Driving an EV: a new practice? How electric vehicle private users overcome limited battery range through their mobility practice

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Abstract

The sales of the electric vehicle, in spite of media coverage, have been less successful than expected. Apart from its price, technical limitations relative to the EV, and especially the reduced battery range, are often mentioned to explain this. Nevertheless, a niche market has been developing in France for some years, which seems to be unaffected by these limitations. How do the owners of EVs cope with these difficulties and overcome them when driving? Our point of departure consists in showing the results of a field study dealing with the routine mobility practices with an EV, conducted in 2013. The EV mobility practice, as we will see from the analysis of our face-to-face interviews amongst EV owners, relies on behavioral adaptations of the driving mode, but also on a better anticipation of the driving distances, on a forecast of the location and arrangements of the parking places and on an invention of one-off solutions in order to manage the unexpected. Some of the EV owners link this use to a technological change register. From this point of view, the EV questions the practice of mobility.

This paradoxical dynamic of practice will be examined thanks to the support of social theories of practice, to the extent that these theories help us understand how fluently this process operates. As a matter of fact, such a process is supported by a co-evolution of meanings, material systems and competences inside the mobility practice. The reactivation of previous symbolic registers and know-how that are adapted to the new material arrangements (including cars and charging infrastructures) both explain the concomitant dynamic of changes and routines. The EV introduces quite small changes in the mode of transportation: driving it remains an individual means of transport by car. When the learning phase is over, the trips become as common place as before. Even the charging gestures are integrated into a daily routine. This evolution towards routinization is obvious for the EV drivers, who recall registers and competence portfolios that prevail in other domains: economy of gestures, anticipation ability, help from the social network, etc. Driving an EV only conduces to reactivate these experimented portfolios.

Introduction

The sales of the electric vehicle, in spite of media coverage, have been less successful than expected. 15,045 fully electric vehicles (EVs) were sold in 2014 in France according to public sources (AVERE), the two-thirds of them corresponding to personal cars and almost a third to commercial vehicles. In other words, EVs cover less than 0,6 % of the 1,7 millions of sales of new cars in France in 2014 (ib.). The spread of EVs among private users remains extremely hesitant. Besides the issue of the price, technical reasons inherently related to EVs and notably the issue of limited battery range (Potoglou & Kanaroglou, 2007; Lieven et al., 2011; Egbue and Long, 2012) are often cited as "barriers to commercialization of electric-drive passenger vehicles" (Axsen et al., 2010, p. 173).

Nevertheless, social sciences articles on the topic (Ryghaug and Toftaker 2014; Ozaki and Sevastyanova, 2011; Pierre, 2015) show that EV private users easily face travelling difficulties and move in a very ordinary way. The sociological survey that we will develop here confirms these results. Conducted

with a small group of individuals who have acquired a fully electric vehicle, it points out how their mobility practice easily overcomes the supposed imperfections of EVs. The development of electric mobility therefore shows two faces: on the one hand, sales to households remain hesitant; on the other hand, users of EVs are more confident and uses are more fluid than expected. A new practice seems to emerge around the electric car for some, whereas the idea of using an EV is incomprehensible for others, the limited battery range (related to its low capacity) being seen as an insurmountable obstacle. This article intends to address the EV's contradiction "slow spreading" versus "effective practices" for private uses. Easy appropriation of EVs is indeed a surprising fact in relation to the alleged defects of these cars. Are satisfied EV users endowed with specific coping skills? How do different sociological theories explain the difference between what constitutes a new practice for some and for others is seen as not being able to be one? More fundamentally, the question is to underline the appropriation of a new technology through the evidence of a new practice.

LITERATURE REVIEW

Social sciences research about EV focus on its acceptability, raising the question of the effects of its alleged drawbacks – especially concerning cost and battery range – on low buying intentions (Potoglou & Kanaroglou, 2007; Lieven *et al.*, 2011; Egbue and Long, 2012). Indeed, as indicated by Rezvani *et al.* (2015, p. 130), "the limited battery range of [Battery Electric Vehicle] is a well-known adoption barrier". This last disadvantage is taken not only as a technical problem, but also at a cognitive level (Axsen *et al.*, 2010). Thus, EV potential purchasers manifest "range anxiety", defined as "the fear of being stranded in a [battery electric vehicle] because it has insufficient range to reach its destination" (Egbue and Long, 2012, p. 723) even though the theoretical capacity of these vehicles would be sufficient for the daily trips. In this perspective, "limited driving range is more of a perceived barrier than an actual one (Rezvani *et al.*, 2015, p. 130).

However, as explained in the literature review addressed by Rezvani *et al.* (2015, p. 133), "it becomes (…) important to focus on the actual adoption behaviour concerning EVs and not only on intentions" – contrary to the majority of the available studies. Some researchers have explored to what extent the very use of EVs will modify its acceptation, and more specifically not the acceptability but the acceptance (Bühler *et al.*, 2014, p. 36): "Acceptance is one's attitudinal and behavioral reaction after exposure to a product. Prior to exposure, only acceptability can be assessed". Indeed, EV usage experience positively impacts EV purchase intentions (because of high satisfaction of users) (Ensslen *et al.*, 2013).

Another point is that most of the studies generally deal with a few days use (Graham-Rowe *et al.*, 2012). However "the issue of compatibility of EVs in the everyday lives of consumers and their habits has also been found as an important contributing factor for potential adopters" (Rezvani *et al.*, 2015, p. 131). In other words upcoming research should involve long time periods, as "it seems promising to focus more on studies that examine acceptance of EVs within the context of real-life experience" (Bühler *et al.*, 2014, p. 35). Let's now describe the main outcomes of the few studies[1] that deal with a long term use of EVs (several months).

This is precisely the subject of an article by Bühler et al. (2014) that shows the effect of the experience and even of an intensive use of EVs on the acceptance. The results from this survey that analyses the perceptions of people who have experimented EVs for six months in Berlin indicate that this use promotes a very favourable opinion (but not a purchase intention, which depends on other factors). These authors classified the experiential benefits on one side and those who do not come from the use of EVs on the other. A result of their study consists in showing that the experiential benefits generally become more prominent after the use of EVs. Nevertheless, according to these authors, "several experiential barriers were not significantly influenced by experience. Limited range, for instance, remained a highly relevant barrier over the course of the study" (ibid. p. 46). But if the use does not appear to have any effect on the perception, it has some on the interaction: "Research indicates that daily range practice has a positive impact on the efficiency of users' interaction with range (Franke & Krems, 2013) but this does not seem to influence the perception of range" (Bühler *et al.*, 2014, p. 46). It is this last point that we wish to explore in this paper: how is this battery range difficulty overcome in the interaction of the driver with his/her vehicle so that the use turns out easy? Our point moves from a question of perceptions to the topic of the ease of practice.

Among these studies, we can also mention a previous paper of us (Pierre *et al.*, 2011) about the pioneers of the early 2000s, those who could be called innovators in the theory of diffusion's terminology (Rogers, 1962). These people, as we had shown, daily overcame the difficulties of the limited battery range through avoidance of certain journeys. Thus EV private users easily faced travelling difficulties and move in a very ordinary way. We had also highlighted their buying motives referring to pioneering-ecological spirit (combination between current ecology and technophilia) and to seizing opportunities (generous subsidies, bargains coming from relatives).

Furthermore we must mention the significant survey from Ryghaug and Toftaker (2014) about EV buyers. Their paper mixes practice theories and theories of domestication, which are interesting for understanding the long term setting up of the electric vehicle in a specific context (see also Jarrigeon *et al.*, 2014). They focus on the incorporation of new practices (or sub-practices) in routines, given that appropriation is at the heart of anchoring an innovation among user groups. This appropriation of an EV is based on a learning process that creates a reflexive momentum for establishing new routines displacement (ib.).

As Ryghaug and Toftaker did (2014), we will combine here a domestication approach with a theory of practice approach, the latter focusing on the social organization of practices rather than on the individual one[2]. As a matter of fact, when one

1. Let's mention an interesting study among EV users coming from "a real-world test" (Burgess et al., 2013) for a several month period. Nevertheless, the authors do not analyse their practice and usage of the vehicles (neither the declared ones) but the meaning that the EV carries for them and their opinion on it.

2. According to Hargreaves (2011: 79): "In contrast to conventional, individualistic and rationalist approaches to behaviour change, social practice theory de-centres individuals from analyses, and turns attention instead towards the social and collective organization of practices."

measures the gap between the views of the general public, unfavourable to the EVs (Skippon and Garwood, 2011; Kanaroglou, 2007; Lieven et al., 2011; Egbue and Long, 2012) and the one of the users, quite favourable (Jarrigeon et al., 2014; Ryghaug and Toftaker, 2014), nothing but practice makes it possible to understand why the EV gets going so well for the users. In other words, the spreading of the EV is not explained by the choices or opinions of individuals in favour of the EV, but we'd rather say that various material and non-material elements will lead to a social activity including travelling by EV.

Our purpose in this article is to analyze mobility by EV under the aspect of a practice. To do so, we will mainly rely on the theory of practice that shows how technical systems help define and produce everyday life. As this theory focuses on social, symbolic and cognitive dimensions, it makes it possible to understand the contradictory dynamics of stability and change practices (Gram-Hanssen Kirsten, 2011). Our study is one of the few to date that concerns private users who bought full EVs, thus having made a significant investment[3]. They are therefore users not for a few weeks but for years. We will describe the overcoming of difficulties that seem inherent in the use of an EV: how daily routines get installed, the constraints that this technology involves and how individuals overcome them, voluntary and conscious changes that they had to make. Our starting point is a field survey conducted in 2013 on the use of electric vehicles and charging infrastructure. After a brief description of the field study, this article is organized into three parts: the first part describes the EV mobility practices in general. In the second part, we show the different colours that this practice takes through the study of some monographic cases. The third part analyses the joint dynamics of routines and change including changes in the material, cognitive and symbolic arrangements.

DESCRIPTION OF THE FIELD STUDY

The context of a demonstration project

The CROME project (Cross-border mobility for Electric vehicles)[4] was to encourage cross-border trips by electric vehicles, France and Germany taking part since 2011 in this European project. Specifically, the project seeks to facilitate access to and use of public charging infrastructure on both sides of the border, in Alsace, Lorraine, Baden-Württemberg and Saarland (Gagnol et al, 2013).

This research consisted in a field study, with the objective of understanding how people used their vehicles and their opinion about the charging infrastructure. These qualitative studies were part of the evaluation workpackage of the CROME project[5]. The results presented here focus on France, and more specifically on private individuals who bought an EV[6]. The study aimed at evaluating the acceptance of electric cars and charging process through a bottom-up method. It consisted of face-to-face interviews of a semi-directive nature, presenting the users' interests, problems, needs and experiences. During the interviews, our aim was to gain an overall vision of travel and charging practices. The interviews generally took place in the work place or at the residence, which offered an opportunity to see the car, the electric installation, and sometimes to observe the users' behaviour with their EV. These vehicles have been used for all types of trips, both private and professional.

The method

The face-to-face interviews were carried out in the fall of 2013 in Alsace, following a semi-directive structure. We interviewed 27 people (as in some cases, both partners are present), referring to about 25 EVs (sometimes the couple has 2 EVs) acquired in the course of the previous year (thus subject to stabilised travel practices). They related to various models of EVs and of charging infrastructures, an aim of the CROME project being to assess the challenge of interoperability.

The sample:

Most of the respondents had quite a well-off situation and graduates predominated but some of them came from a more modest background. Respondents lived in various family types, but rarely in single-person households. A good half lived in the center of Strasbourg, the other half in the neighboring countryside. Another interesting point concerns their professional sector: we have noted an over-representation of healthcare professionals (pharmacists, physicians, researchers in the field of health, dentists, etc.), which can be explained by income related higher than average, frequent trips in a pool of life (for those who make home visits) and perhaps a greater integration of environmental concerns related to health. There was also an overrepresentation of persons whose business relates, in one way or another, the energy sector, which is less surprising: electricians, engineers, professor of technology, architect, etc. Finally, a third professional group is quite present in our sample of occupations in which jurisdiction is the calculation expenses (asset manager, banker, accountant, math teacher, etc.).

The sampled EV users are obviously early adopters of early EVs and not representative of the general population. However their case underlines how this practice is embedded in daily life and in this sense they are crucial for widespread acceptance (see also Bühler et al., 2014, p. 47). We will show how their practice easily meets a group's needs (and not everyone's needs). If this social differentiation of the theory of practice does not explain the slowness of the spreading of EVs, we could nevertheless infer to which social groups the articulation of the

3. In this perspective, it is comparable to the studies from Ozaki and Sevastyanova (2011) and Caparello and Kurani (2012) about plug-in-hybrid vehicles.

4. The CROME project consortium consists of major carmakers (Daimler, Porsche, PSA, Renault), energy suppliers (EDF, EnBW), tier supplier (Schneider Electric, Siemens, Bosch) and research institutions (Karlsruhe Institute of Technology (KIT), EDF R&D and IFSTTAR) from France and Germany. Associated partners including Nissan and Toyota as well as Local Authorities (Communauté Urbaine de Strasbourg, Région Alsace, Conseil Général de la Moselle) in France and energy suppliers (E-Werk Mittelbaden, Stadtwerke Karlsruhe, Stadtwerke Baden-Baden, Star. Energiewerke Rastatt) on the German side of the border take also part. The project was funded by French and German Ministries (in France: Ministère du Redressement Productif and Agence de l'Environnement et de la Maîtrise de l'Energie; in Germany: Bundesministerium für Wirtschaft und Technologie, Bundesministerium für Verkehr, Bau und Stadtentwicklung) since January 2011.

5. This comprehensive and inductive method completes the online questionnaires carried out by the Karlsruhe Institute of Technology by gathering the users' and fleet managers' spontaneous opinions on using an EV and charging practices.

6. Another part of the qualitative study targeted employees using commercial cars for professional purposes. We decided to exclude them from the present paper, because of various reasons: their investment in the project is mediated through their position in the company, they can diversify their transportation means (other combustion engine company cars are available in their fleet) and their appropriation is less intensive than for private people theoretically facing the battery range limitations every day.

three elements works best and therefore deduce potential appropriation of EVs.

The next chapters relate the outcomes of our field study as inferred from the discourses that have been gathered during the interviews with EV users.

Daily practices, crossing changes and routines

As the battery range of the EV is quite limited, it is legitimate to wonder if users have full freedom of movement with this car. The narrative of journeys made by EV – and of trips impossible to achieve – tells us about it: EVs often become the first car of the household and in some cases the only car. According to statements from interviewees[7], the average distance travelled is 13,000 km per year (varying from 6,000 to 25,000 km). Indeed, some people travel quite large distances. According to the declared travelling routines, the problem of autonomy seems to be secondary. EV users settle for the maximum battery range distance and this limitation does not preclude intensive use of EVs.

Most encountered users realize by EV short or medium range trips on a regular basis. Commuting trips are the emblematic ones. And it happens that regular trips made by EV concern a relatively large distance: EVs are not exclusively used for short trips, but also for medium range trips on a regular basis by people not living in urban areas. This is the most frequently used mode of transport from their transportation portfolio.

Users enjoy new driving sensations (including silence) and apply a smoother and fluid driving. Some of them claim to be more aware of their energy consumption. This result confirms what Ryghaug and Toftaker (2014) explain in their qualitative study based on interviews and focus groups with EV buyers: the pleasure of driving and less polluting has replaced the pleasure of freedom that the conventional car previously brought. So that other authors can conclude that trying an EV is a factor leading to long term adoption (Peters et al., 2011).

For the interviewed EV users who we met, borderline situations are rare – even if some regret the limited battery range of their EV. Indeed, many households still have a combustion engine car to achieve the longer trips. And those without any are often able to obtain one (loan, lease, use of another household's vehicle).

How does the recharging practice take place? In many cases, the domestic charging seems to be enough. The charge, wherever it takes place (in houses or in building's basements[8]), is the subject of routine practices and is done easily often in the evening. The charging gesture is well integrated into everyday practice for most users[9]. They practice what we call a reasoned charge[10], that is to say, they recharge the EV when the need arises and not systematically as soon as the EV returns to the charging-parking place. The path at which the battery empties for purposes of travel induces the recharge frequency, usually every 2 to 4 days depending on the mobility practices. Thus this refill frequency is fixed on the basis of a remaining battery capacity development in line with the need to cover journeys.

If recharging the EV mainly takes place in the homes of respondents, it happens to some users to extra charge it on other places, whether in the public space (in the street or in off-street parking places, for example) or at relatives who they visit. Mobilizing the social network for recharging remains occasional, but is very appreciated because it allows users to increase their outreach capacity. Most users, not just those who do not have a garage, consider that public recharging stations that give an open-access to all electric vehicles are necessary. The need for public charging points makes no doubt for these users.

In summary, in the basis of discourses gathered during the retrospective interviews, mobility practices are comparable to what prevailed before. Destinations and mileage remain relatively constant. However, some behavioural adaptations occur especially with respect to the driving mode, the anticipation of the destination parking place and distance and punctual solutions to manage the unexpected (borrowing of a conventional car). The recharge at home or in its vicinity has become a routine gesture integrated to domestic practices. The high use intensity of EV shows that the battery range is not a high limitation. It seems to be overcome for example through charging at a relatives' place or using another car. In other words, an imperceptible change in the mobility behaviour took place thus forming a sort of sub practice. This change consists in EV practitioners segmenting among their trips eligible routes to EV driving and those requiring a combustion engine car.

How this practice is coloured from a practitioners' group to another

How can we report the variation in practice in this model and the fact that it works well in some cases and less in others? Our exploration of the concrete performance of the EV driving practice shows the benefits of an approach in terms of theory of practice, as the articulation of the meanings, material arrangements and skills explains the banality of a new practice and its strangeness for non practitioners.

This interweaving of the three components of the EV driving practice explains the fact that it works well in some cases, less in others. Indeed variations operate in how practice occurs (its performance, to use the Schatzki's term, 2001).

The theory of practice is able to explain, through the exploration of the relationship of its components, the different forms that this practice takes, according to the own arrangement of each group of practitioners[11]. We will describe in the following paragraphs three different EV users: in each monographic case, mobility practice VE takes a slightly different colour.

7. The interviews were generally made after 3 months to 8 months of use, and sometimes more (2 years), annual averages were inferred. It should therefore be considered with caution.

8. Note that four of our sample does not have a private parking slot rely on the public space to charge their EVs.

9. See also Franke and Krems (2013) on this topic.

10. As we speak in France about "agriculture raisonnée" to mention the sustainable farming.

11. Kirsten Gram-Hanssen (2011) had already shown it in a paper about heating practices. In the context of a constant material arrangement, the appropriation of a technology is diverse because of the changing relationships of the various components of practices. Thus, to show that families did not domesticated heating technologies in the same way, the author draws on a detailed description of embedded knowledge, rules, commitments and skills that heating practices reveal for each of them. We can likewise show the various developments that this triptych takes for the case of EVs.

PATRICK, THE CASE OF A REASONED PRACTICE

Patrick, an accountant, has come to the EV (a Zoe model) for financial reasons: the additional bonus of Alsace region lowered the cost of the EV in such a way (to €12,000 instead of €24,000) that he did not want to miss this opportunity. This acquisition was combined with his wish to change car (he sold his previous one).

He made the EV acquisition in coordination with friends and relatives, three of them buying the same EV model at the same time, but in a different color. In his system of meanings, the peer pressure has a certain place. It is within the same network of peers that he exchanges a shared car (especially for the holidays): his grandfather's combustion engine car, which is an integral part of the material arrangement allowing the system to operate.

Patrick uses his EV everyday for all of his business trips (he works on his own) and personal trips on all medium and small amplitude paths. He calculated that he saves €25 per month with this EV. Since booking a garage is too expensive in the city center, he does not have private parking space for his EV, but recharges it only in public places all 3–4 days (free of charge at this moment). He then left the EV plugged all night and disconnected it when going to work the next morning. Any structural change in the public charging conditions (price, parking availability, etc.) would modify this balance and could make him change his mind concerning the EV possession.

Patrick practices a reasoned recharge, only when necessary (only 15–20 reserve km). In his case, as we can guess, locating the network of public charging stations is a necessary skill, as is anticipating charging moments (and distances to cover for future trips).

Thus in the case of Patrick, economic rationality prevails.

LEA AND LEON: AN ADJUSTED PRACTICE

In the case of Lea and Leon (farmers), we are dealing with a very adjusted practice that changes shape depending on the circumstances and that proceeds by trial and error.

This couple of farmers acquired a blue Ion because it was an "oil-free car", which is a very important point for this couple who has installed solar panels and wants to save on energy. The fuel tank that serves as heating system is too expensive and since they already paid for a significant electricity subscription for the needs of their business (farm producing eggs), they knew that the EV would generate very little additional costs.

The three members of the household (a couple and their son) use the EV and even "fight" to use it because it is the funniest and cleanest of their own cars (other vehicles are soiled because of rural conditions). The son uses it to go and study and his parents for eggs deliveries. In about a year, the EV already has 40,000 km on the clock while the leasing contract provided only 10,000 km per year. This intensive use requires good timing between different users, in terms of borrowing and recharge planning management.

The Ion is plugged into a domestic reinforced outlet that has been installed for the occasion by their local electrician. This installation is due to a problem with the previous wire (it has grilled), after what they have invested in a specific outlet. Once again this couple adjusts oneself, engaging repairing when it does not work. Charging is systematic whenever the EV is back at the farm, so that it can always meet the following user's needs. This means that any user must know how to charge it and assess the distance between the points of delivery (to be sure not to be under the battery range).

FRANCIS, AN IDENTITY PRACTICE: A PHILOSOPHY OF LIFE

Francis develops a more identity related practice, reflecting a profound ecological and technophile commitment.

This consultant is very interested in energy issues and describes himself as an ecological activist. He lives in winter in the center of a large town in Alsace (in a building), and in summer 50 km away, in a large country estate converted into a B&B cottage where he leaves and work. The EV is used mainly for Strasbourg trips to his village (and the return trip) as well as around the cottage.

Francis decided to get an EV as a personal approach related to his convictions. He saw this as "live according to his beliefs" and as a way to stop having ties to the oil industry. His work and his aspirations have contributed to raising technophile and ecological issues. In his country estate, he hired an energy diagnostic approach to its housing and has installed solar panels. It has installed there a "smart" charging wall box (in his words), since it is set to off peak hours. He joins the EV to this environmental approach. So he asks his guests not to park their vehicle in the courtyard of the property where only EVs are allowed.

Francis has a passion for the EV considered as "a walking laboratory" because he can monitor the recovery of energy from braking. He noted that the EV consumes very little energy. It's also a game for him to consume as less energy as possible: his children and he challenge themselves in this direction. He appreciates very much the "pedagogy" of the EV, supporting a slower driving style.

DISCUSSION ABOUT THE THREE MONOGRAPHIC CASES

The three mentioned cases are really heterogeneous and help us contrasting the range of early adopters but also underline many similarities:

- The handling of the car is depending on the motivations: economical rationality, the daily balance between ecology and current mobility needs or the technological oriented philosophy of life.
- Overcoming the limited range is not managed the same way by each type of user: the first one only recharges the car when required (on a public charging station) whereas the seconds are charging at home after each trip and the third is more regarding the energy issue (off peak hours) than the battery level. What also makes these practices innovative is that the "performance" of driving an EV varies from one group to another, with reluctant people, people who adapt the practice, procedures which are exported from one practice to another[12], etc.
- The EV driving practice is related to other past experiences. The practice is rooted in a prior routine so that it is not so

12. As Warde showed (2005, p. 139), "empirical evidence indicates differences between groups of people with regard to their understandings of a practice, the procedures they adopt and the values to which they aspire." The three aspects of practices vary widely among practitioners groups. Practices have a development path and also will deploy differently in different institutional arrangements, locations, times, social, etc.

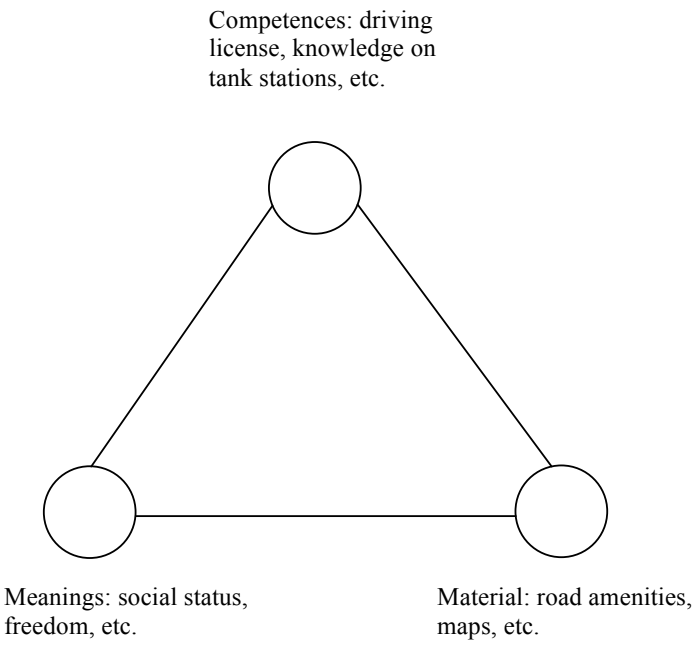

Figure 1. Links being made for the practice of driving a private car (inspired from Shove et al., 2012).

disruptive, which gives us information on how individuals come to this new practice.

- It is crucial to deal altogether with trips and charging issues within mobility practice, which is generally overlooked by the literature about EVs[13]. One of our contributions is indeed to insist on the complete system of mobility, in other words both the EV and charging infrastructure, while most read surveys cover only one aspect – frequently forgetting the aspects related to the recharge (wall box, charging cord, etc.).

In the following third part, we intend to explain these differences and similarities using the theory of practices.

What remains stable and what changes with an EV

Mobilizing the theory of practice now helps us understanding the changes that are occurring and why they are happening relatively transparently.

Shove and Pantzar and define the practices "as made up of Images (meanings, symbols), Skills (know-how, forms of competence) and Materials (artefacts, technologies that are actively and recursively integrated through everyday performance" (2005, p. 7). Here we reproduce the Material, Meaning and Competence triptych as outlined in Shove et al, 2012, p. 25, figure 2.1 and adapt it to the case of the present-day combustion engine car (Figure 1).

The combination of these three elements explains the dynamics of change: "New practices involve novel combinations of existing elements […]. Such integrations are themselves transformative: material, meaning and competence are not just interdependent; they are also mutually shaping "(Shove et al, 2012: p. 32). In the theory of practice, innovative practices indeed come from breaks between these three elements, which are initially relatively consistent (Hargreaves et al., 2012).

We now intend to look at how the technical change introduced by the EV use alters the practice of travelling by car.

QUITE STABLE MEANINGS

The meanings are of some importance in the spreading of a practice. In the case of EVs, we are facing a strong symbolic landscape.

With EVs, one is no longer unconscious of driving but the EV increases one's sensitivity to technological aspects[14]. When asked about the reasons for acquiring an EV which is a significant investment, the purchasers report a technophile rationale that goes beyond the acquisition. They place this investment on the registry of change, as a kind of acting out. Individuals who bought an EV relate the feeling to be part of a historical change and participating in a technological breakthrough[15]: according to them, EVs are really advance cars.

Moreover, many people refer economic reasons to justify the choice of EVs, notably the constraints to higher gasoline prices, or the cost of repairing combustion engine vehicles.

Ecological factors generally occur in the background. Users evoke a concern to reduce noise in town or to limit CO2 emissions, which prevailed in the interest for these EVs, but for most of them environmental issues is certainly a substantive argument, but not a decisive factor for having purchased an equipment of such an amount[16].

As the public charging stations deliver fast charging, charging in the street arouses a feeling to participate in a modern society. This enhancing impression is increased because parking in public places is the occasion to trigger curiosity from the pedestrians.

Finally, our analysis showed that the EVs remain individual vehicles which change little to car general meanings. As before, the individual car is a statutory marker[17], but this status is manifested through technology: EVs carry a high-tech image dear to the users and which sometimes supports an identification of the person with the object. For some people of the sample it carries an environmental significance and for other an opportunistic positioning (financial savings) – and sometimes both.

A WIDE ADAPTATION OF MATERIAL ARRANGEMENTS

Some of the EV drivers simultaneously separated from a small-sized combustion engine car when acquiring the EV. But most of them are multimotorised households for whom the other car – the combustion engine one – remains important, especially for long distance trips. Many of the respondents describe how the EV became the favourite one, which underlines that the conventional car suffered from a downgrading, becoming a mono-functional car (for holidays and long journeys).

13. We can mention two remarkable exceptions: Franke and Krems, 2013 (that describes the charging styles) and Pierre and Huguet, 2015.

14. Previous studies already developed this point (see Pierre et al., 2011; Ryghaug and Toftaker, 2014).

15. This aspect has been also mentionned in Caparello and Kurani, 2012.

16. See also Ryghaug and Toftaker on this point.

17. See Pierre, 2015.

The disappearance of certain equipment generates well perceived material changes: it is no longer necessary to travel to the gas stations, vehicle maintenance is less frequent, the gearboxes of EVs are automatic, which brings hence a gain of driving comfort.

The dashboard communicates more information including real-time consumption, prompting an eco-driving to spare the battery range. The battery directly appears in this socio-technical landscape, since it is in the minds of the driver through the mediation of the dashboard: one can have a real time look at the regenerative breaking for instance. Recharging duration management is an action in which learning is often done through mobile phones including smartphones.

Secondly, electricity takes its place in the material aspects considered by the EV users: it is for the French EV drivers a low carbon energy. Thanks to its use in other domestic contexts, it seems fairly well known. Most users know the cost of recharging, which they consider quite low; they show a strong confidence in the low level of electricity consumption.

We also note the emergence of charging as new practice. The acquisition of the wall box had not been expected in most cases. Many questions remain open: in particular the possibility of using an extension cord, the outlet standard, etc. The ins and outs of the system are also unknown whether in terms of safety standards and in terms of installation law in the case of shared garage (for buildings). A big change occurs when using a public charging station, where the complete ergonomic process has to be learned (using a pass, different socks, etc.).

Finally, the EV brings many changes in the material arrangements due to the car itself (gearboxes, dashboard, reparations etc.) and especially due to the charging materials (cable, wall boxes, electricity, outlet, public charging station etc.). All the interviewed people had been concerned with these material changes.

NEW SKILLS

Some EV users pay more attention for their energy consumption and their driving mode. The charging frequency is fixed on the basis of a remaining battery range in line with the need to cover journeys and requires consequently the acquisition of a skill to assess this ratio. In other words, EV users need to learn how to 'see' the energy dropping from a battery and to know what activities are causing the drain and at what rate.

The predictive ability of planning trips, distances and parking locations has been acquired fairly quickly during the first months of use although it is complex. The skills to manage the household's mobility are slightly broadened in preparing the trip, because in some cases it is necessary to think about his trip the day before (and parking spots and charging on arrival).

After a few months of use, EV users have a better understanding of all the influential parameters on the battery capacity, and spontaneous eco-driving is taking place[18].

Moreover, EV users have learned how to recharge the car. This charging gesture was not difficult since it related to known practice, for example similar to recharge the mobile phone. The regularity of this gesture does not seem to be a problem and is comparable to the daily practices such as "taking out the trash". Thus, the skills needed to recharge the car at home appear to have already been present before the introduction of the EV and therefore do not require significant changes. It's a little different for public charging stations, which need to be located properly. Mobilizing family in case of need extra recharging requires activating a relatives' network.

We previously mentioned another change consisting in EV practitioners segmenting among their trips eligible routes to EV driving and those requiring a combustion engine car. This skill is probably inherited from the classical situation that many multimotorized households experiment, frequently choosing between a big and a small car.

Finally, we see a growing competence on the management of the battery. These skills are social as shared by all EV drivers and concern the cost of electricity, the assessment of the level of the battery and the charging required frequency.

In Figure 2, we describe the new practice system that is being set up with the driving of an EV.

Discussion: Invisibility as a sign of domestication?

We have just described the new practice system that is being set up with the driving of an EV. Just as we did, Kirsten Gram-Hanssen (2011) showed that the arrangement of the various elements of the practice may find a relative stability when the symbolic dimension is consistent with the developed skills and the innovative products.

The reorientation of EV practices happens relatively smoothly for users who use resource portfolios that are largely mobilized in other areas of everyday life, and simply reactivated during the practice of travelling by EV. Indeed, this triptych mobilizes portfolios that have been experienced through other practices: driving a private vehicle is of course common (but including the identification of a sub-practice consisting in routine travel and medium range trips); the frequency of gesture charge has been experienced with mobile phones; the charging gestures at home remind domestic practices such as the garbage down or using an electric waffle; anticipation distances and parking places are also familiar, so is mobilizing family (in case of need of extra charging). It seems that the limited range of the EV is not a problem for the users because of the new competency that they developed to prepare their trips and because they get well with the new material like the energy check on the dashboard and the charging equipment at home. Our analysis shows the interest of the approach in terms of theory of practice, to the extent that the latter, in underlining the co-evolution of systems of meanings, material arrangements and skills, reflects the ease with which this system can evolve. One of the advantages of this theory of practice is to show both routine and dynamics of change: on one hand there is truly a change in practice for example in the charging gesture; on the other hand the change is relatively invisible (and easy) because it fits on the daily actions previously experienced at home.

We can make the hypothesis that the invisibility of changing practices ensures successful change. According to Chappels et al. (2011, p. 701), "a dominant approach within sustainable consumption research suggests that changing embedded habits

18. On this point, see also Jarrigeon et al., 2014. We confirm here what Ozaki et al. (2013) had demonstrated for PHEVs: "There exists a complex process of the driver using sight and sound to coordinate bodily action with that of the engine and knowledge about the road".

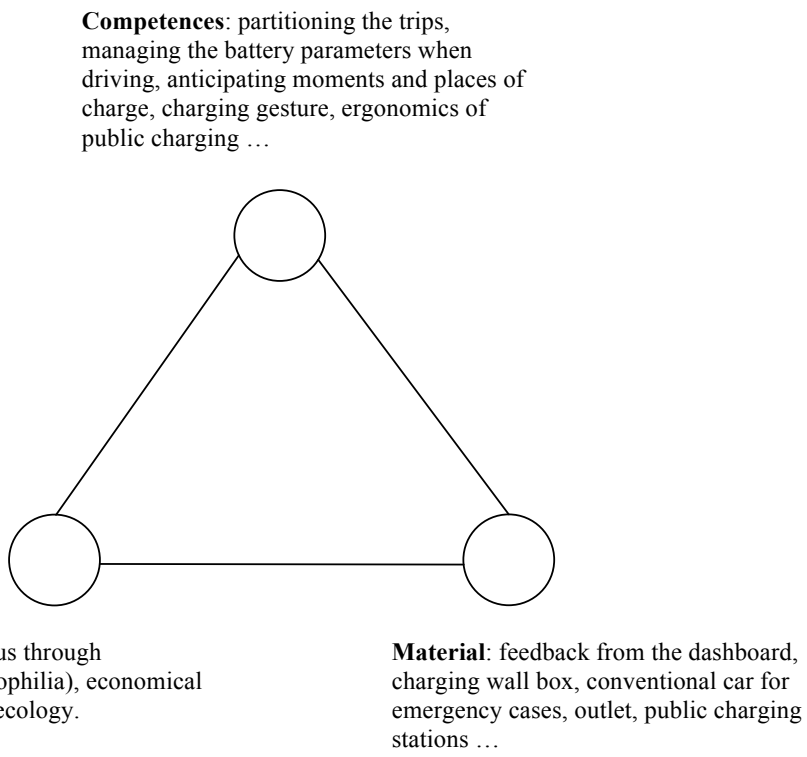

Figure 2. The new practice system that is being set up with the driving of an EV.

and practices requires making them visible and subject to overt decision-making and discussion. An alternative practice-based perspective suggests that enduring change emerges through the amplification of social orientations and does not necessarily depend upon explicit contestation and debate".

Conclusion

This paper challenges the technical point of view on success/failure factors focusing on limited range of EVs.

This research insists on analysing the complete system of electric mobility, in other words both the EV and charging infrastructure, while most read surveys cover only one aspect – frequently forgetting the aspects related to the recharge (wall-box, charging cord, etc.).

A main outcome of our study is that EV users are very satisfied with their car, using it frequently. Battery range limitations are indeed overcome in the daily mobility practice by EV users, either they charge at the place of relatives, they modify their trip, they use (sometimes borrow) a combustion-engine car or they use a public charging station.

The results of the focus on 3 different users show diverse acceptance regarding the electric car and especially the range limitation. The user with an economical rationality overcomes the range limitation by having a reasoned recharging behaviour in public places (free of charge at this moment). The second case shows users who are more concerned with charging at home after each trip in order to extend the flexibility. Whereas the user with a high technological awareness is more sensitive to energy purposes (production, consumption and management) thus showing more acceptance for the limited range of his car.

At last, we have sought support from the side of the theories of practice to analyse how these perceived difficulties are easily exceeded every day. The practices are rooted in stable interrelated elements that help achieving the new mobility practice and appropriating the EV. The third part of our paper is giving the deep causality of this different practices from EV users' point of view.

The changes come from modifications to some of the components, not invented but exported from other practices. Routines explain how people meet perfectly their every day mobility, far from what others consider as obstacles to the development of the EV. Exceeding these obstacles through a sustainable anchoring of this practice took for instance the following forms: a routinization of journeys, anticipating distances and locations of parking places, segmentation between EV eligible journeys and ineligible ones. In other words, it has corresponded to soft modifications in material arrangements (domestic wall box, occasional use of a combustion engine car, etc.), meanings (dispersed ecology, technophilia as avant-garde feeling, economic rationality) and skills (assessment of the battery range level, etc.). This practical system is stabilized because these three elements are exported from other stable practices.

People being able to develop new competencies in partitioning the trips, managing the battery parameters when driving, anticipating moments and places of charge, charging gesture, as well as being able to get well with new material like feedback from the dashboard, charging wall box, outlet, public charging station are satisfied users of EV. The interviewed users could make those behavioural changes because they already had well-known practices with other new technologies (like charging handy). It seems that public charging stations are especially

requiring a high adaptability from the users and a wide change in practices.

This study concludes with the causal explanation of good acceptance of EVs. It doesn't explain totally the slow diffusion of electric vehicles but it highlights the necessary changes in competences and material for an overcoming of the range limitation. It seems that people with high capacity of adapting their skills and understanding of new material arrangements would be also dealing well (as the sample of this research) with the electric vehicle. It could be interesting to analyses if the people deciding not to buy an EV don't have the capacity to adapt their skills, their material arrangements and their values to this new technology. On the one hand it is possible that people who are open for these changes would represent the future market for EV. On the other hand the automobile industry could work in reducing these changes for users in order to increase the population proportion susceptible to share the EV practice.

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