what would you do?

What's the feeling surrounding all the new services and interfaces (that change from charger to charger, and other services related to EVs)?

- Does energy and digital literacy come into play in this scenario?
- Do your clients usually go to you for help, when they have problems charging their cars? Does this happen more with public or private chargers?

Regarding batteries, this is a point of big concerns when talking about EVs, especially regarding battery degradation. What's your take in this subject?

- Are users advised to use certain types of charges more often than others? (example, prefer slow chargers rather than fast ones)
- What is the average duration of an EV battery?
- What kind of rules and incentives are in place regarding battery disposal?
- Do you believe battery recycling will be possible in a near future, in large scale? Why, or why not?
- Do you consider this will have an impact regarding mass adoption of EVs?

Companies with EV fleets

What's your main motivation for acquiring an EV fleet?
If you had to order the following items by importance in your decision to have an EV fleet, how would that look like?

- Economical concerns
- Ecological thinking (concerns about CO2 footprint)
- Cultural or societal influence (if car is perceived as a status symbol, and owning an EV means something when positioning yourself before others)
- State incentives

Do you believe EV cars are better for the planet? Why, or why not?
Would you be willing to have an EV if there were no state incentives?
What kind of incentives do you believe would be useful to implement, to help with EV mass adoption?
Talking about charging habits, do you have visibility on how often your employees charge their cars?

- Do you provide chargers at the office? Why, or why not?
    - How does the charging system work? Everyone charges simultaneously? Or is it a "first in first out" (FIFO) system? What would you prefer?
- Where are your employees allowed to charge the cars? Do you give them some kind of support regarding charging costs?

Regarding batteries, this is a point of big concerns when talking about EVs, especially regarding battery degradation. What's your take in this subject?

- Were you advised to use certain types of charges more often than others? (example, prefer slow chargers rather than fast ones)
- Do you give those types of instructions to your employees?
- What do you believe is the average duration of an EV battery?

- If batteries were recyclable, do you consider this would have an impact regarding mass adoption of EVs?

Communities & Associations

What was the drive that lead to the creation of your organisation? Did it start with a group of private EV users? Were there any political or comercial interests involved?
When was the association founded?
What's your main goal?
What are the main reasons people contact you?

- Mainly new users, or mainly "frequent users"?
- Main pains from EV users (new and frequent)
- Main benefits users get from the association
- Regarding existing incentives to adopt EVs, what burocracies are involved? Easy to navigate? Are people generally aware of these incentives?
- Chargers in condominiums, are they normal or not? Are there any regulations involved?

What is the daily activity of your association? What do you regularly do?

- Do you organize activities, events or other types of actions?
- How often?

How do you reach you users / interested people?
Do you support or intend to support any kind of comercial interests?
Do you have future plans, regarding EV users support?

General - V2X

What do you know about V2X technology?
What's your position regarding this technology?
Would you trust V2X technology? What would be necessary for you to agree to that technology?

APPENDIX C: Survey questions

Page 1 - Introduction

This study aims to understand users' opinions and experiences regarding electric vehicles (EVs) and V2X technology, from EV owners point of view. Your task will be to answer some questions regarding EV perception and use, as well as V2X technology. You will also indicate basic demographic data, which will only be used to describe the sample of this study.

You will need approximately 15 minutes to complete this survey.

Participation, Benefits and Risks

Participation in this research study is completely voluntary. You have the right to withdraw at any time or refuse to participate entirely. If you desire to withdraw, please simply close your internet browser. Risks are minimal for involvement in this study. It is very unlikely that answering these questions affects you emotionally or otherwise.

Confidentiality and Questions

All data obtained from participants will be kept anonymous. There will be no record that links the data collected from you with any personal data from which you could be identified (e.g., your name, address, email, etc.). Once anonymised, this data may be made available to researchers via accessible data repositories, and possibly used for other related research purposes. The data will be stored for at least 10 years.

Page 2 - Prolific platform

1. Please fill in your Prolific ID. [open ended question]

Page 3 - Energy Literacy

2. Please indicate from the list below the concepts that you recognise and would be able to explain to other in your own words.

[classify each item as “Don’t recognise”, “Recognise, but can’t explain”, “Recognise, but difficult to explain” or “Recognise, and easy to explain”]

- Your household’s contracted power
- The reason why your household’s contracted power is higher or lower than others
- The average kWh spent per month in your household
- What a energy efficient equipment means
- Identify equipments’ power usage
- The different types of energy sources that provide electricity in your country
- The difference between primary energy and useful energy
- The difference between a renewable and a non-renewable energy source
- Identify renewable energy sources available
- The difference between energy and electricity
- Identify the most important component of a battery

Page 4 - About EV’s

3. Considering electric vehicles, what’s your opinion regarding the following topics?

Please use the scale provided to answer each item. Consider that EV means "electric vehicle", and that ICEV means "internal combustion engine vehicle".

[drag a slider 1 or 2 points in the direction of the position they most agree with]

- EVs are very bad for society ← 0 → EVs are very good for society

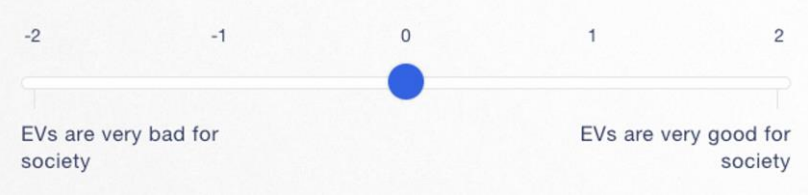


Figure 19: Example of the slider participants see in the survey

- EVs are very bad for the environment ← 0 → EVs are very good for the environment
- EVs are much more expensive than ICEVs, when accounting for the sum of purchase and "fuel" costs ← 0 → EVs are much cheaper than ICEVs, when accounting for the sum of purchase and "fuel" costs
- EVs are less efficient in using "fuel" than ICEVs ← 0 → EVs are more efficient in using "fuel" than ICEVs
- EVs are harder to "refuel" than ICEVs ← 0 → EVs are easier to "refuel" than ICEVs
- EVs are less durable than ICEVs ← 0 → EVs are more durable than ICEVs
- EVs need more maintenance than ICEVs ← 0 → EVs need less maintenance than ICEVs

4. How did you acquire an electric vehicle? [single choice]
   - I bought it
   - It's a company car
   - Other: _____

5. Did the company let you choose if you wanted an electric car? [single choice, only for participants who answered "It's a company car" in question 4.]
   - Yes
   - No

6. From the list below, select up to 3 main reasons that led you to have an electric car: [multiple choice, only for participants who answered "I bought it" in question 4., or "Yes" in question 5.]
   - Better for the environment, due to low CO2 footprint
   - Less noise
   - Cheaper "fuel"
   - State incentives / benefits / discounts for electric vehicles
   - The technology associated with electric vehicles
   - Someone I know has one and convinced me
   - Other: _____

7. What kind of incentives for the purchase of electric vehicles are you aware off in your country? Please elaborate. [open ended question]

8. Considering the list below, reorder by importance the types of incentives you would like to have, to push electric vehicle adoption: *Change the order according to your preference (1. - most important, 5. - least important)* [change order of items]
   - Percentage of EV cost price subsidised
   - If I change my internal combustion engine car for an electric one, I'll have a fixed value discount
   - If I change my internal combustion engine car for an electric one, I'll have a fixed percentage discount
   - Fiscal benefits during a 3-year period after the purchase, namely paying fewer taxes
   - Pay less electricity during a fixed amount of time

9. Is there any other type of incentive you would like to have, that wasn't listed above? [open ended question]

10. Would you consider acquiring a used EV? [single choice]
- Yes
- No

11. Why? [open ended question]

Page 5 - EV usage

12. How often do you use your car? [single choice]
- Every day, more than twice a day
- Every day, once or twice a day
- Every other day
- Two or three times a week
- Once a week
- Every other week
- A few times a month
- Less than once a month

13. On average, how long are your car rides, in Km? *Count only single drives, not go+return distance* [numeric input]

14. Choose from the list below the main purposes for which you use your car: [multiple choice]
- Go to work (daily commute)
- Other work-related trips
- Drive kids to school
- Supermarket
- Shopping (besides groceries)
- Leisure journeys/visits
- Other: _____

15. Besides the car, do you use any other kind of transportation means? Select below all that you use on a fairly regular basis: [multiple choice]
- Train
- Bus
- Subway
- Taxi (includes car riding services)
- Car sharing
- Bicycle (owned by me)
- Bicycle sharing
- Motorbike (owned by me)
- Motorbike sharing
- Scooter (owned by me)
- Scooter sharing
- I don't use any other type of transportation
- Other: _____

16. Choose from the list below the main purposes for which you use the alternative means you chose in the previous question: [multiple choice]

- Go to work (daily commute)
- Other work-related trips
- Drive kids to school
- Supermarket
- Shopping (besides groceries)
- Leisure journeys/visits
- I don't use any other type of transportation
- Other: _____

17. Do you feel like having an electric vehicle changed anything in your daily life? Please describe what has changed, and why. [open ended question]

Page 6 - Charging habits

18. Please indicate the average number of charges you do per month, in each of these types of chargers: [classify each item as: “None, I don't have or use this option”; “Less than 5 per month”; “Between 5 and 10 per month”; “Between 10 and 15 per month”; “More than 15 per month” or “I use this option everyday”]

- Charger at home
- Charger at office's garage or parking lot
- Charger in parking lot (not from your work's office)
- Charger in public space, inside the city
- Charger in highway charging point

19. On which context do you use each charging mode you chose on the previous question? [classify each item as: “Not applicable”; “Preferred method(s) of charging”; “Regular charges”; “Occasional charges”; “Emergency charges” or “Only use for long journeys or when I'm away from my city”]

- Charger at home
- Charger at office's garage or parking lot
- Charger in parking lot (not from your work's office)
- Charger in public space, inside the city
- Charger in highway charging point

20. If you had problems charging your car, who would you contact for help? Select the one you would most likely contact first. [single choice]

- The car dealership that sold me the car
- The car manufacturer
- Energy provider
- Charger provider (if you could trace it)
- Other: _____

21. Why? [open ended question]

22. Please only select the option “10 to 20 years”. [single choice, attention check question]

- Less than 1 year
- 1 to 5 years
- 5 to 10 years
- 10 to 15 years
- 10 to 20 years
- More than 20 years

Page 7 - Battery concerns

23. When charging your car, at which percentage do you decide it's necessary to charge the battery? Please consider your most regular criteria. [single choice]

- I charge it every day, regardless of the battery percentage
- When the battery percentage is around 50% - 60%
- When the battery percentage is around 40% - 50%
- When the battery percentage is around 30% - 40%
- When the battery percentage is around 20% - 30%
- When the battery percentage is around 10% - 20%
- When the battery percentage is around 0% - 10%
- Other percentage or criteria: _____

24. Why? [open ended question]

25. When charging your car, at which percentage do you stop charging? Please consider your most regular criteria. [single choice]

- I unplug the car as soon as I have to drive, regardless of percentage
- I always charge based on range needed, so I stop charging when the percentage equals the range I need
- When it reaches 100% (fully charged)
- When it reaches around 90% - 100%
- When it reaches around 80% - 90%
- When it reaches around 70% - 80%
- When it reaches around 60% - 70%
- When it reaches around 50% - 60%
- Other percentage or criteria: _____

26. Why? [open ended question]

27. Considering the list below, characterise your level of concern regarding batteries, that you feel impact you the most in your regular use of your car. [classify each item as "No impact", "Low impact", "Some impact" or "A lot of impact"]

- Difference in battery impact of using slow, normal and fast chargers
- Battery degradation that occurs over time
- Velocity of battery discharge depending on driving habits
- Life-expectancy of a battery
- Price of new batteries

28. Do you consider there's another concern regarding batteries, that wasn't listed above? [open ended question]

Page 8 - Future of E-Mobility

29. Imagine a scenario where chargers are largely available in public parking spots. On a scale of 1 to 7 (1 - zero benefit; 7 - maximum benefit), how much do you think that would benefit different public space users, namely: [classify each item on a scale from 1 to 7]

- People with electric cars
- People with non-electric cars
- People with other electric vehicles (example: electric bicycle)
- People with other non-electric vehicles (example: motorbike)
- Pedestrians

30. Why? [open ended question]

31. With which of these positions do you agree the most with? [single choice]
- Public parking spaces that have chargers should be exclusive to electric vehicles. Each neighbourhood should have enough parking spaces for the electric cars in that area.
- Public parking spaces that have chargers should be exclusive to electric vehicles. Each neighbourhood should have an equal number of parking spaces with and without chargers.
- Public parking spaces should be available to all cars, regardless of having a charger or not. There shouldn't be any parking spaces exclusive to electric cars.

32. Why? [open ended question]

33.Have you ever parked in a parking space dedicated to electric vehicle charging, but without the intention of charging your car? [single choice]
- Never
- Only for an emergency or quick errand
- Sometimes
- All the time

34. Do you notice other drivers parking in a space dedicated to electric vehicle charging, but without the intention of charging their cars? [single choice]
- Never
- Sometimes
- All the time

35. Do you feel safe leaving your car charging in a public charger during the night, while you're asleep? [single choice]
- Yes
- No

36. Why? [open ended question]

Page 9 - V2X

37. Have you ever heard of V2G or V2X, regarding electric vehicles? [single choice]
- Yes
- No

Page 10 - V2X uses and concerns

V2G stands for "vehicle to grid" and is a technology that enables energy to be pushed back to the power grid from the battery of an electric car. With this technology, a car battery can be charged and discharged based on different criteria, such as energy production or consumption nearby, and can help balance the power grid.

V2X stands for "vehicle-to-everything" and is about the communication between a vehicle and any entity that may affect, or may be affected by, the vehicle. It is a communication system that includes other types of communication, such as V2G (vehicle-to-grid), V2V (vehicle-to-vehicle), V2P (vehicle-to-pedestrian), V2D (vehicle-to-device), among other connections.

The main motivations for V2X are road safety, traffic efficiency, and energy savings, among others.

38. What kind of everyday uses would be most beneficial to you, considering a future where V2X technology is implemented? [open ended question]

39. Imagine a future where all vehicles are electric ones, and V2X technology is everywhere. Choose from the list below up to 3 main concerns you would have in that scenario: [multiple choice]

- Electricity availability for every car
- Public chargers network (guarantee enough public chargers)
- Car charging times
- Battery degradation
- Cost of electricity
- The compensation I should receive if the grid uses electricity from my car
- I would have no concerns
- Other: _____

40. Considering the possibility of your car functioning as a battery for the electric grid of your neighbourhood, what do you believe your electricity provider should do in that scenario? [single choice]

- Give me a discount on my electricity bill
- Pay me for the electricity used from my car (at the electricity price at that moment)
- Allow access to partners' offers and benefits
- Provide discounts on new battery purchases
- Ask if I allow my car's energy to be used before using it, and ensure it would be put back in a short time frame
- Nothing
- Other: _____

41. Why do you believe your electricity provider doesn't need to do anything? [open ended question, only for participants who answered "Nothing" in question 40.]

Page 11 - Demographics

42. With which gender do you identify? [single choice]

- Female
- Male
- Transgender female
- Transgender male
- Non-binary
- Prefer not to say
- Other: _____

43. What's you age group? [single choice]

- Under 18 years old
- 18 to 29 years old
- 30 to 49 years old
- 50 to 66 years old *[numbers changed in each geography, "66" should be replaced by age of retirement minus 1]*
- 67 to 75 years old *[numbers changed in each geography, "67" should be replaced by age of retirement]*
- 76+ years old

44. Would you say your home is located in what kind of setting? [single choice]

- Urban
- City outskirts
- Rural
- Other: _____

45. Which of these options best describes your home? [single choice]
- House with garage
- House without garage
- Apartment with garage
- Apartment without garage

46. Which of these options best describes your work routine? [single choice]
- Mostly remote work (never or very rarely at place of work)
- Hybrid work (sometimes at place of work and sometimes at home)
- Mostly in-person work (always at place of work)

47. How far away from your place of work do you live, in Km? [numeric input]

48. What's your highest level of education? [single choice]
- Elementary school
- Middle school
- High school
- Bachelor's degree or equivalent
- Master's degree or equivalent
- PhD or equivalent
- Other: _____

49. What's your household's average gross annual income? [single choice, numbers changed in each geography, values depend on minimum wage in each country]
- Less than 15.000€/year
- 15.000€ to 30.000€/year
- 30.000€ to 60.000€/year
- More than 60.000€/year

50. How many people are there in your household? [numeric input]

51. Do you have any comments you would like to add regarding any part of this study? [open ended question]

Extra questions:
Since we had to share our survey through other means, we added the following questions, to make up for the lack of screeners the Prolific platform assured.
1. Do you have an electric vehicle? [single choice]
- Yes
- No

2. Have you answered any other surveys regarding Electric Vehicles in the past 3 months? [single choice]
- Yes
- No

3. Are you currently living in [country where survey is being shared]? [single choice]
   - Yes
   - No

APPENDIX D: Field Trip Research Protocol

For each field trip, we conducted 3 types of research activities:

- User interviews;
- Workshop with local EV4EU partners;
- Ethnographic observations.

We expect each visit to last 6 days, distributed as follows (small adjustments might be necessary, depending on each geography and possible recruitment constraints):

Table 5: Field trip activity plan

Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Travel to site	2 User interviews + Ethnographic observations	2 User interviews + Ethnographic observations	2 User interviews + Ethnographic observations	Workshop with local partners	Return trip

For each research activity, we have specific goals defined, as well as guidelines for conducting them.

User interviews:

Goal:

Understand how users perceive and interact with the public charging network available for them. Discover what users expect from a V2X reality, specifically their needs, concerns, and opinions about that technology.

How to conduct:

Recruit 5 to 6 participants, considering the following recruitment constrains:

- 50% male and 50% female users, from different age groups if possible;
- EV drivers (either privately owned or company car, try to ensure both);
- Should use public chargers on a regular basis, or at least have already used them before;
- Have participants with varying driving habits (everyday vs. occasional; short vs. long drives);

Each interview is predicted to last around 1 hour, and should be conducted as follows:

- Initial conversation about EVs and the user's driving habits and routines, as well as an introduction to the V2X technology and what it entails (around 30 minutes);
- Accompany the participant to a charging point, and ask for a charging process demonstration (around 20 minutes);
- Debrief and final questions, including main barriers and frustrations associated with EV public chargers, and V2X concerns (around 10 minutes).

Script:

Intro topics and questions:

- What's your position regarding electric vehicles (EVs)?
- Do you believe EV cars are better for the planet? Why, or why not?
- Please describe a typical day when you drive your EV. What do you do?

- What do you need, to make driving your EV increasingly better?

Motivations:

- What's your main motivation for acquiring an EV?
- If you had to order the following items by importance in your decision to have an EV car, how would that look like?
    - Economical concerns
    - Environmental thinking (aka CO2 footprint)
    - Cultural or societal influence
    - State incentives (do you know any?)
- Would you be willing to have an EV if there were no state incentives?
- What kind of incentives do you believe would be useful to implement, to help with EV mass adoption?

Charging habits:

- What are your charging habits?
- How often do you charge your EV?
- Usually, how do you decide you need to charge your car? Were you advised to do so? (battery percentage left, kms left, charge everyday to avoid having empty battery, other criteria - *try to understand plug-in rate here*)
- Have you ever run out of charge, or got really close to it? How did you cope with that? (range anxiety)
- Do you prefer to use slow of fast chargers? Why? Were you advised to do so?
- Where do you charge it? Why? Why not other places? How is that experience?
    - [if place with lot of chargers] → How does the charging system work? Everyone charges simultaneously? Or is it a "first in first out" (FIFO) system? What would you prefer?
    - [if in condominium]:
        - At your home, do you know where your electric meter is located? (inside the apartment, outside, in garage, etc)
        - Do you know your contracted power, and if it is a mono-phasic ou tri-phasic installation?
        - Do you know where the common services installation board (electric meter for common areas) is located?
        - Do you know the common services contracted power, and if it is a mono-phasic ou tri-phasic installation?
        - Did you have to install a wall-box, or do you use a normal plug? Problems with condominium approval? How was the process? How is the electricity paid for?
        - Do you know the power of your charger? (3.7kW, 7.4kW, 11kW, 22kW)
- What's your opinion regarding public chargers?
- Are there any public chargers close to you (home or work)?
- Have you ever charged in a public charger? How was that experience?
- If you had problems charging your car, who would you contact for help? (for different types of chargers, but focusing on public ones)

Concerns with batteries:

- Regarding EV batteries, what's your take in this subject? (battery degradation)
- Were you advised to use certain types of charges more often than others? (example, prefer slow chargers rather than fast ones)
- What do you believe is the average duration of an EV battery?

- If batteries were recyclable, do you consider this would have an impact regarding mass adoption of EVs?

V2X scenarios:

- There's a technology developing that allows you to provide electricity to the city. This means that, for example, you're charging your car during the night, and it will eventually reach 100%, but if something else needs energy more urgently, then the electric grid will take electricity from your car's battery and use it for something else. What do you think about this?
- Do you believe this could bring you benefits?
- Imagine the following scenario:
  It's the year 2050, there are many electric cars. The technology mentioned is in use, and everything is connected.
  Could you please give more details about this scenario? What do you imagine this future could be?
  [support questions]
  - amount of chargers? where are they?
  - queueing rules? charging management systems? what's fair? what rules are in place?
  - with what exactly does your EV connect with? how is that good for you?
  - what if the system would transfer battery to your neighbour's car, because it knew somehow you didn't need it and he did? (this to avoid an energy peak) - considerations about being an automatic decision, versus you being asked every time by the system
  - what if the system would charge your battery to avoid wasting energy (like renewables). How this work for you? - considerations about being an automatic decision, versus you being asked every time by the system
- Would you trust this type of technology? Why?
- What would be necessary, to make something like this a reality?

Charging demonstration:

Ask participant to take us to a charging point and show us a bit of how this process can occur.

- Was it easy to find a charger? Which method was used?
- Was the charger available/working? If not, what's the feeling? How to overcome this?
- When you get to the charger, what do you do next? Is it a simple or complex process?
- Can you tell how much you're gonna pay before charging? (if applicable)
- If you need to ask for help, because something's not working. What do you do?

Debrief topics and questions:

Draw a simple journey with an emotion curve with the participant, to recap all the steps, what was needed, and how the person felt in each moment.

- How did the observation go?
- What's the feeling in the participant, regarding the experience?
- Did this feeling vary during the whole process?
- Would this change in a V2X reality?

Workshop with local EV4EU partners:

Goal:

Share main findings collected with stakeholder interviews, surveys and user interviews. Work with partners on perceived barriers, opportunities and concerns. Prioritise what to tackle and ideate possible scenarios, focusing on local needs and barriers.

How to prepare:

1. Schedule the session before the visit, collecting a participants list for each geography.
2. Define workshop activities and agenda.
3. Work with partner at location to book a room for the workshop.
4. Prepare materials needed for each activity of the workshop.
5. Share workshop agenda with participants (at the beginning of the workshop).
6. Conduct workshop.
7. Analyse results.

Agenda:

Table 6: Agenda for Workshops with partners

Time	Activity	Description
10 mins	Ice Breaker – "Get to know the locals"	Create a "typical local persona". What characterizes the local people? Do it as a "cartoon", like creating a stereotype. Rules: - list 5 key characteristics of any local person
20 mins	Share info & take notes	SEL teams presents findings from that location, collected so far. Each participant takes notes on post-its. Rules: - notes can be anything, thoughts or ideas that come to mind, questions/doubts you have, something you didn't know or you don't agree with, etc. - only 1 note per post-it - write as many as you like
30 mins	Share notes & affinity map	Each participant presents their notes to the group. Rules: - each participant can only share a maximum of 10 notes (choose the best/most relevant, the others will be placed on a "parking lot") - participants can write additional notes while they hear others share theirs (maximum note rule still applies)
15 mins	Coffee break	-
30 mins	Discuss & ideate	Divide participants into 2 to 3 groups. Each group must generate formal ideas, based on notes shared previously and on notes available in the "parking lot". Rules: - each group can only present 2 ideas in the end. Extra ones can also be added to the "parking lot" (nothing is lost, we'll just focus on the most relevant things, and the rest will be looked at later) - ideas should include why it is important to the project and to themselves
25 mins	Present ideas + Q&A	Each group presents their 2 ideas, and others can ask for clarifications.
40 mins	Final discussion	Moment to reflect on what was shared. If there's time, look at the "parking lot" and discuss possible extra ideas that could be interesting to explore.

10 mins	Wrap-up	Final remarks, a recap of ideas shared and how this will inform the rest of the tasks. Participants fill small survey, evaluating work session.

Ethnographic observations:

Goal:

Collect qualitative information that can complement findings from surveys and user interviews, also including the perspective from non-EV drivers. We want to focus on the following topics:

1. Opinion on EVs
2. Opinion on EV public chargers
3. EV charging experience [exclusive for EV drivers]
4. Reasons for not owning an EV, and what would make them consider acquiring one [exclusive for non-EV drivers]

How to conduct:

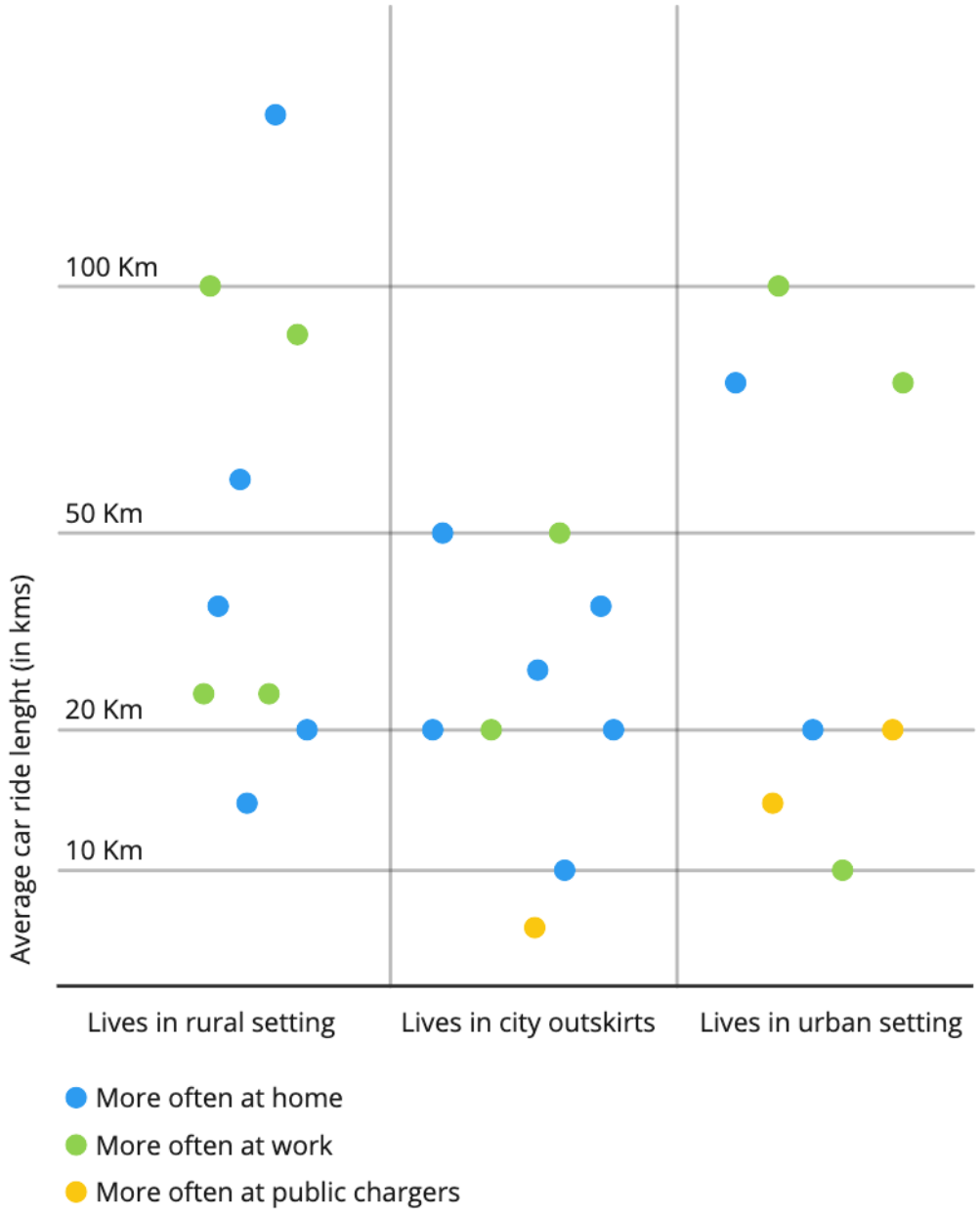
These observations will be conducted everytime the team is available and is nearby a public charging station. We will conduct short talks with EV drivers at charging stations.
Also, the team will search for people that are not EV drivers and conduct short talks with them.
This is a highly volatile activity and will only happen if possible.

ANNEX I

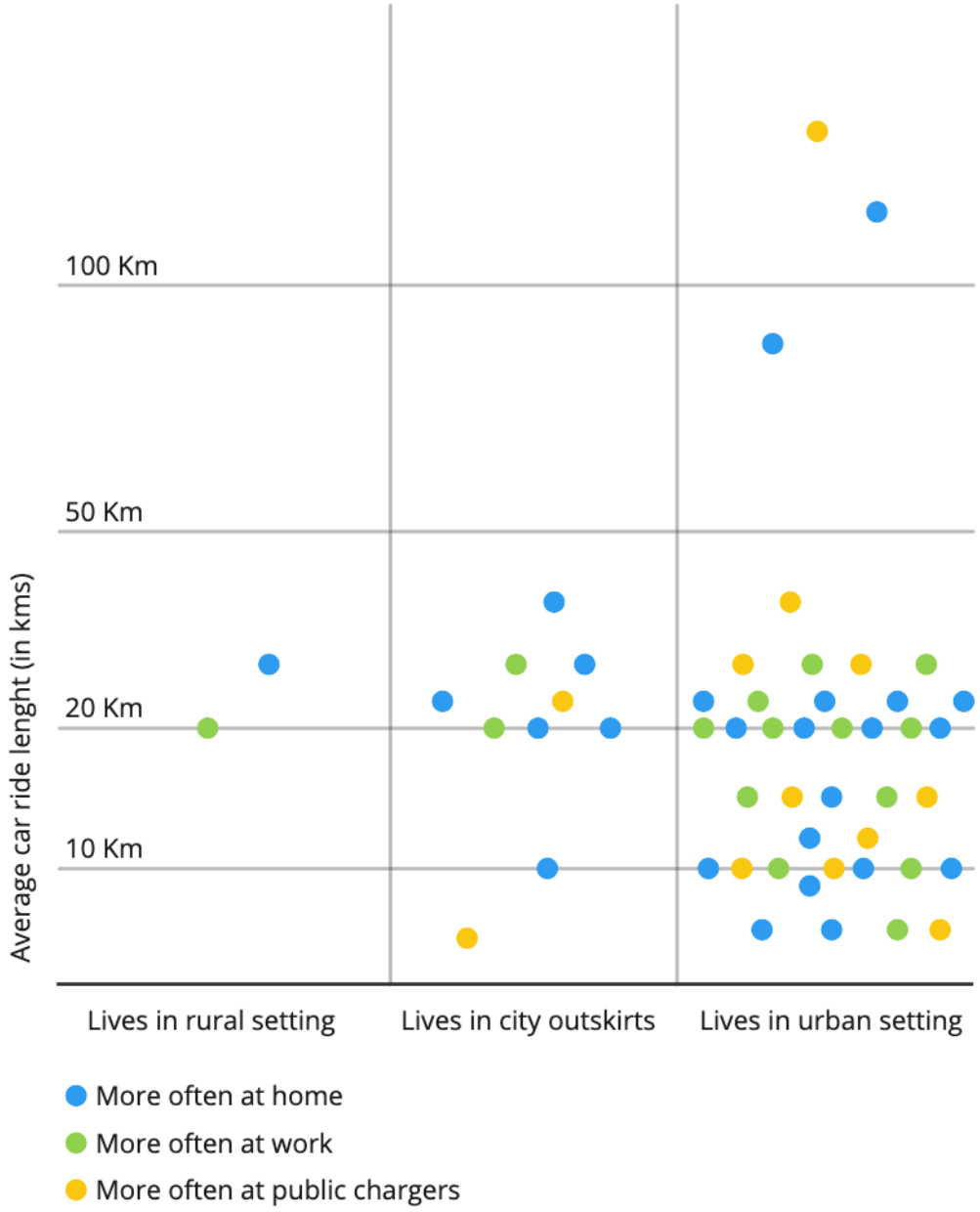
Correlation between type of residence area, average distance for each trip, and where EV charges more often for each country

These results were collected with quantitative data from surveys in each country. The visualization of these results is as follows:

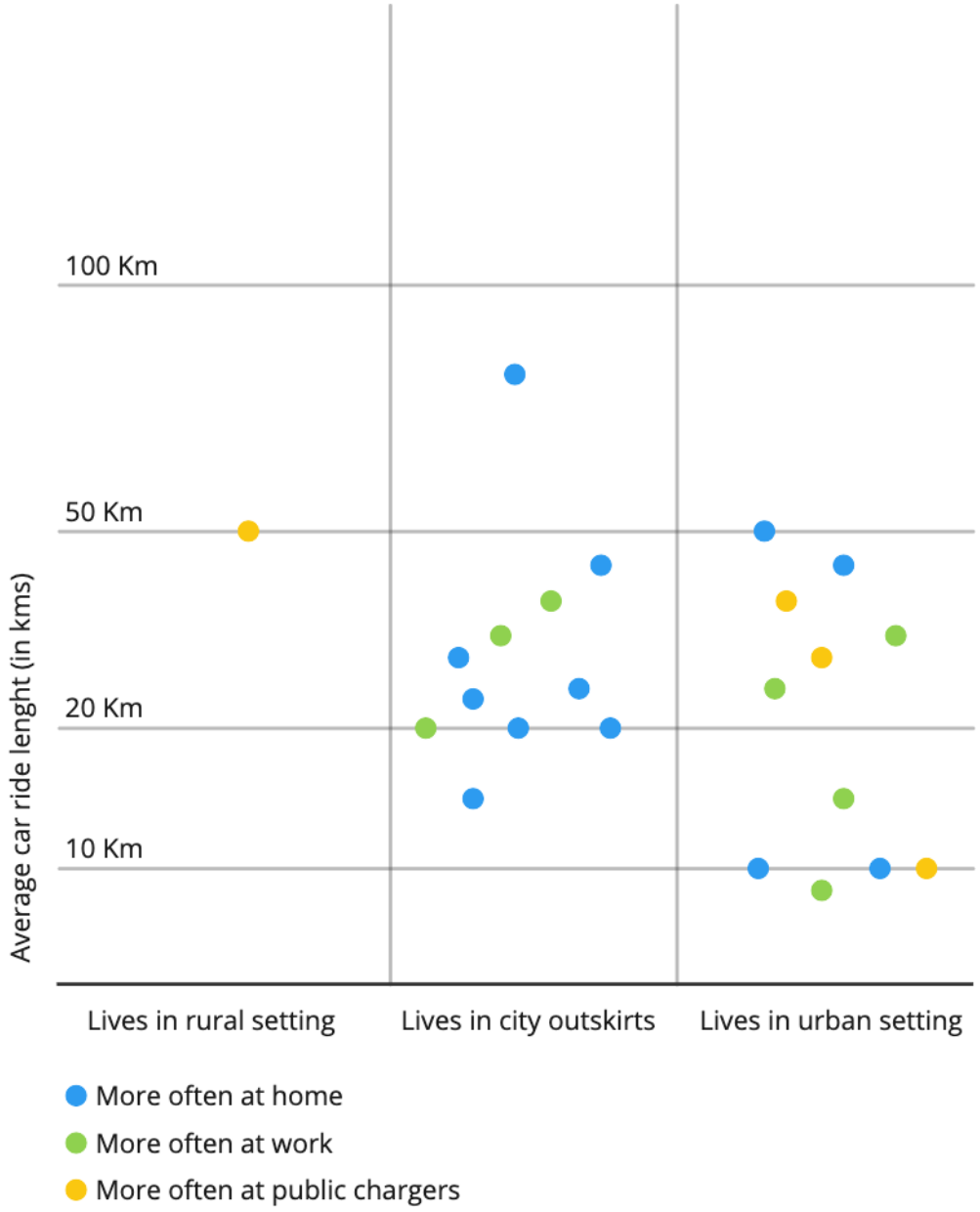
Slovenia:



Greece:


100 Km
50 Km
20 Km
10 Km
Average car ride lenght (in kms)
Lives in rural setting
Lives in city outskirts
Lives in urban setting
More often at home
More often at work
More often at public chargers

Denmark:


100 Km
50 Km
20 Km
10 Km
Average car ride lenght (in kms)
Lives in rural setting
Lives in city outskirts
Lives in urban setting
More often at home
More often at work
More often at public chargers

Portugal:


100 Km
50 Km
20 Km
10 Km
Average car ride lenght (in kms)
Lives in rural setting
Lives in city outskirts
Lives in urban setting
More often at home
More often at work
More often at public chargers