8 Adoption of EV in the French‐German context

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A significant data source for the user evaluation has been created during the three online interviews during the project phase. Between September 2013 and July 2014 answers to the third survey on acceptance of EV used in a professional environment within the CROME project were collected. This survey focused on the users' and fleet managers'[33] long-term experiences with EV in the French-German project region. Professional as well as private EV adoption intentions are analysed in this article. After presenting a brief literature review, this chapter characterises the sample of CROME's third online questionnaire. The survey participants' sociodemographic background, their mobility behaviour as well as EV usage patterns are described in detail. Furthermore, the participating organisations, their fleet managers and the vehicle fleets within their organisations are characterised. Afterwards, relevance of different car purchase decision criteria in the private and organisational context are compared. As EV users' expectations given in the first two surveys concerning range, purchase price and charging time are only satisfied to low degrees (cf. Schäuble et al. forthcoming and Ensslen et al. 2015), these barriers are analysed in detail by measuring the EV users' willingness to pay, the minimum range required and acceptable charging times. Furthermore, the participants' stated preferences concerning their next car purchase intentions are analysed and evaluated. A binary logistic regression model is derived from the survey data providing information on private EV purchase intentions. This model takes into account socio-economic data, mobility behaviour, survey partic-

[33] The persons in charge of the EV in the companies who have partly been involved in the decision making process to acquire the EV.

ipants' attitudes towards the environment as well as their willingness to seek for information on future developments of EV in order to characterise potential future EV adopters. The sample is suitable for research questions on private EV purchase intentions, as (i) the sample is comparably unbiased, i.e. the major part of the survey participants had not bought an EV for their private purposes when they completed the survey, so self-selection process might be negligible (cf. Globisch et al. 2013). Furthermore, (ii) the professional EV users had already experienced EV, which is a decisive factor influencing EV purchase intentions (cf. Ensslen et al. forthcoming). The purpose of the chapter is to analyse purchase intentions of a specific population: EV users and fleet managers who experienced EV during a period of about two years in a professional context.

8.1 The third survey in the context of the CROME project

Comparing market developments of EV[34] in France and Germany leads to the conclusion that the French market for EV currently rather captures the position of a lead market, as in France 37,100 EV were registered in June 2014 whereas only 24,000 EV were registered in Germany in July 2014 (cf. Nationale Plattform Elektromobilität 2014). The French car market is considerably smaller than the German (cf. Dudenhöffer et al. 2014). Germany on the other hand is rather characterised as lead supplier for EV together with the United States (cf. Nationale Plattform Elektromobilität 2014). The Nationale Plattform Elektromobilität (2014) even provides an explanation for the high dynamics of EV diffusion in countries like Denmark, France, the Netherlands and Norway. According to the authors the monetary incentives provided constitute a large lever for EV diffusion (cf. Pfahl et al. 2013). The Nationale Plattform Elektromobilität (2014) compares the markets from a macroeconomic point of view by considering national framework conditions, national EV stock and number of charging points.

[34] Within this study 99 % of the respondents were users of pure electric vehicles (BEV). In this article BEV users are considered and referred to as EV users.

Furthermore, information on German EV users' willingness to pay (WTP) for EV and their perception of the EV specific particularities concerning range and charging infrastructure are provided (cf. Nationale Plattform Elektromobilität 2014 and Plötz et al. 2013).

In order to analyse German and French EV users' and fleet managers' perception of EV, user acceptance has been analysed within the CROME project based on a multi-methodological, interdisciplinary approach (cf. Figure 50). The acceptance analysis as part of the evaluation concept consisted of repeatedly questioning the CROME participants using and managing the EV in a professional environment by online surveys with different focuses (expectations, first experiences and long-term EV adoption), as well as of face-to-face interviews of some private and professional users (cf. chapter 4) and workshops with fleet managers. Additionally, technical data on trips such as speed and acceleration were collected by using data loggers and smartphones (cf. chapter 2).

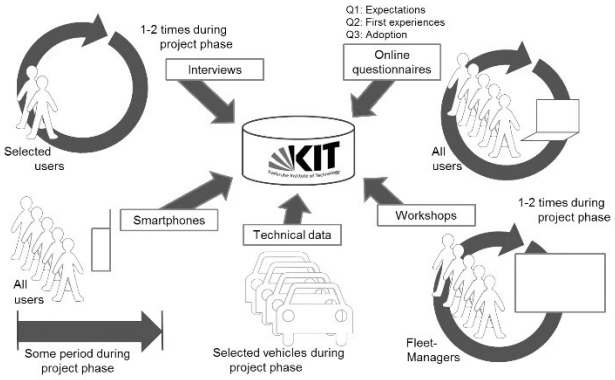


Figure 50: Evaluation concept for EV user acceptance in the CROME project (cf. Ensslen et al. 2013a).

Before the project CROME started in 2011, the projects Kléber in Strasbourg (cf. Pierre 2014; Pierre 2015) and MeRegioMobil (Paetz et al. 2012) in the region of Karlsruhe analysed EV user acceptance in the Upper Rhine region, but from a rather national perspective. Afterwards the projects

CROME, ELEC'TRA (cf. Tanguy et al. 2015) and RheinMobil (Stella et al. 2015) analysed EV user acceptance from a binational point of view.

General information on CROME can be found in Gagnol et al. (2013). Details on the subjective and qualitative part of the user acceptance study, i.e. results from the interviews with professional and private EV users and fleet managers are available in Pierre (2014). Details on current research on technical issues of EV, i.e. the analyses of data from dataloggers in the vehicles are available in Pfriem and Gauterin (2013), Pfriem et al. (2014) and chapter 7.

This section puts its focuses on the findings of the online questionnaires among the professional EV users within the multi-methodological, interdisciplinary approach of the CROME project. More precisely we are focusing on the findings of the subjective and quantitative part of the user acceptance analysis, i.e. the results of the first two online questionnaires on the CROME participants' expectations (Q1) and their first experiences (Q2) are presented before corresponding research questions for the third online survey (Q3) and this article are derived. Furthermore, early private EV adopters amongst a specific population are characterised, notably amongst EV users who experienced EV during a period of about two years in a professional context.

8.1.1 EV users' expectations (Q1)

Between 2011 and 2013 the car manufacturers participating in the CROME project (cf. CROME 2014) could convince some organisations purchasing EV to participate in the CROME project and to take part in the EV user acceptance studies. In order to collect quantitative data on the EV users' and fleet managers' opinions on EV usage and to learn about their expectations, the first online survey was distributed directly to the fleet vehicle users after their organisations decided to take part in the CROME project. Furthermore, the survey was completed by addressing the participating organisations' fleet managers and decision makers. In order to analyse EV

users' and fleet managers' expectations responses to the first survey were collected from September 2011 until April 2012 (cf. Ensslen et al. 2012). Most of the EV users stated that the EV are allocated in their employers' vehicle fleets and are used by several persons, predominantly for professional trips. At that point of time some of the EV users had already made first experiences with the EV, others did not have any experience with the EV at all. Ensslen et al. (2012) tackled the research question whether there are differences concerning user acceptance of EV between the French and German respondents. According to their results, the French respondents seem to be more optimistic about purchasing an EV for their private purposes within the next 10 years than the German EV users. Less of the French answered "maybe" and more of the French chose the answer "yes". The question, who of the EV users within CROME could envision purchasing an EV for private purposes within the next years was further analysed in order to identify main characteristics of early EV adopters in the French-German context. Therefore, Ensslen et al. (2015) developed two binary logistic regression models. One of the two models estimated the EV users' and fleet managers' purchase intentions based on their socio-economic background, their experience levels with EV as well as their car usage behaviour. Results show that respondents who could envision purchasing an EV within the next 10 year are likely to have a higher level of income, to have a household equipped with two or more cars and to travel more than 50 kilometres a day on average, not necessarily by car. This model additionally shows that possibilities to experience EV (e.g. by test drives) are important leverages to support adoption of EV by private car buyers. As organisations kept on joining the CROME project until August 2013, 238 responses to the first questionnaire were collected from September 2011 until November 2013 (cf. Figure 51).

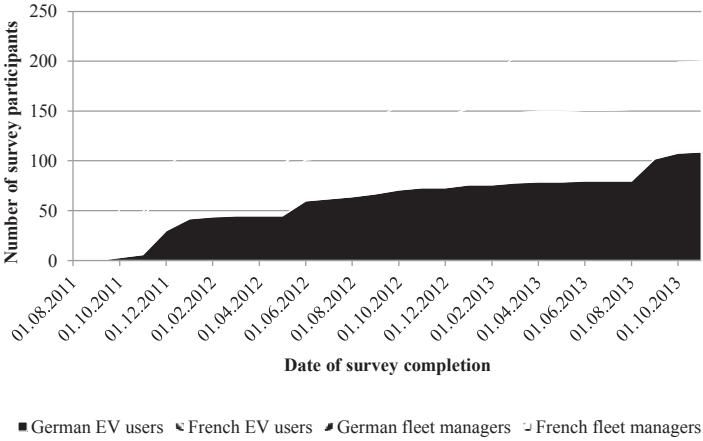


Figure 51: Date of survey completion of the first survey (Q1) in CROME.

8.1.2 EV users' and fleet managers' first experiences (Q2)

Based on the second survey which was completed between September 2012 and May 2013, the CROME participants are characterised according to their attitudes, values and norms. Ensslen et al. (2013b) characterised the survey participants, who had on average experienced EV for one year, based on 19 items assessing their individual innovativeness, environmental awareness, price sensitivity, attitudes to EV and the perceived image of EV. The second binary logistic regression model developed in Ensslen et al. (2015) used this characterisation and joined these factors with the respondents' answers provided in the first survey (Q1) on their EV purchase intentions. According to the model presented dependencies between the respondents' attitude towards EV, their innovativeness as well as the perceived image of EV can be observed. Dependencies between the respondents' EV purchase intentions and their environmental awareness as well as their price sensitivities could not be observed. Unfortunately these findings are limited as the model had to be estimated based on only 60 answers of respondents, who completed the first as well as the second questionnaire.

8.1.3 Research questions, methods used and structure of this article

Based on the findings of the two first online questionnaires (Q1 and Q2) presented above and results of the qualitative user acceptance study (cf. CROME 2014: pages 63 – 67) the third online questionnaire (Q3) was developed focusing on the professional EV users' and fleet managers' long-term experiences and their willingness to further adopt EV in the professional as well as the private context.[35] EV acceptance is assessed by individuals' EV purchase intentions. Therefore the field test participants were interviewed about their planned next car purchase profoundly. The article analyses the differences between criteria influencing purchase decisions in the private and organisational context. Statistical significance levels of differences are determined by nonparametric Mann-Whitney U tests[36]. Identifying respondents who have a higher probability to choose an EV when being asked about their next car purchase decisions is of particular interest. Hence, the focus is on describing powertrain choices based on exogenous variables accounting for attitudes, sociodemographic background and mobility behaviour. Corresponding dependencies are estimated by using binary logistic regression analysis.

In order to characterise potential EV adopters and EV specific barriers this article has the following structure: Section 8.2 presents the data sample including the sociodemographic background of the survey participants, their mobility behaviour, EV usage patterns and their employment by industry. Section 8.3 compares car purchase decision criteria mentioned by EV users buying cars for private purposes and fleet managers buying cars for professional reasons. Section 8.4 describes the professional EV users' next private car purchase intentions before section 8.5 assesses EV specific barriers provided by the EV users. Potential early EV adopters are characterised in section 8.6 before a conclusion and an outlook complete this chapter.

[35] With further focus on additional services (cf. Chapter 3).
[36] With IBM SPSS Statistics®

8.2 Sample description

The following analyses are derived from the third online survey (Q3) that was distributed to the professional EV users within CROME. This survey was completed by the EV users and fleet managers between August 2013 and July 2014 and focused on their long-term experiences with EV. Overall 134 responses from 67 French and German respondents were collected. 82 respondents stated to be only EV user, 37 stated to be fleet manager and EV user, 7 stated being fleet manager only and 5 provided the answer of neither being EV user nor fleet manager. 3 persons did not provide any answer in this issue. The EV used by the survey participants are owned by organisations in different sectors (cf. Figure 54).

8.3 Sociodemographic background

The majority of the survey participants are male (81 % of the Germans and 69 % of the French). On average they are about 45 years old (SD=10) and well educated, as more than half of the respondents have an academic background. Only 18 % of the French and 10 % of the German respondents live in single person households. More than a third of the survey participants did not want to provide information about their households' net income level. On average the German EV users have a net household income of 4,088 Euros and the French of 3,547 Euros (cf. Figure 52). Compared with national averages female participants are underrepresented. Well-educated male respondents living in multiple person households with a high income and being between 30 and 59 years old are overrepresented (cf. Ensslen et al. 2013a). Although this repartition is not representative for the French or the German population, it might be representative for the people working in the participating organisations.

The French as well as the German EV users participating in this survey majorly live in municipalities with less than 20,000 citizens whereas most of them state that their workplaces are located in municipalities with more than 20,000 citizens (cf. Figure 53).

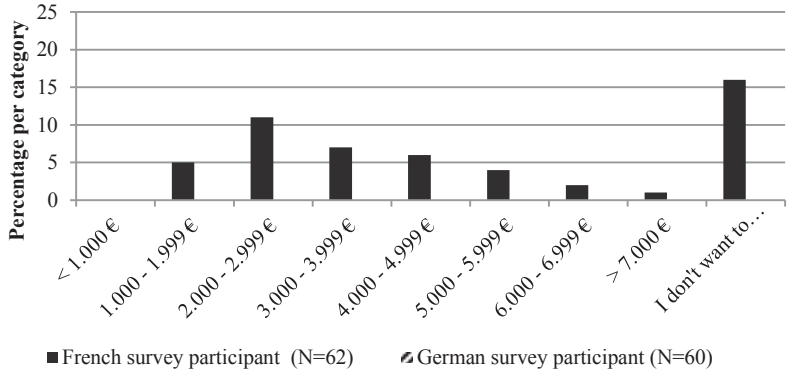


Figure 52: CROME EV users' monthly net household income.

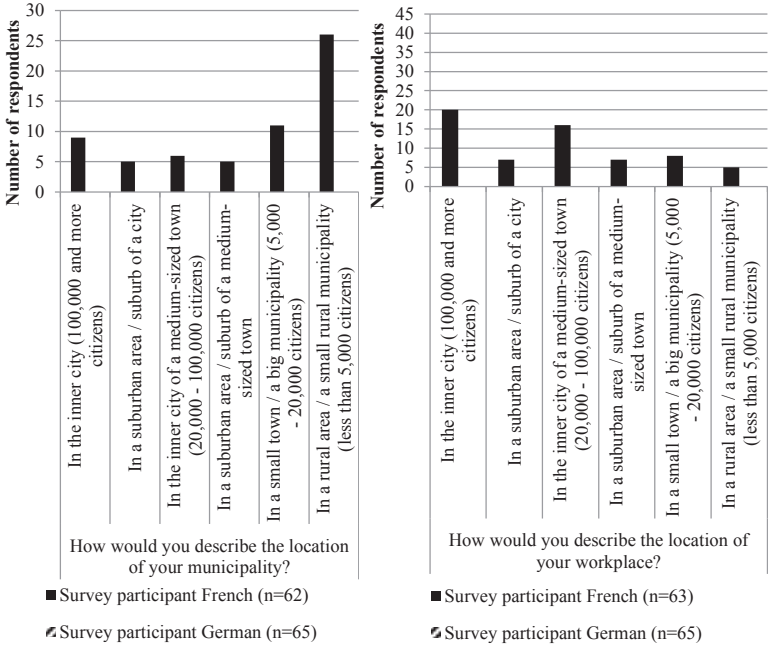


Figure 53: Number of citizens in the home municipalities of the EV users (l.h.s.) and in the municipalities of their workplaces (r.h.s.).

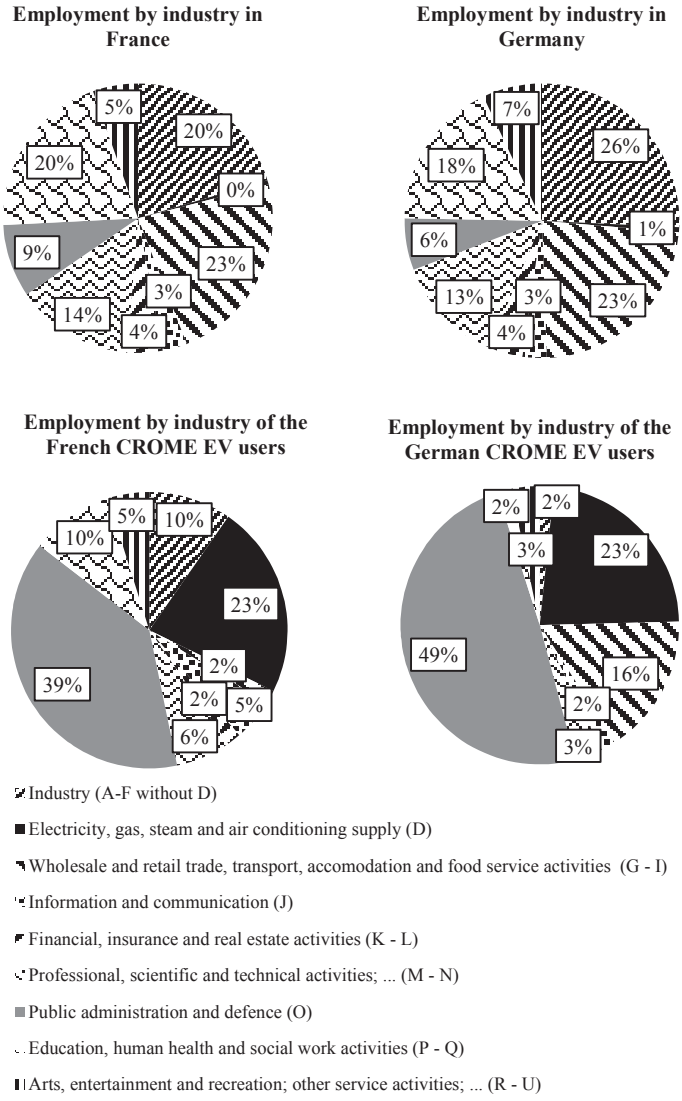


Figure 54: Employment by industry of the CROME participants (n=123) and employment by industry in France and Germany; Data source: Eurostat (2012).

44 % of the CROME EV users participating in the third online questionnaire state to be working in public administration. 23 % of them in the energy sector. Those two sectors are heavily overrepresented, shown by the distribution of employees in France and Germany (cf. Figure 54), as employment in these sectors normally makes up for less than 10 % of the total employment in France as well as in Germany. Only about a third of the survey participants work in other sectors representing an employment share of more than 90 % in France and Germany (cf. Figure 54).

The overrepresentation of the respondents in the sectors public administration and energy supply might be linked to these organisations' interests as e.g. development of new business segments. This might have been a driving factor for energy supply companies to participate. As several municipal utilities participated in CROME, they might have influenced public authorities to participate. Furthermore, employment stakes and the positive communication effect of showing to be environmentally aware and innovative by using EV might have been another important factor influencing organisations in the public administration sector to participate.

8.4 The respondents' mobility behaviour

Three out of four survey participants (n=117) use cars on a daily basis and about 20 % of them at 1-3 days per week. As the EV has predominantly been acquired as a fleet vehicle used on average by more than 10 persons for professional trips (cf. Table 12), it is used less frequently than cars in general (cf. Figure 55). 23 % of the survey participants use an EV on a daily basis, 34 % at 1-3 days per week and 25 % at about 1-3 days per month. About 18 % use an EV less frequently. The German field test participants use the EV less frequently on a highly significant level (cf. Figure 55) what could explain why individual trips of the German users are shorter but have longer cumulated daily distances than the EV used in France (cf. chapter 7.5.2). The fact that the EV used by the German survey participants are used by more people than the French EV further supports this assumption (cf. Table 12). Furthermore, about half of the survey participants state

to do walking trips on a daily basis. The other modes of transport are less important for most of the EV users (cf. Figure 55). This might be linked to the fact that the major share of survey participants lives in rather rural areas, where public transportation is rare, and uses cars for commuting to the workplaces allocated in the inner cities.

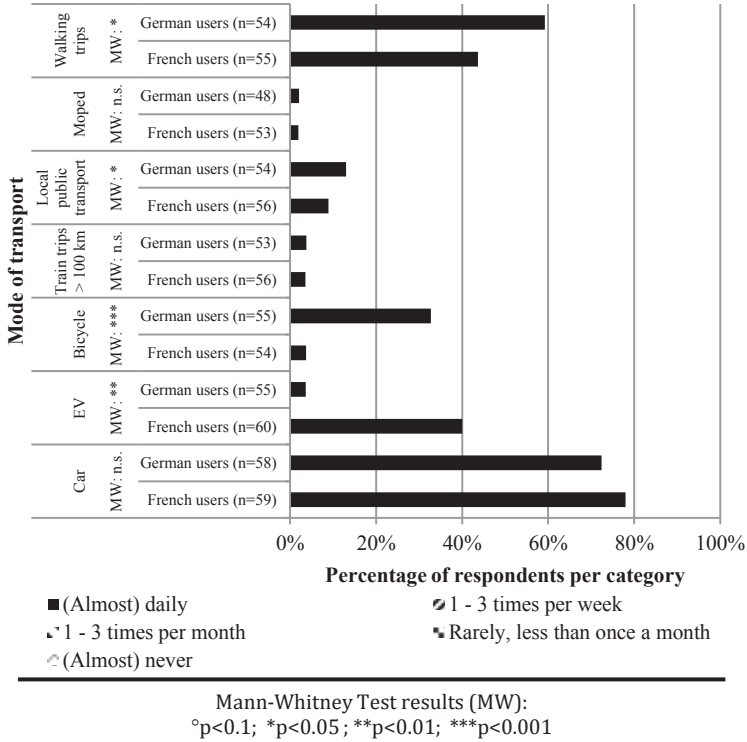


Figure 55: CROME EV users' mode of transport.

8.5 EV usage patterns in CROME

As already stated, on average the French as well as the German survey participants experienced the EV for almost two years. The EV within the

CROME project driven by the French participants are used by less persons than the EV driven by the German field test participants (cf. Table 12).

Table 12: Experience, number of EV users and EV usage purposes in CROME.

			French EV users		German EV users		P-Value (Mann-Whitney U Test)
			N	Mean	N	Mean	
Experience with EV (in months)			71	23.31	68	21.72	0.35
How many persons use this EV?			47	11.91	21	12.95	**0.08**
I use the EV ...	...to commute…	...during ... % of the trips.	69	12.78	56	4.64	**0.001**
	...for private purposes...		69	3.91	56	1.30	**0.003**
	...for transportation of goods...		69	7.39	56	0.00	**0.098**
	...for provision of services...		69	51.78	56	39.20	**0.099**
	…for transportation of persons…		69	10.72	56	2.71	**<0.001**
	...for other professional job completions…		69	13.41	56	52.14	**0.006**

Furthermore, the EV users were asked which purposes they use the EV for. It can be observed, that the EV usage scenario of the French survey participants is more diversified. The EV is used for commuting more frequently. It is also used more frequently for private purposes at week-ends or during holidays, for transportation purposes of goods (e.g. in order to transport products, material or machines) or in order to transport persons. The French as well as the Germans stated to use the EV very frequently for provision of services (e.g. installation, repairing, consulting, visiting and care); the German fleet test participants use the EV almost exclusively for professional trips (cf. Table 12).

8.6 Characterisation of the participating organisations and fleet managers

The fleet managers were asked about their influence on car purchase decisions in their company[37]. Most of the fleet managers do not take the car purchase decisions in their companies alone. Most of the respondents state to have a certain influence on their organisations' car purchase decisions (cf. Figure 56). This is the reason why this population is particularly interesting for providing information on future car purchase intentions, particularly EV.

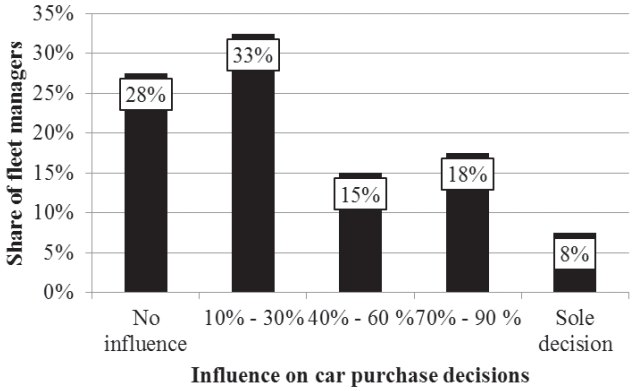


Figure 56: Fleet managers' estimate on their influence on future car purchase decisions within their organisations (n= 40).

The fleet managers were asked about the powertrains of the vehicles in their current fleet today and their estimation for 2020. As only fleet managers of EV owning organisations were questioned, alternative fuel vehicles including hybrids in general already account for 21 % of the participating organisations' vehicle fleets today (15 % EV, cf. Figure 57). According to the participating fleet managers the share of alternative fuel vehicles will be

[37] Differences between the French and German fleet managers' answers are not significant. N=40; U=192.5; Z=-0.206; p=0.837.

more than doubled until 2020 and PEV, i.e. PHEV, REEV, BEV will make up for more than 30 % of the vehicles in their organisations' fleets in 2020.

CROME might have been an important project for the participating organisations in order to experience future developments. According to the fleet managers the EV share in the participating French organisations is currently significantly higher than in the participating German organisations (cf. Figure 57). According to the fleet managers' answers the share of EV in 2020 will be significantly higher in the French organisations (cf. Figure 58).

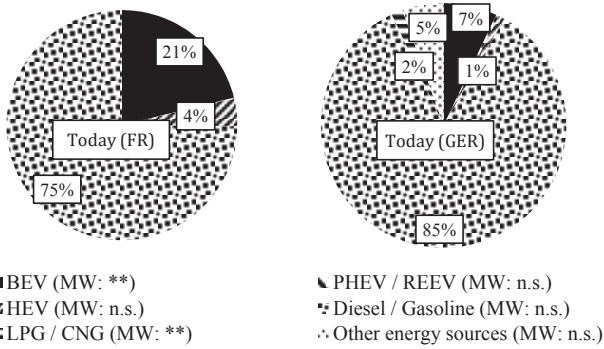


Figure 57: French (l.h.s; n=25) and German (r.h.s.; n=18) fleet managers' descriptions for the composition of their current organisations' vehicle fleets.

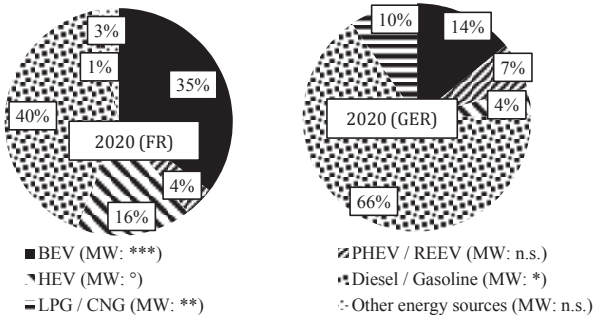


Figure 58: French (l.h.s; n=25) and German (r.h.s.; n=18) fleet managers' descriptions for the composition of their current organisations' vehicle fleets.

8.7 Car purchase decision criteria – private vs. professional

The fleet managers and the EV users within the CROME project were asked which criteria they consider during the vehicle buying process. Fleet managers were asked to provide information about the differences in their purchasing decision for private and business purposes. According to the results provided in Figure 60, price is the most important criterion for a large part of EV users and fleet managers. Surprisingly, the difference between the two groups was not significant for this criterion. According to the results provided in Figure 59 the next cars' emissions are of higher relevance in professional decision-making. On the other hand design, acceleration and fuel efficiency is more important for private car purchase decisions.

Engine size[38] and car brand[39] is more important to the French fleet managers, whereas versatility[40] is significantly more important to the German fleet managers. This might be linked to the differences observed concerning sectoral distributions of the French and German organisations participating in CROME and the purpose the fleet managers intend to purchase the cars for (e.g. vehicles as fleet cars or as company cars). The purchase decision criteria safety[41], emissions[42], versatility[43] and fuel efficiency[44] are more important to the German EV users than to the French.

Comparing the results of Figure 59 with the results of Peters & de Haan (2006) who asked 1307 Swiss households in representative telephone interviews in 2005 about the criteria influencing their decisions when purchasing new cars, the most important criteria (purchase price, car size, safety) are on average ordered in the same way. Differences can be observed concerning the ranking of the criterion fuel type. The findings pre-

[38] N=32; Mann-Whitney U = 68.5; Z=-2.178; p=0.029.
[39] N=32; Mann-Whitney U = 76.5; Z=-1.870; p=0.062.
[40] N=32; Mann-Whitney U = 66.5; Z=-2.324; p=0.020.
[41] N=104; Mann-Whitney U = 1005; Z=-2.324; p=0.020.
[42] N=104; Mann-Whitney U = 1071; Z=-2.093; p=0.036.
[43] N=104; Mann-Whitney U = 987; Z=-2.491; p=0.013.
[44] N=104; Mann-Whitney U = 881.5; Z=-3.248; p=0.001.

sented in Figure 59 oppose the results of Peters & de Haan (2006) where fuel type is ranked behind the criteria design and gearshift. According to Figure 59 fuel type is similarly relevant as fuel consumption, total cost of ownership (TCO) and car brand and definitely of higher relevance than gearshift. Availability of EV and the possibility to experience the new technology might have influenced the CROME users and fleet managers to give fuel type a higher weight than the Swiss households back in 2005.

8.8 EV users' next car purchase decisions

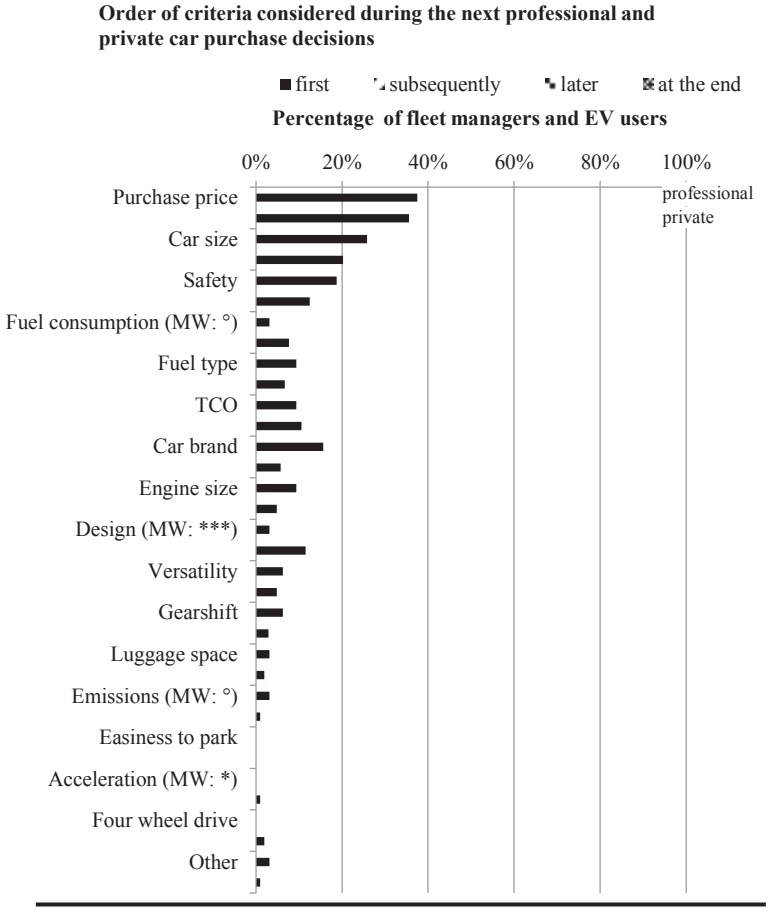
The CROME sample of professional EV users is suitable for research questions on private EV purchase intentions, as (i) the sample is unbiased, i.e. the major part of the survey participants had not bought an EV for their private purposes when they completed the survey. Consequently self-selection processes might be negligible (cf. Globisch et al. 2013). Furthermore, (ii) the professional EV users had already experienced EV, which is a decisive factor influencing EV purchase intentions (cf. Ensslen et al. 2015). The CROME EV users participating in the survey were asked about their experience levels of purchasing cars[45]. Only 7 % of them state not ever having purchased a car. 84 % of the 125 EV users answering this question state having purchased a car at least twice; 31 % of the 125 EV users even stated having purchased a car 6 times or even more frequently. The EV users were asked whether they plan to purchase a new car or rather a second-hand car for their private purposes. About one third of them stated planning to purchase a new car[46]. Furthermore, the EV users were asked whether the next car they intend to purchase will be an additional car or whether it will replace another car in the household[47]. Only 9 % of the 123 EV users providing an answer to this question stated that the next car will be an additional car or the first car ever purchased in the household. 64 %

[45] Differences between the French and German survey participants' answers are not significant. N=125; X^2=1.623; df=3; p=0.654.

[46] Differences between the French and German survey participants' answers are not significant. N=121; X^2=0.283; df=1; p=0.595.

[47] Differences between the French and German survey participants' answers are not significant. N=123; X^2=8.002; df=5; p=0.156.

stated that the next car will replace another car in the household. 27 % of the respondents did not know which vehicle they intend to replace or if they want to purchase an additional car (cf. Figure 60).



Mann-Whitney Test results (MW) for testing the difference between professional and private car purchase decisions (only calculated for selected criteria):
°p<0.1; *p<0.05; **p<0.01; ***p<0.001

Figure 59: Relevance of different criteria during the purchase decision of cars in the private and professional context (private n=104, professional: 32).

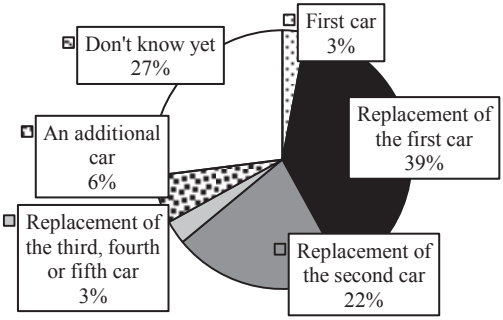


Figure 60: According to the respondents, will the next car be an additional car or a car replacing another car in the household? (n=123).

Being asked about medium and long-term car purchase intentions, 60 % of the EV users state that they will purchase a new car during the next 10 years[48]. 30 % of them state that they will maybe do so. Only 10 % state that they will not buy a car during the next 10 years (cf. Figure 61).

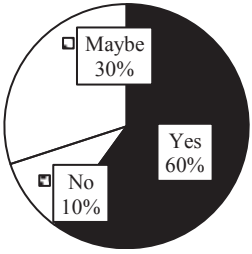


Figure 61: Statements of EV users on car purchase intentions for their private needs during the next 10 years (n=125).

The EV users were also asked whether they could envision purchasing an EV within the next 10 years for their private needs[49]. More than a fourth of them stated yes, about half of them was rather undecided and stated may-

[48] Differences between the French and German survey participants' answers are not significant. N=125; X^2=1.945; df=2; p=0.378.

[49] Differences between the French and German survey participants' answers are not significant. N=126; X^2=0.911; df=2; p=0.634.

be and one fifth of them stated not being willing to envision purchasing an EV within the next 10 years (cf. Figure 62). The same question had been asked in the first survey and was analysed for the CROME users providing an answer to this question between August 2011 and April 2012 (cf. Ensslen et al. 2012). Surprisingly the share of respondents answering "Maybe" increased somewhat and the share of respondents answering "Yes" decreased slightly, but not significantly[50]. The share of respondents providing the answer "No" remained relatively constant. Please note that only a small share of the survey participants of the third survey had also participated in the first survey, so the population in the samples changed. Therefore analysis concerning the development of the same users' private EV purchase intentions over time is not possible.

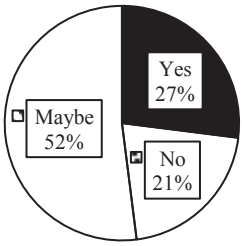


Figure 62: Could the EV users envision purchasing an EV within the next 10 years (n=126).

Furthermore, the EV users were asked to choose among different powertrain technologies when they buy their next car[51]. The respondents had the possibility to choose between the following alternatives: (1) internal combustion engine vehicles (ICEV) driven with gasoline, (2) ICEV driven with diesel, (3) liquefied petroleum gas (LPG) or compressed natural gas (CNG) vehicles, (4) BEV, (5) PHEV or REEV[52], (6) hybrid EV which can not be charged with electricity and (7) indifferent. About half of the 113 respondents chose ICEV, 14 % stated that they are indifferent concerning power-

[50] $N_{Q1,\ April\ 2012}$=108; N_{Q3}=126; Mann-Whitney U = 6316.5; Z=-1.027; p=0.304.

[51] Differences between the French and German survey participants' answers are not significant. N=113; X^2=9.792; df=6; p=0.134.

[52] PHEV and REEV have been grouped together, as both powertrain technologies combine the possibility to charge the EV with electrictricity and to extend the vehicles' range by using gasoline.

train choice. Only 12 % chose BEV, but 28 % stated to choose PEV consisting of BEV, REEV and PHEV (cf. Figure 63). This is consistent with the 27 % of respondents stating that they could envision purchasing an EV within the next 10 years for their private needs provided in Figure 63.

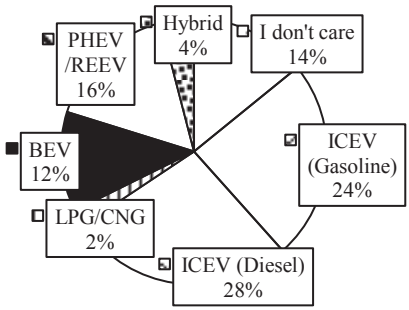


Figure 63: Which powertrain technologies state the EV users to choose when they purchase their next car? (n=113).

8.9 EV specific barriers

As no significant differences between the French and German respondents' answers concerning the minimum range of an EV can be observed[53], the cumulative distribution of answers provided by the 116 French and German EV users is presented in Figure 64. About 20 % of the EV users would be satisfied with a minimum range of 176 km, 40 % with 240 km and 70 % with 300 km. 90 % of the EV users would be satisfied with a minimum range of 500 km (arithmetic average: 308.28 km, median: 300 km).

The French and German EV users' expectations concerning charging time for 100 km range differ on a low significant level[54]. 50 % of the French respondents expect a charging time of 30 minutes or less whereas 50 % of the German respondents expect a charging time of an hour or less. Overall,

[53] N=116; Mann-Whitney U = 1647; Z=-0.185; p=0.854.
[54] N=116; Mann-Whitney U = 1362; Z=-1.771; p=0.077.

60 % would be satisfied with a charging time for 100 km of 30 minutes. 50 % would be satisfied with a charging time of one hour (cf. Figure 65).

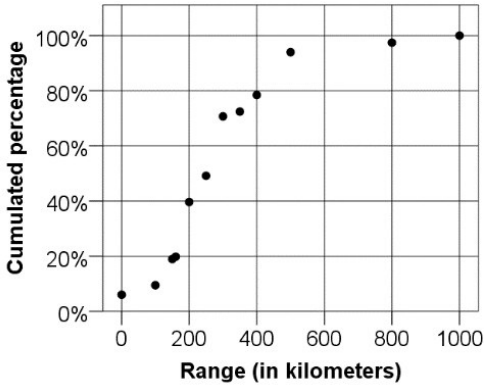


Figure 64: Minimum range of EV so that the EV users would consider purchasing an EV when they buy their next car (n=116).

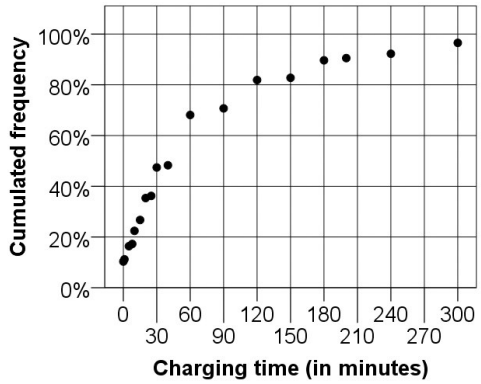


Figure 65: What is the maximum time an EV needs to be charged in for 100 km range so that you would actually consider an EV when you buy your next car? (n=116).

No significant differences between French and German respondents' answers concerning relative Willingness to Pay (WTP) for all kinds of PEV

(BEV, PHEV or REEV) were observed[55]. About 40 % of the EV users are willing to pay more for a BEV than for a gasoline driven ICEV. Somewhat less than 40 % state equal WTP between BEV and a gasoline driven ICEV (cf. Figure 66). WTP for a PHEV or REEV is somewhat higher. Somewhat less than 60 % of the EV users' state being willing to pay more for a PHEV or REEV compared to a gasoline driven ICEV. About 40 % of the EV users expect equal prices (cf. Figure 67).

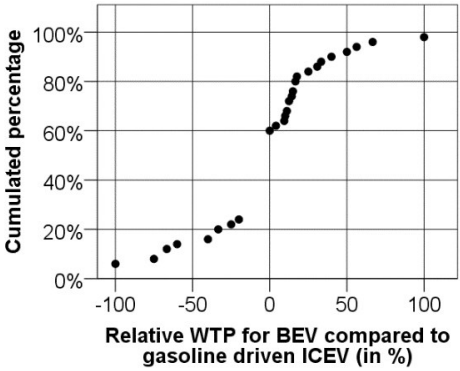


Figure 66: Relative willingness to pay (WTP) for BEV(n=50).

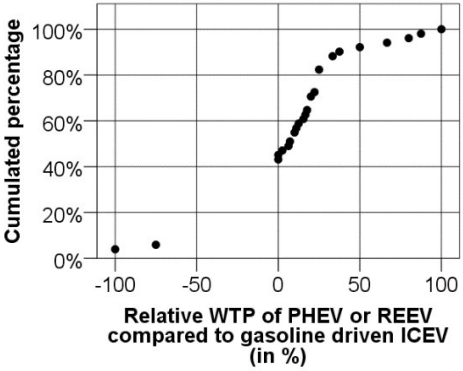


Figure 67: Relative willingness to pay (WTP) for PHEV and REEV (n=51).

[55] BEV vs. ICEV: N=50; Mann-Whitney U = 299; Z=-0.02; p=0.984.
PHEV vs. ICEV: N=51; Mann-Whitney U = 280.5; Z=-0.47; p=0.638.

8.10 Characterising EV adopters

In order to characterize the CROME users choosing a PEV during their next car purchase decision, the different powertrain alternatives are grouped in two clusters: A PEV cluster consisting of the two subgroups BEV and PHEV / REEV and another cluster including all other alternatives. According to Backhaus et al. (2008) a subgroup used in logistic regression analyses should at least contain 25 respondents. With regards to contents as well as limitations concerning the size of subsamples provided, this was the only possible option for pooling the subsamples, as the subgroup of respondents indicating EV choice only contained 25 users. In order to identify and characterise the EV users who stated that they will choose an EV during their next car purchase decision, a binary logistic regression model is estimated (n=86).

Table 13: Quality criterions of the Logit model.

Quality criterions for the model	Cox & Snell R^2: 0.404	Nagelkerke R^2: 0.577	Hosmer-Lemeshow test: p=0.565
Interpretation (cf. Backhaus et al. 2008)	Portion of variance explained by the predictors: (Very) good results		No significant difference between the forecasted values of the model and the observed values could have been observed. According to Backhaus et al. (2008) acceptable if p>0.7.

The model's parameters and corresponding interpretations indicate a good model fit particularly concerning the model's Nagelkerke and Cox & Snell R^2. According to the Hosmer-Lemeshow test results no significant difference between the forecasted values of the model and the observed values can be observed. Nevertheless, according to Backhaus et al. (2008) the p-value in this test should be above 0.7. Unfortunately this is not the case. An overview of the results is provided in Table 13. The following two equations describe the resulting probability of individuals' intention to choose a PEV during the next car purchase decision of the EV users depending on their car usage frequency, EV usage frequency, nationality, environmental

awareness and willingness to seek for information on further development of EV in the future (cf. equations 1 and 2).

$$P(y = 1) = \frac{1}{1+e^{-z_k}} \quad (1)$$

with

$$z_k = -9.452^{**} - 2.741x_1{}^{**} + 2.508x_2{}^{*} + 2.002x_3{}^{**} + 1.219x_4{}^{**} + 0.552x_5{}^{*} + \varepsilon \quad (2)^{56}$$

Description of the variables:

y: Choice of a PEV when buying the next car (0: No / 1: Yes)

x_1: Daily car usage (0: No / 1: Yes)

x_2: Daily EV usage (0: No / 1: Yes)

x_3: Nationality (0: German / 1: French)

x_4: Information seeking on further development of EV (6 point Likert scale)

x_5: Environmental awareness (6 point Likert scale)

ε: Error variable

According to Table 14 all variables in the model discriminate significantly between the EV users choosing an EV when they purchase their next car and those who rather chose another powertrain alternative. Daily car usage negatively impacts the choice of a PEV in the next car purchase decision. On the other hand a daily EV usage has a positive impact at a similar magnitude. The French respondents are rather willing to choose a PEV as well as respondents who are environmentally aware[57] and who seek for

[56] Significance level of Wald statistic: *: p<0.05; **: p<0.01; ***: p<0.001. Further information on the model's variables and coefficients is provided in Table 14.

[57] Environmental awareness is measured by the item "If we continue as before, we are heading towards an environmental disaster". A 6 point Likert scale with an additional „Don't know" answering option is applied.

information on further developments of EV[58]. These results are in line with the findings of Frenzel et al. (2015) who interviewed more than 3,111 private as well as professional EV users. According to their results the motivation of German EV users to adopt EV can amongst others be explained by their interest in innovative technologies and their willingness to reduce their personal environmental impact.

Table 14: Quality criterions of the Logit model.

	β	S.E.	Wald	df	Sig.	Exp(β)	95 % C.I. for EXP(β)	
							Lower	Upper
x_1: Daily car usage	-2.741	0.821	11.131	1	0.001	0.065	0.013	0.323
x_2: Daily EV usage	2.508	0.967	6.725	1	0.010	12.278	1.845	81.709
x_3: Nationality	2.002	0.767	6.813	1	0.009	7.401	1.646	33.266
x_4: Information seeking on further development of EV	1.219	0.429	8.093	1	0.004	3.384	1.461	7.837
x_5: Environmental awareness	0.552	0.277	3.969	1	0.046	1.737	1.009	2.991
Constant	-9.452	2.816	11.266	1	0.001	0.000		

8.11 Conclusion and outlook

In this chapter, selected results of the third and final questionnaire among professional users of the CROME project were presented, notably the participants' socio-demographic backgrounds and their mobility behaviour including EV usage patterns. The comparison of usage patterns between French and German users showed that the German field test participants share their EV with more other users than the French. The French participants on the other hand use the EV in more diversified ways. The partici-

[58] Information seeking on further development of EV is measured by the item "I will keep myself informed about the future developments of EV". A 6 point Likert scale with an additional „Don't know" answering option is used.

pating fleets were examined including expectations of fleet managers concerning future fleet composition regarding powertrain technologies. According to the fleet managers' expectations the share of alternative powertrains will more than double until the year 2020. In the participating French organisations, the share of EV in the vehicle fleets is significantly higher already today – as well as in 2020 – than in the participating German organisations. Criteria influencing car purchase decisions of fleet managers purchasing cars for organisations and professional EV users envisioning to buy EV in the private context are compared. Several differences are observed, but criteria representing monetary aspects (purchase price) turned out to be the most important.

The next car to be purchased by the EV users will predominantly replace another car in the household. According to the respondents' answers, 27 % of them can envision purchasing an EV within the next 10 years. The observation of EV specific barriers showed that about 40 % of the EV users expect the prices of EV to be equal to those of ICEV, so they would consider purchasing an EV when they purchase their next car. On the other hand, 40 % of the survey participants providing answers on their WTP for BEV and ICEV would be willing to pay more for a BEV. Even 60 % would be willing to pay more for PHEV or REEV than for ICEV. National differences between French and German participants were examined concerning charging time. French users are suspected to wish slightly shorter charging times. 60 % of the respondents stated to be satisfied with a charging time of 30 minutes for 100 km. Concerning the range of the EV, 70 % of the users would be satisfied by a range of 300 km. Given this information about EV specific barriers, one can assume the potential that lies in further improvements, particularly concerning EV range and purchase prices. Potentials for EV adoption could certainly be increased by reducing these EV specific barriers. Binary logistic regression analysis was applied in order to characterise potential future private PEV adopters. The following two clusters of powertrain choice (1) PEV (BEV, PHEV, REEV) and (2) others (Hybrid, LPG/CNG, ICEV Gasoline, ICEV Diesel, Indifferent) were used. While daily car usage in general is assumed to constrain a positive choice

of an electric powertrain, the model implies positive impacts of daily EV usage. Experiencing EV on a daily basis might lead to the conclusion that EV fulfil daily mobility needs. On the other hand, survey participants using conventional cars every day without making the experience of using an EV every day might not experience that an EV fulfils daily mobility needs. Further items positively impacting stated EV purchase intentions are environmental awareness as well as the willingness to seek for further information on the development of EV. On top of that, the model depicts the French users to be more likely to decide purchasing an EV in their next car purchase decision. As the sample sizes of participating fleet managers to assess future professional vehicle purchase decisions were limited, further data needs to be collected in order to obtain stable results.

8.12 Acknowledgements

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