Charging of electric vehicles and potential for end user flexibility: Case study from Norway

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Research Article

Keywords: flexibility, end-users, electric vehicle, smart charging, domestication

Posted Date: June 2nd, 2021

DOI: https://doi.org/10.21203/rs.3.rs-417639/v1

Abstract

Background

Norway is currently in the process of replacing internal combustion engine (ICE) vehicles with electric vehicles (EV). The steadily increasing number of EVs being charged in the mornings and evenings in Norway has added strain to local electricity grids. This article presents findings from a qualitative study of participants in one Norwegian demonstration project on smart EV charging, which intends to make charging more flexible. In order to establish a systematic overview of the relationship between everyday complexities and EV charging end user flexibility, we employ a domestication theory approach and analyze how different charging practices becomes a part of everyday life.

Result

In this paper we argue that the domestication theory approach, with its focus on symbolic, practical, and cognitive aspects of technology use and appropriation, highlights how EV uptake and ancillary technologies is modulated by a wide array of factors. Our findings present four different motivations behind our respondents' choice to participate in a smart charging pilot. The first one is the fire safe charging device. Second is motivated by the pure joy of smart home technology, third is the practical-economical motivation, and the fourth is flexibility as comfort.

Conclusions

In the green transition whit new renewables and the electrification of transport system the EV charges are a hot spot. By analyzing how different EV owner's domestication their EV charging we can understand how flexibility from the end-user are individual practice that is connected to the everyday life routine and interest. EV owners do not have one profile but are driven by different kind of motivation. This micro perspective of understanding the flexibility is crucial when the individuals EV charging practice is both a part of the challenges and the solution in the energy transition where the electric grid need to be stabilized.

Introduction

As energy transitions unfold, new complexities emerge as changes across infrastructures and sectors affect one another [1, 2]. The electricity grid is particularly prone to be impacted by such dynamics. On the one hand, new and variable renewable energy production provides new challenges in terms of synchronizing the supply and demand of electricity in time [3–5]. At the same time, the demand for electricity increases, as sectors such as transport becomes electrified [6, 7]. Such dynamics have resulted in an increasing interest amongst policy makers and innovators in working to make energy consumption

more flexible [8–10] through reducing demand during peak-load hours and shifting it to other times of the day [11].

In this paper, we focus on flexibility amongst households, and more specifically work that seeks to make the charging of electric vehicles more flexible. The focus amongst those working to instigate flexible energy consumption amongst households has been to provide economic signals, often combined with technologies mediating these signals in order to guide individual households to adjust their energy consumption. This has often been referred to as demand-side response (DSR) or demand-side management (DSM). Most mechanisms of this type have assumed that the flexibility of individuals will be motivated by economic incentives and rational choices [12–14] although this is something that many social scientists have been problematized.

Over the last decade there has also been an expansion in the way that the social sciences have analyzed schemes that are supposed to provide end-user flexibility [15] focusing on the elements that constitute practices in everyday life [16]. Through such expansions, focus has also shifted from mainly addressing how to implement DSR to exploring the unanticipated consequences of such mechanisms. One example is the work of Powells and Fell [17], that explores how price signals and technologies that promote flexible consumption of energy tends to re-enforce existing social divisions. Through the observation that the affluent have both the technological means (e.g. electric vehicles, thermal loads, batteries) to capitalize on flexibility, and the financial means to choose if they want to participate or not, they develop the concept of ´flexibility capital´ to highlight that not everyone has the same ability to be flexible. Johnson [18] use the idea of “flexibility woman” to show who takes the burden of doing flexibility work in households that are unable to afford smart home equipment. This type of research is important to point towards potential risks, unwanted impacts and injustices that may be reinforced by the introduction these technologies.

Another approach taken by social scientists have been to reality check some of the assumptions (such as the assumption that people are mostly motivated by economic gains) that tend to enter into design processes in the largely top-down driven implementation of smart energy technology for home users [19]. As more such technologies are envisioned and deployed in the home setting in more and more advanced iterations, it is increasingly important to evaluate to what extent technology development processes employ a salient user perspective vis-à-vis the more traditional economic and technological approaches to grid optimization.

Smart EV charging is one of the newer add-ons to the different configurations of smart home devices. Thus, in this paper we zoom in on the Norwegian case, where a rapidly unfolding electrification of transport [5, 20] has resulted in a new, local demand for flexibility. This paper investigates a case featuring flexible EV charging to explore how end user flexibility, stemming either from technological fixes or behavior change, enter and modulate everyday life. In the last decade or so, this kind of demand response (DR) technology has been rather immature and the issue of flexibility has been treated on conceptual level, with few empirical studies looking at actual implementation of for instance smart

charging and its relation to flexibility work. Thus, in this paper we study the shaping of flexibility as individual processes of the use of smart electric vehicles charging in private households. We ask; What are the ways in which the EV-charger is domesticated, and what can this tell us about the potential for flexible end use of EV charging?

The following section will first purview some central aspects of EV policy and regulatory measures, as they pertain to the rather rapid deployment of EVs in Norway. Thereafter, a short state of the art of smart grids and charging in Norway will be presented. Section 3 will be dedicated to describing the domestication theory approach, and give samples of how this perspective may be applied to understand how technology is appropriated, used, and made sense of by users – a suite of simultaneously ongoing processes that each have a determining effect on how and whether a technological artefact becomes a part of everyday life of end users. Finally, Sect. 4 and 5 are dedicated to analysis of results and conclusions respectively.

The Norwegian Ev Politics And The Smart Charging

The Norwegian electricity system is close to 100% renewable. This means that to achieve its commitment to emission reductions as promised under the EU renewable energy directive and the Paris climate agreement, the main policy attention has been on the transport sector and on increasing the share of electric mobility. Norway has implemented a series of quite radical policies over the last 25 years to stimulate the uptake of electric vehicles. The political goal has been that all new cars sold by 2025 should be either zero emission (electric or hydrogen) or low emission (plug in hybrid). Over the last years, electric vehicles have become a mainstream and normalized element in Norwegian mobility culture [21] and today more than 52 % of new car sales are electric in novembere 2020 (EV association, 2021). Therefore, it seems the policy efforts aimed at the transportation sector have, although not without its costs in subsidies and benefits for EV owners, been successful. Even though a ceiling of EV adoption rate is still nowhere in sight, a question of future adoption rates still remains, as deployment targeted at for instance rural areas are lagging behind.

Even so, the rapid rate of adoption in Norway means that electric vehicles to some degrees have become a substantial contributor to an increasing demand for grid capacity in Norway. Although electric vehicles are very fuel efficient and electrification of the total private car park represents a modest 0,42 % of the total electricity use in Norway [22] , this can still impact local conditions where many new electrical appliances (i.e. in lieu of phased out oil burners) are added yearly to local, aging neighborhood grids, affecting them considerably. Thus, the increase in deployment of EVs has resulted in several new practical challenges, especially related to providing enough charging infrastructure for people living in apartment buildings, community housing, and other buildings without alternatives to public parking, consequently with little access to charging and few prospects of introducing it.

This challenge has been exacerbated by stricter regulations and the advent of a responsible charging culture that stresses safety more. In the early days of electric vehicles in Norway, car owners would just

simply plug their electric vehicle into a regular socket wherever one was found in any available spot and charge outside their home or in their own garage. However, where once familiar scenes of cords emerging through second story kitchen windows to bridge the gap between car and grid, safety concerns have now encouraged all but most EV users to install dedicated EV charging stations. These are a huge improvement on fire safety, and provides the added bonus of higher charging speed. This has resulted in a mass market for different kinds of EV chargers in Norway, and they often come bundled with the car at a discount. On the pilot front, many actors, especially grid operators, are busy implementing these chargers in all kinds of homes in order to employ their smart charging capabilities, allowing them not only to provide safer, faster charging, but also load patterns that are sensitive to grid congestion.

Domestication of the smart home charger.

In this study we employ the domestication theory perspective [23, 24]. In its first iteration it was employed to understand how media technology was a matter of active use rather than passive consumption [25]. This was a perspective that at the time gave back some long-lost agency to users of media technologies, that hitherto had been described mostly as passive consumers vulnerable to dangerous effects of media content [26]. This is relevant for other technologies as well, as it makes us less prone to blaming technological outcomes, whether successful or not, simply on the design of the technology itself [27]. In other words, it comes in handy for us when we are, as now, at a point in time where we need better knowledge on how to facilitate for EV adoption.

Domestication is good to use when we want to highlight how technology is becoming a part of user's everyday life, in this case especially how charging of the EV becomes a part of the habits and routines that are already present, and that make up the constellation of household members, electric vehicles and other appliances, old or new. But more importantly, the domestication theory brings to the foreground how such micro-networks form relationships between humans, artifacts, knowledge and institutions, and the interplay and influence of the everyday practices [23].With the concept of re-domestication [28] we can further understanding how the EV owners when adopting an EV not only need to learn how driving an EV differs from driving a conventional car, but also ancillary activities like how to charge the EV. Filling up the tank, or in this case the battery, is different than how one does with a fossil fuel car. And, as we pay attention to how new kinds of practices arise, we see that the difference is more substantial than what is revealed in a cursory analysis of the moment of plugging in. In other words, the EV owners charging habits is a part of the EV owners' domestication of the EV.

Thus, domestication theory stresses the importance of the symbolic value, not just the pure function, of technologies [29]. In short, a domestication analysis considers three aspects of technology appropriation and use: the symbolic, the practical, and the cognitive. These aspects of technology appropriation and use is provided by scripts and produced by the way the script is read and the object is used [30, 31]. This can be viewed as the communicative aspect of technology, how technology can be read as a text, and by which users interpret the technology and pass on their interpretations to others. In other words, a higher (order) "value" may be attached to the use of the object, which is capable of conveying parts of our

identities to our surroundings. Practical aspects of technology use address the actual use of a technology, its affordance (or lack thereof), or whether the use is considered to successfully achieve the expected results. Plainly, it is answered by the question “how practical is it?”. Finally, cognitive aspects are related to learning, how and in what ways we are given a chance to get to know a technology, how we come to learn or teach ourselves or one another how to use it – and, of course, whether learning occurs at all [24].

Domestication theory enables our attuning towards the practical as well as cognitive and symbolic aspects of use and can qualify negotiations between users and technology along those three domains. Although not hierarchical, successful domestication is qualified only by the presence of mutually adaptive activities in all three domains [27]. Finally, domesticating is rarely a lonely undertaking; it always happens in relation to the remaining social and technological surroundings.

Previous studies finds that the EV user are been more conscious of their own energy consumption and more environmentally aware after buying a EV [32]. This can be understanding as a unintended side effect of saving time and money. One way of saving times is that they can chargers their EV at home where the electricity is cheaper than fusil fuel. In Norway the most EV owner owns their own house whit their own parking lot and want to charge their EV at home. This means that the EV charging are expanding the electricity peaks in Norwegian. To overcome this challenge different kind of smart charging solution is been developed, but we dos not only need a technological fix, we also need to understand what drives the EV user that are willing to test out the smart charging solution.

Method And Pilot Description

In Norway, 97 % of the fuse boxes have a smart meter and many EV owners have their own parking space at home. As mentioned in the introduction, grid companies in Norway is facing a massive increase of EVs in the grid, and a consequent need for costly upgrades to the low-voltage network. Thus, the goal of the pilot here studied was to test solutions that could aid in postponing these investments and at the same time provide EV charging as needed. The innovation that was tested in this pilot was allowing the smart meter to communicate with the EV charger to avoid charging at peak hours. The charger in question could connect to all kinds of EVs. However, the most common in this pilot was the BMW i3, and the study also included EVs of other brands like Mercedes, Tesla and the Hyundai Ionic.

The grid company recruited participants through announcing the pilot in the newsletter, where they also offered a 50% discount on a charger. In 2019, chargers were quite expansive (around €1800-2000). Because of technical issues, the smart part of the charging was not up and running before 2020 after we did our interviews. However, the pilot succeeded with its mission statement, and off-peak charging is now offered by this charger in this grid operator’s area.

Research design

This paper is built on a qualitative research design. Our study is based on semi-structured interviews with 14 of 18 pilot participants and users of smart EV chargers in Stavanger, western Norway, a town of about 130 700 inhabits. The informants were all over 18 years and did consent verbal that we could use the empirical martial. All the informants are been anonymized. Most of the interviews were conducted in the home of the respondent. The qualitative interviews are intended to provide in-depth knowledge and thick descriptions about the topic we want to research and took as the main departure point an ambition to discover each respondent's motivation for being a pilot participant in the first place. Originally, as we were attached to this pilot site ourselves, our mission was to gain insight on the smart charging experience, but because of technical issues causing delays in the project the smart charging user interface was not operational at the moment of inquiry. The interviews were undertaken at the latest possible convenience, in January and February in 2019, and besides the lacking smartness (i.e. load and price forecasting and machine learning capabilities) of the charger it was fully functional. Besides, many smart aspects were present after all, given that modern EVs come complete with advanced interfaces and programming capabilities in a companion app.

Our access to the pilot users were given by their own consent to be studied as research objects when signing up for the pilot, and practical access provided by the demo site owner, the local grid operator. They had18 smart charging pilot users, and we conducted in-depth interviews with 14 of them. We asked questions like; "What made you sign up for this pilot?", "What charging solutions did you have before" and "Do you schedule/program the car's charging hours?". The interviews lasted from one to one and a half hours, and every interview was audio recorded and consequently transcribed verbatim. For the readers of this paper quotes have been translated by the authors from Norwegian into English. Our analysis is inspired by grounded theory which is guided by an inductive approach that places as the foundation of the analysis the empirical results [33].

Analysis: Domesticating smart charging - four motivations

One of the main motivations we found driving participation of our respondents in the pilot studied here was in fact a rather mundane one, namely saving money. This was due to the fact that participation in the demonstration was rewarded with a state-of-the-art EV home charger (wall mounted) at half price. This was such a great offer that it resulted in the pilot being fully signed on just half an hour after the network owner posted the offering in their newsletter sent to customers by email that day. This makes it evident, indeed as does the responses we received, that a good deal on a charger was a significant driving force for signing up for the pilot in the first place. However, few people buy new gadgetry for the sole reason that it is half price, especially if it includes the prospect of having to engage in a research project as an object of study. For this reason, we think there still is a question posed here of why the charger is so popular among this small group of Norwegians, and that it has to do with something more than simply the economic aspect. Indeed, our analysis discovered four different, albeit somewhat overlapping, motivations in total for participating in the pilot and appropriating a charger. They will be presented in the following, and they are 1) fast and fire safe charging, 2) technological interest and fun, 3) practical-economic concern, and 4) flexibility as comfort.

Fast and fire safe charging

One important reason for wanting to procure a charger at the household that we uncovered in our inquiries was their concern for the lack of fire safety inherent in the practice of charging from a regular outlet. Indeed, even though the fuse on the circuit to which one would couple and charge an EV would be sufficient in many cases (many models draw around 8-10 kW), the added impedance on a long cord used to do so can risk adding to the amperage requirements without any immediate indication, resulting in cords overheating and eventually catching fire. Stories of this had been more or less a recurring theme in news in step with increased EV adoption in Norway, and finally the Civil Proteciton and Emergency Directorate (DSB) issued stark recommendations on how to charge EVs safely. This included an advice to install a dedicated charger of some kind, but there were several concerns. In cases where it is absolutely necessary to use a regular outlet, the EV owner needs to make sure that it is earthed, and that is on a separate circuit with at minimum a 10 Ampere (A) fuse. Furthermore, a connector (usually the one that comes with the car as standard equipment) can be damaged because of its weight, and thus it is recommended to hang it on a hook or in a basket. If not, the optimal solution according to DSB is a home charging station. Such a device usually uses 16 A or 32 A fuse, but it can also be up to 63 A, and if such amounts of power is available in the local grid this can be accommodated by the installer. This awareness of EV charging and safety can be interpreted as a part of the cognitive and practical dimension in the domestication theory. Many of our EV owners were aware of this recommendation from the DSB but had not yet purchased a charger station because of their relatively steep high price. So, when they did get an offer of half price in the mail, they immediately responded. Like this man and woman describe why they did get the charger:

Man: Better charging. Faster.

Woman: We had an EV like the one [Man] has, so I often was able to borrow it and thought this was a safe solution.

Interviewer: In terms of fire safety.

Woman: Yes.

Man: If you have extension cords over a long period of time, they can get worn

INT nr?

The charging station is considered more effective and is simply better to use than the outlet, as one informant described it: “I’ve come to realize it is much safer to use it, we can control it much, much more than you can with a regular outlet, when considering the fire hazard” (Int. 13). Another said “I had just bought an electric car and was of the opinion that if you have an electric car you should have a charger in the house and not charge on a regular outlet” (Int.5), indicating they would think about this in terms of a responsible, packaged solution. This shows how the attitude for charging at a regular outlet is clearly connected to the risk of fire. The EV owner in this pilot found it down right unproper to not charge from a

dedicated charging station, even though at the same time it is not in any way illegal or uncommon to do exactly that. In other words, the norm of charging in a fire safe manner is high among our EV owners. In contrast to the somber safety concern of the above referenced statements, other EV users were signing up purely out of a keen technological interest and a prospect of fun and playfulness that supposedly was obtainable through the use of smart technology.

Technological interest and fun

The motivation described by the users we have a closer look at here, was ascribed to an interest in mixing, matching and playing with smart home technology. One EV owner explains it like this: “I like to control the thing myself…. I think is fun to optimize things…. I think the technology and project is exciting” (Int 10). Another one stated outright offers of technology in general, like the smart charger offered through the demonstration project, was not interesting if he could not play with it: “I don’t pay for it if I cannot play with it…. It is when you can knock yourself out and try things and do things that you find interesting solutions…. I do not like technological solutions that are locked to one system or brand” (Int ??). This kind of creative playfulness shows another, totally different kind of motivation than the somber safety aspect. The EV owners here however ran into their own problems when running into lock-ins, bundling, or any kind of proprietary gadget or app, restricting the possibilities of play DIY aspirations, no longer affording a kind of mixing and matching of gadgets to achieve creative solutions and optimal conditions. In other words, were a piece of technology not to afford this kind of user the prospect of freely configuring it into an already existing technical landscape in the household, it would never be considered for appropriation.

Even though sometimes the consequences of the smart and technical endeavors of this playfulness could for instance constitute a kind of load shifting, this often was not the main interest and did not seem to be the ultimate goal of the engagement with the technology. Rather, the fun of exploring technology and making smart solutions work was the driving force, and any grid optimization result would be more or less coincidental. This indicates how these kinds of EV owners get a kind of joy out of tinkering and being in control of one’s technical equipment, which as a phenomenon is not particular to this study - This playful joy also functions as a motivation for some of the users that are part of the DIY communities on the internet as described by Hyysalo et al., 2013, but which meshes poorly without a personality that identifies strongly as somewhat technologically avant garde, technologically competent, and not to mention (even though mail order components from China may be cheap) having the income to sustain such a hobby. The playfulness is in this case a motivation for signing up for smart EV charger where load shifting may become a second order effect of having fun and interpreted as belonging to the symbolic dimension of the domestication of what kind of meaning the EV charger have for these kinds of informant. The charger is appropriated into an already existing network of gadgets, and as part of a hobby and area of expertise, relates to a matter of identity for these users.

The practical-economic concerns

The practical rationale for smart charging as motivation was first elicited by the discount on the charger, but when asked to elaborate, we were given the impression that signing up for the pilot was motivated by the prospect of installing smart home technology such as smart chargers because its first and foremost *practical*. Like on respondent said, “because it is smart, not cool (int 2)”. Another one of the pilot users compared it to having installed a smart thermostat in the bathroom to stabilize the floor temperature, not to save electricity. At first glance, this type of EV owner *seemed* to be interested in the technology but did not have the same feeling of fun in the optimalisation of the smart house as mention above. Not to be confused with the kind of user represented above, this user was explicitly *not* in it for fun, but on the contrary was motivated by a somber, common-sense, grudging dedication to fighting entropy, wherever it may be found, and in this case in the everyday life of mobility.

In a way there is an element here also of economic interest, but in a different way than the one regarding a good offer on the charger itself. This EV owner was more interested by economic benefits brought on by the prospect of a charger that only charges off the peaks, and when electricity is cheaper due to less demand. This kind of motivation can also be seen as a typical reflection of the resource man that assign control through set-and forget [16] as already described by Harper-Slaboszewicz [34]. This motivation we also found in descriptions of why users did choose an EV when exchanging the old one, simply because they got more car for their money, given the many policy measures favoring EVs like tax reduction, free parking, permanent car pool lane access, and free admission on toll roads.

Flexibility as comfort

When inquiring about charging habits we found many different practices played out. Some would immediately plug in and charge their EV the minute they came home, others after “the last trip of the day”, yet others every second or third day simply because they did not drive so much in the everyday life. We also found that even if the charger was not smart capable at the moment of our interview, some of the EV owners would use the companion app that came with the car in order to achieve a level of smartness. In some cases, users would even manually set the car to start charging at night and then off peaks via the interface inside the car itself. One of the EV owner actually explained that he did it because he wanted to alleviate grid congestion, but most others pointed out that they program to start charging at night because they wanted the battery to be healthy. Finally, another practical concern that influenced charging practice was because of comfort in the wintertime.

“Yes, when it is like it is in this time of year I had, and then it’s normal to set it to charge and set it so that it’s done in the morning, then you have a pre-heated battery, that’s important in the winter, that the battery is pre-heated”

To pre-heat the battery in the wintertime in Norway was important for some of the EV owners due to expectations about battery health and life expectancy (arguably one of the bigger concerns of the EV owner as opposed to ICEV). But night charging and preheating also brought about aspects of comfort, as the car would be warm before setting out in the morning.

Well, the way I use the app is that I've set up the car so that it will charge in a certain period, it'll pre heat to a certain time or another, and that's automatic, or I just set it up to be warm at 0721 or thereabouts. And then it's been charging for three hours. (Int 3)

As this EV user explained he had set the car to start charging at night, and in the extension of this the heating in the car would switch on. Another EV owner explained that he had timed the charging because his wife did preferer to get into preheated car in the morning. In fact, preheating is also common to do with ICEVs in the wintertime in Norway with the aid of an electric engine heater. This is both fuel efficient and healthy for the engine, as well as adding comfort in the morning, and is really an already existing part of the Norwegian comfort-oriented driving culture [21]. Some of the EV owners did this preheating when the EV was charging, but others also used a car heater whiteout using the battery in the car. In short, preheating is a way of providing comfort that also can be a motivation to do load shifting.

In this analysis we have seen examples of how the charger becomes part of everyday life through for instance a cognitive dimension of fire safety and optimal charging conditions, a symbolic dimension represented by technological interest and fun, and finally a practical dimension where economic and comfort concerns were catered to through flexibility oriented user behavior.

Through this analysis we have been seen example on cognitive dimension (fire safe and fast charging), Symbolic dimension (technological interest and fun) and practical dimension (practical-economic concern and flexibility as comfort.) The reasons for and ways in which our EV users go about appropriating and putting to use in everyday life an EV home charging station is different, but have all resulted in some kind of charging behavior or other. In short, we find that the ways in which the charger is domesticated is not determined by the charger itself, but by how the charger becomes a part of the home life.

Conclusions

Smart charging is a part of the plethora of demand-respond (DR) technologies that are being developed to bring end user flexibility into play in order to alleviate grid congestion. In short, the flexibility will be used to do load shifting and peak shaving in the household aided by the use of ICT. Even if the ICT in the charger in this study was not up and running when we did our interviews we still claim that the analyses of this small sample of EV users gives us several insights in what the smart charging station can afford to different kind of EV owners, and in turn how this will impact the potential for flexibility and grid optimization.

In Norway the EV fleet is increasing rapidly and it is argued that the EV in itself have what Pinch and Bijker [35], describes interpretative flexibility, to the different EV owner [21]. In this paper we argue that the EV charger also have this kind of flexibility when it becomes domesticated in the household. Where the domestication process is a part of a micro network between fire safety (DSB), politic, the grid and the EV owner charging practices.

In our study one of the informants was charging her EV in the same way she charged her mobile phone, and as she would unplug her mobile charger when going to bed, so she did with her electric car. This is something we often find in studies of the flexibility potential in households in Norway. We do not wash clothes or use the dryer at night because of concerns of fire safety. As we saw this was a motivation for EV owners to get a dedicated charger for the EV as well. The smartness and the abstract goal of alleviating the grid in itself was not important, but in some cases could materialize as a side effect of other concerns that would effectively drive adoption of smart charging, perhaps in conjunction using the charger to play with or add to a general project of governing the household according to values such as common sense and what is practical.

Smart charging is about the ICT that connects the charger to the smart meter in the fuse box.

To use ICT to reduce charging speed is a way of providing flexibility to the grid through load shifting. Energy flexibility can be provided by different levels of automating energy consumption [36]. In our analyses we found evidence of flexibility being generated connected to charging practices even if the charger was not smart. In some cases, the EV owner was not even aware that their charging practices was providing flexibility. In the table below are listed some of the different practices we found:

Flexibility charging	Smart charging
EV- user plug in the charger of peak hours	Charging station use ICT to charge when the peaks and price are low.
EV- user set up the EV to charge at a specific time throw app or in the car.	
EV-user program the charging station to charge at a specific time throw app.	

Though understanding how different EV owner's domestication their EV charging different we see that some is already established charging practices that provide flexibility. We can also highlight that EV owners do not have one profile but are driven by different kind of motivation.

Acronyms

DSM: Demand side management

ICE: Internal combustion engine

EV: Electric vehicle

SMH: Smart home technology

DLC: Direct load control.

Declarations

Ethics approval and consent to participate

The informants was voluntarily for this study and they were all over the legal age in Norway (18). They have verbally consent to be a part of this study and have been provided whit the contact information to withdraw when the want to.

Availability of data and materials: Yes, transcription of interview in Norwegian.

Competing interest: Non

Funding: This study is funded of the European Union's Horizon 2020 Research and Innovation program under Grant Agreement No 731148.

Authors' contributions: All authors have contributed the same.

Acknowledgements: All the participation in this pilot.

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