FRANKFURT UNIVERSITY OF APPLIED SCIENCES

Results of “E-FACTS” WP4

Next generation EV users and their needs

Faculty 1: Architecture · Civil Engineering · Geomatics
Department New Mobility

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Structure

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1 Introduction and objectives of work package 4

The Frankfurt University of Applied Sciences (Frankfurt UAS) is responsible for the accompanying research of the E-FACTS project. The general goal is, to identify the next generation of electric vehicle (EV) users and their needs. This means, to identify and point out ways to remove barriers to uptake the number of EVs. Legal, social, economic and behavioral aspects are relevant. More precisely, the needs of customers to adopt the EV-technology and the reaction to incentives were identified. With the subsided projects in the participating cities, the knowledge on sustainability and environmental factors were taken into account as well.

During the project meetings with the entire E-FACTS partners, the procedure of the accompanying research was attuned. Suggestions of the Frankfurt UAS were discussed and the proposals of the procedure were adjusted. Further necessary agreements were coordinated by e-mail or by telephone.

The following chapters describe the objectives, methods and results of every implemented survey. At first, a general comparison and requirements of the participating countries introduce into the topic and display the most significant developments in the field of electromobility within this project. After the three basic surveys are delineated, the expert interviews complete that chapter. The document ends with a conclusion, which describes the results in a compact shape.

2 General comparison and requirements of the participating countries

The E-FACTS project members are out of three different cities from three different countries. As a basement of the surveys, a general comparison of the requirements in the different countries is necessary. Regarding various legal guidelines and laws, different kind of habits or differing technologies and infrastructure standards, a comparison is quite challenging.

The local E-FACTS projects are concentrated on inner-city transport. Today, 25% of the CO^2 emissions from transport are caused by urban transport. The European goal is, phasing out the conventionally-fuelled vehicles from the urban environment. That would be a major contribution to significant reduction of oil dependence, greenhouse gas emissions and local air and noise pollution (European Commission, 2011).

"The EU and national governments can create the enabling framework and invest in the knowledge base". (European Environment Agency, 2014)

The European Union is the basic institution to set future ambitions, which have to be adopted on national levels. That is why the European Commission set goals for a competitive and resource efficient transport system for achieving the 60% *greenhouse gas (GHG)* emission reduction target. The local E-FACTS projects support the goal, to halve the use of "conventionally-fuelled" cars in urban transport by 2030 and phasing them out in cities by 2050.

GERMANY

"After far more than 100 years of developments in the internal combustion engine, electromobility heralds the dawn of a new technological era in road transport."
(BMUB, 2009)

In the year 2009, the German government published the German Federal Government's National Electromobility Development Plan. The starting point of the paper was, that electromobility has been identified as a major element and detected as a strategic role in the German Federal Government's policy agenda. The corresponding Economic Stimulus Package II aims at combining near-term economic impacts with strengthening Germany's long-term future viability. Referring to the National Development Plan, Electromobility can make a major contribution to reducing CO^2 emissions in the transport sector. Of all CO^2 emissions in Germany, car traffic causes approx. 14% of it. (BMUB, 2009) In comparison with the statistics of the year of 1990, the general GHG should be reduced by 40% until 2020 and until 2050 by minimum 80% (BMVI, 2014). Electromobility is also an important factor for a

long-term protection of employment and value added. (BMVI, 2014) In 2011, Chancellor Merkel set the goal "that until 2020, more than one million EVs should be on German streets." (Die Bundesregierung, 2011) To reach that goal, the national projects of the "Electromobility Model Regions" and the *"Electromobility Showcases" got implemented in different focus areas. The City of Frankfurt is a member of the regional Model Region Rhine-Main.*

THE NETHERLANDS

Ready to market - ready to innovate and create

(Nederland Elektrisch, 2015)

The Dutch government wants to reach a critical mass of 200.000 electric vehicles on the roads in the Netherlands by 2020 (Nederland Elektrisch, 2015). To reach that goal, the Dutch Ministry of Economic Affairs published the national Action Plan for Electric Driving in the year of 2009. With that plan, the Netherlands should become an international laboratory for electromobility (Delft University of Technology, 2012).

The national Action Plan 2011-2015 shows a further step. The Netherlands are planning to have one million electric vehicles on the streets until 2025. To show the citizens that electromobility is working, a lot of demonstration projects were carried out. The success of EVs would improve the quality of life in cities and towns, because the vehicles will produce no emissions and therefore do not need to be excluded from the inner-cities. Another important factor is the reduction of fossil fuel dependence. The Dutch government focuses their activities on specific areas as well. Arnhem/Nijmegen is one of these areas, were a lot of experiments and projects are carried out. (Netherlands Enterprise Agency, 2011)

SWEDEN

Measures to reduce greenhouse gas emissions must […] be implemented in several different ways, in parallel." (City of Stockholm, 2014)

Sweden wants to become an emission-neutral country by 2050. This task seems to be very ambitious and extensive, because the work required will affect the whole society. To break down that work, the government started to produce a National Roadmap 2050 (Government Offices of Sweden, 2015). In comparison to the other two E-FACTS partners, Sweden is concentrating their activities on the City of Stockholm.

In 2014, the City of Stockholm published the Roadmap for a fossil fuel-free Stockholm 2050. By this document, the City of Stockholm has declared its ambition to be fossil fuel-free by the year 2050. This document is linked to the Urban Mobility Strategy paper. Until 2050, 40% more vehicles will be on the street, but the city hopes, that the EU regulations on emission standards for new vehicles and the price of fossil fuel will minimize the issue. The focus is also on shifting private to public transport. (City of Stockholm, 2014)

3 Quantitative and qualitative surveys

To identify the next generation users and their needs, quantitative and qualitative surveys were necessary. The E-FACTS project members agreed on the implementation of three quantitative surveys as well as on qualitative expert interviews.

The project “erster! – Das Handwerk fährt emobil” was carried out in Frankfurt. The users of the vehicles filled out an online survey. As a supplementary part, a survey with EV tester at a public event in Frankfurt was another focus. Arnhem had the contact details of people, asked for a charging pole in their city. This opportunity was used for a third survey regarding charging issues. To gain comprehensive and international perceptions, experts from the three different countries were interviewed to evaluate the actual developments in the sector of electromobility.

3.1 Survey “erster!” – Electric vehicles for craft businesses in Frankfurt

One of the local E-FACTS projects is the financial support of handcraft companies buying electric vehicles for their own fleet. That initiative started in the year of 2013. With the support of the cities of Frankfurt, Wiesbaden and the State of Hesse, 37 companies were equipped with EVs. In the beginning of the project, the companies could choose an EV from an explicit list of vehicles. After a short period of time, this limitation was abolished. The companies were now free, to choose a Battery Electric Vehicle, (BEV), a Range Extended Electric Vehicle (REEV) or a Plug-In Hybrid Electric Vehicle (PHEV) with a maximum CO^2-emission of 50g/km.

3.1.1 Objectives

The objective of that survey was, to identify handcraft companies as one of the best fitting inner-city businesses to adopt electromobility in their daily mobility. Furthermore, the EVs should be visible in the cities to make them a part of the daily routine. Negative prejudices should be disproved as well.

3.1.2 Methods

A three-tier survey concept is the basis of that project. Just before the EV was delivered to the handcraft company, the Frankfurt UAS contacted the handcraft company, to ask them to take part in the first initial survey (T0). With that survey, general mobility behavior, expectations on the EVs, cost aspects and socio demographic data could be captured.

Additionally, the contact person of the companies received a list of ID-numbers, which the contact person had to distribute to the other users in the company. With the ID-system, a combination of the surveys can indicate long-term changings in the mobility behavior. The ID-system is totally anonymous and no personal inferences can be drawn. The interim survey (T1) should be filled out after the fifth use of the EV. It is similar to (T0), but first experiences get documented as well. In the end of the project, the users filled out the subsequent recovery (T2). This survey is based on the findings of previous surveys and contains detailed questions referring long-term use of EVs.

Overall, 217 ID-numbers were distributed to the contact persons of the companies. This amount reflects the number of the potential EV-users. The challenge of this survey was, to motivate the users to participate in the questionnaire. The responsible persons of the companies were contacted several times, to motivate their colleagues to participate in the online-surveys.

3.1.3 Results

The results of the chapter were analyzed in five different ways. The amount of completed questionnaires is varying between 24 and 40:

- T0: Initial survey, (n=40)
- T1: Interim Survey, (n=24)
- T2: Subsequent recovery, (n=38)
- CS: Cumulated bowdlerized statistics; aggregated data from all three surveys, (n=individual)
- DEV: Development of the attitude during the whole evaluation period, (n=individual)

>> Smaller vehicles are preferred, but the source of energy is not green. <<

According to the user group of handcraft companies, one would expect that handcraft companies choose a bigger vehicle, to transport their machineries and equipment. But the cumulated statistic shows, that the Smart fortwo electric drive was the car, the interviewed persons used the most. The Smart is followed by the Renault Twizy and the Renault Zoe (Figure 1). It is important to note, that some companies had two or even more vehicles funded.

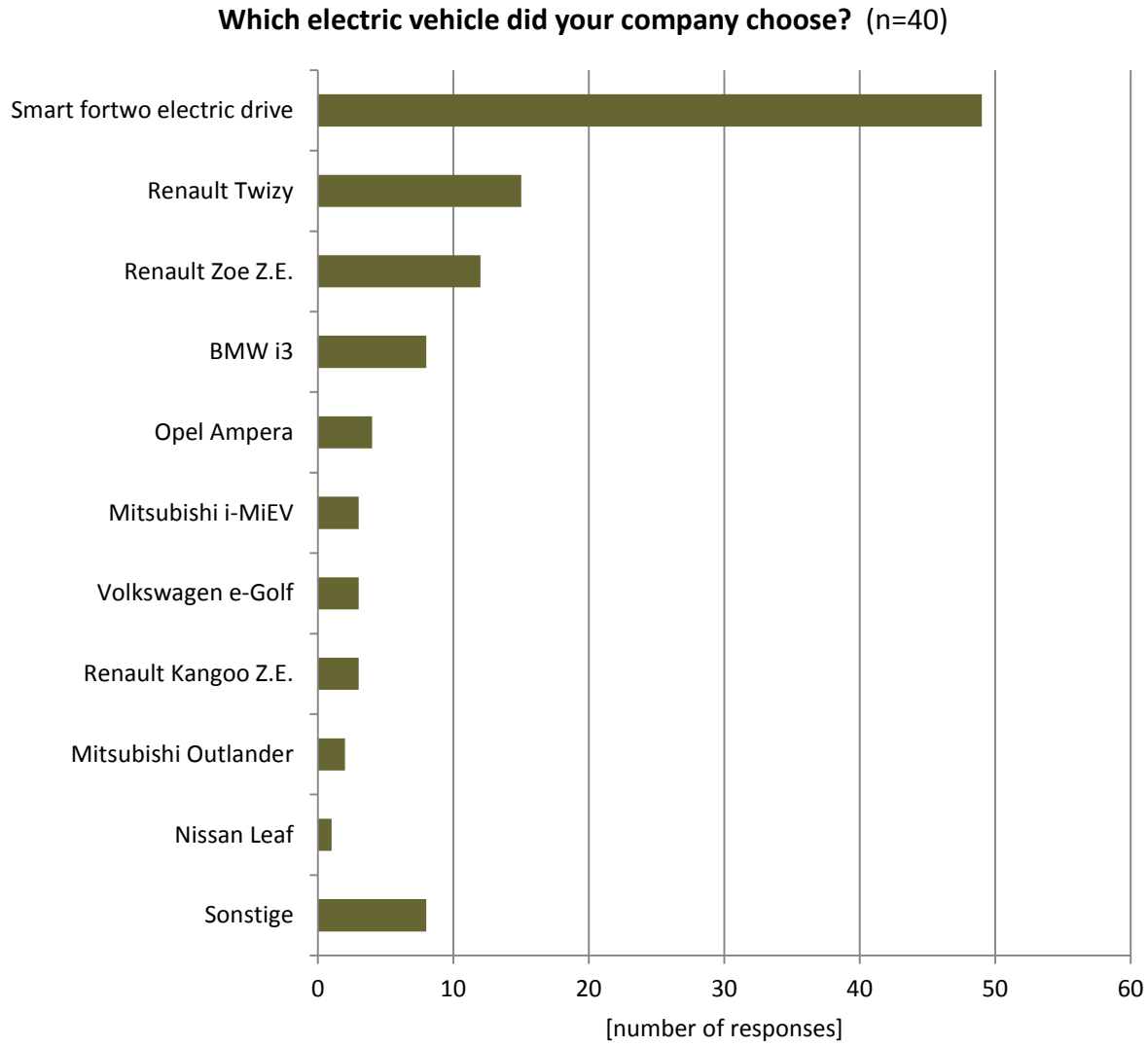

Figure 1: Type of vehicles (CS)

The source of energy is one of the most deciding factors regarding the eco-friendliness of EVs. Figure 2 is showing that the majority of the respondents don't use green electricity to charge their car.

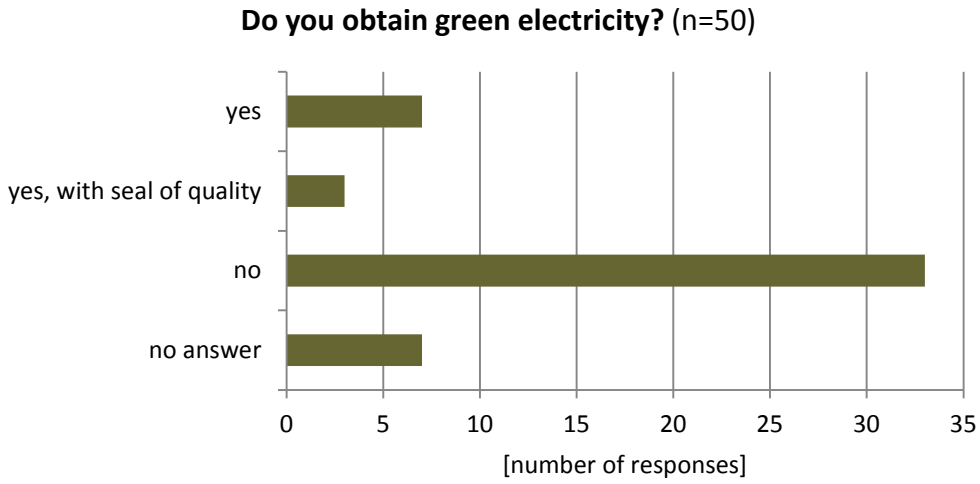

Figure 2: Source of energy (CS)

>> A vehicle is used by several people per day on several days a week <<

The initial survey identified that the EVs of the handcraft companies were used in two thirds of the cases by two or three different persons per day. Six out of 40 respondents said that the car will be used by 4 or even more people a day (Figure 3).

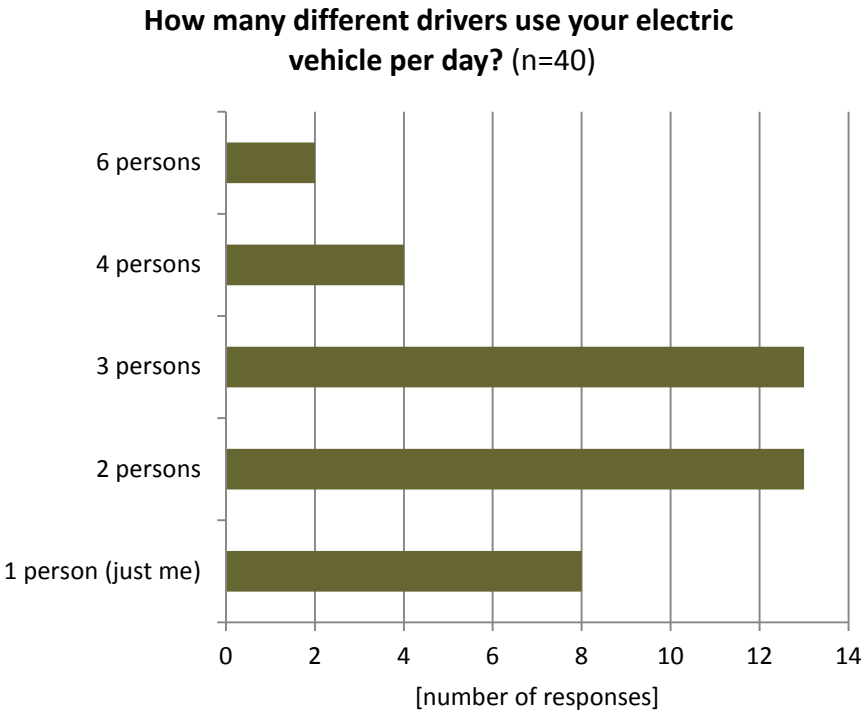

Figure 3: Users per day (T0)

After driving the EV for a longer period of time, more than half of the respondents said, that they used the EV (almost) daily. Just three out of 38 people used the EV less than one day per month (Figure 4). Comparing the development of all three surveys (DEV), especially how often the car was planned to use or was finally used, the trend in all the three surveys is a "regular daily use" or a "usage of 1-3 days per week". The "almost never" and "rarely" usage answer wasn't given more than five times in any of the surveys.

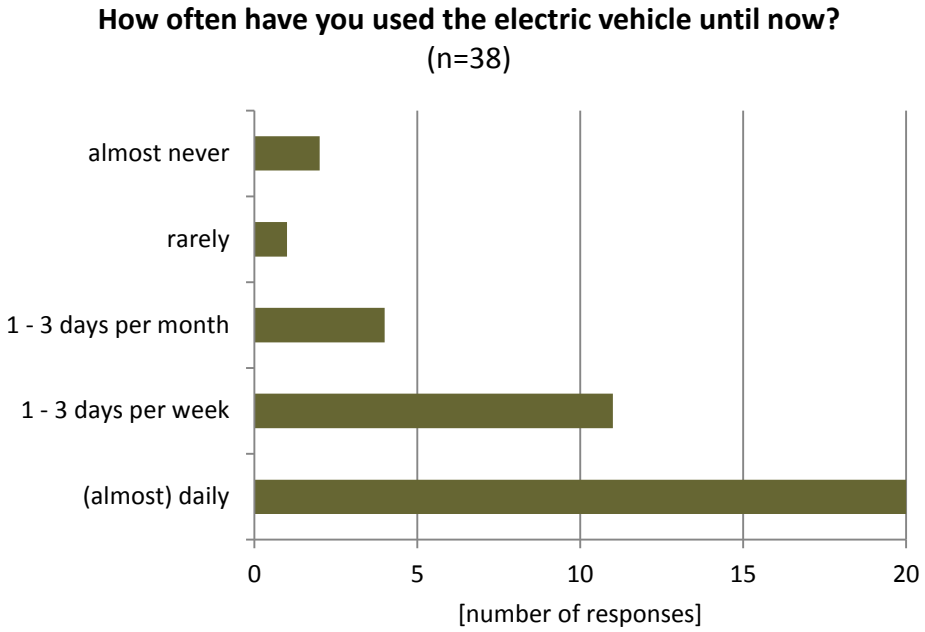

Figure 4: Usage of the electric vehicle (T2)

In the context of the usage, it is important to mention that the question of the EV usage was answered similar in questionnaire (T0) and (T1). The majority of the people used the car mainly or only for business reasons. But around one out of three users used the EV for business and for private purposes.

>> Handcraft companies are a perfect target group for the usage of EVs, because they drive a short daily distance <<

The daily route of handcraft companies is usually concentrated on inner-city distances. The results of the initial survey (Figure 5) show a varying result of the distances which are driven for business purposes per day. The most given answer is 21-50 km a day per car. Nowadays, the standard range of EVs covers 37 of 38 answers without any range problems. Just one person marked a distance more than 100 km per day and car. The average of the distances, which is covered privately with the electric vehicles per day, is much lower. The answers

with 1-5 and 6-10 km are chosen most often. 10 users chose “no answer”. This can be justified by the fact, that the users are not aware of their daily driven distances.

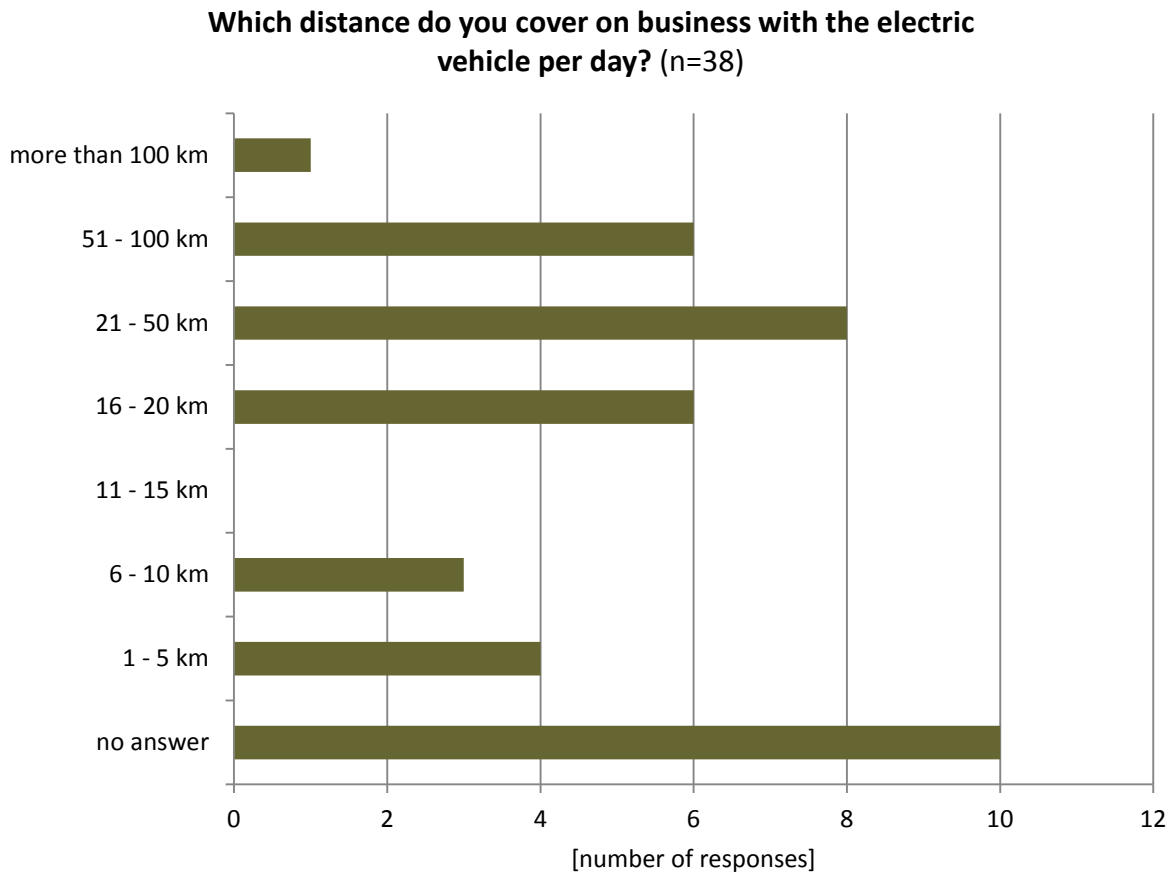

Figure 5: Distances on business per day (T0)

An assessment of the average range of a full-electric vehicle without a range-extender shows a realistic estimation of the users of 123 km.

Analyzing a further estimation of the users, which range an EV should cover at least, the attitude of the interim survey and the subsequent recovery vary a lot. The answers of the interim survey show a very heterogeneous distribution of the answers (Figure 6). 21 of 38 users answered in the subsequent recovery, that the range should be more than 250 km, that an EV would be a realistic option for them (Figure 7). This trend is surprising, because during the time of use, the drivers figured out that the range of the EVs is sufficient for most of them.

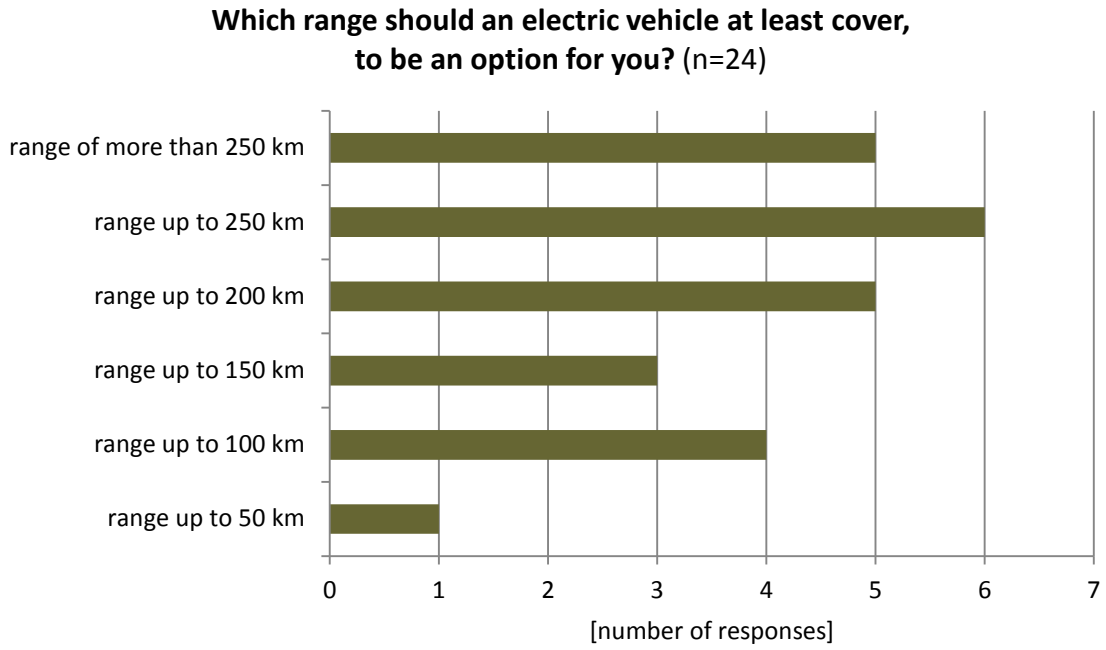

Figure 6: Necessary range (T1)

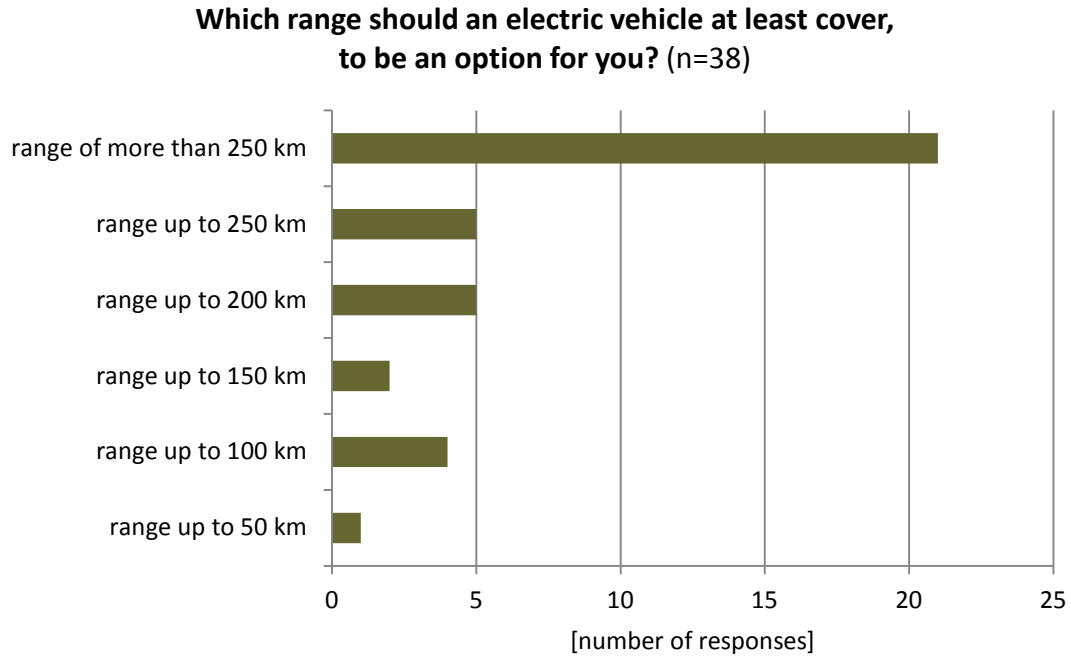

Figure 7: Necessary range (T2)

>> Charging at work is easy, public charging entails some issues <<

After a long-term usage (T2), 27 out of 38 users said that they charged their EV at work at a single parking space. 14 users charged the car at home at a private charging option. 31 out of 38 users agreed with the hypothesis, that the charging time is too long. Another charging issue is, that there are too less charging points in public and semi-public spaces. 29 users agreed with this hypothesis. The hypothesis, that charging points are hard to find and billing systems of the electricity costs are too complicated wasn't agreed a lot (13/9 out of 38).

As already mentioned before, a main focus is charging infrastructure in public space. The next question in the subsequent recovery identified the main criteria of public charging stations by their importance. The best ranked criteria are the "reserved parking spaces for electric vehicles at charging points". The second most important criteria is the "easy access/well signposted" followed by point, that "charging should be usable independent from the electric grid provider".

33 out of 37 users support the idea of a dense network of public charging infrastructure, that electromobility will be successful and that electromobility gain acceptance in their private surroundings (T2).

A further deciding factor is the time, the electric vehicle is standing on the companies ground. That time can be used for charging. In just 4 out of 27 cases, the vehicle will be just 1-5 hours nearby or on the ground of the company, which could cause temporal problems concerning charging time. But in the all other cases, charging at the company ground wouldn't be a timing problem (T0).

Charging at home wouldn't be an issue for the users. 37 of 57 people answered, that they have a (potential) charging possibility at home. Just 3 out of 57 people said, that they have no charging possibility at home (CS). If users would take their car back home, they wouldn't have a problem to charge it overnight.

>> The EV is not used as a main transport mode <<

The first question in the interim survey was, if the EV is the main mode of transport for business purposes. That wasn't the case for 14 of 24 users. Eight respondents answered, that the electric vehicle was the main mode of transport. This trend is even clearer in the private usage; 21 of 24 respondents didn't use the electric vehicle as the main mode of transport.

If one looks at the mode of transport, which was used beside the electric vehicle, there is no significant variance of results comparing the initial and the interim survey. In these two

surveys, it was already prompted, why people used another mode of transport beside the EV. The most given answers were the “pleasure of use with the other vehicles” and “to get to work since the availability of the electric vehicle is not always guaranteed” because the EV is just a business car and/or not personal dedicated.

>> The overall assessment of the EV is mostly positive <<

In the interim survey, the users had the possibility, to evaluate the driving performance of their EV. By rating statements with “1” (don’t agree at all) up to “6” (totally agree), the users could express their opinions. The best evaluated statement is the good acceleration (5.42), followed by pleasant driving noises (5.25) and a high driving pleasure (5.21). The lowest points got the statement of an appropriate maximum speed with still 4.08 points (Figure 8).

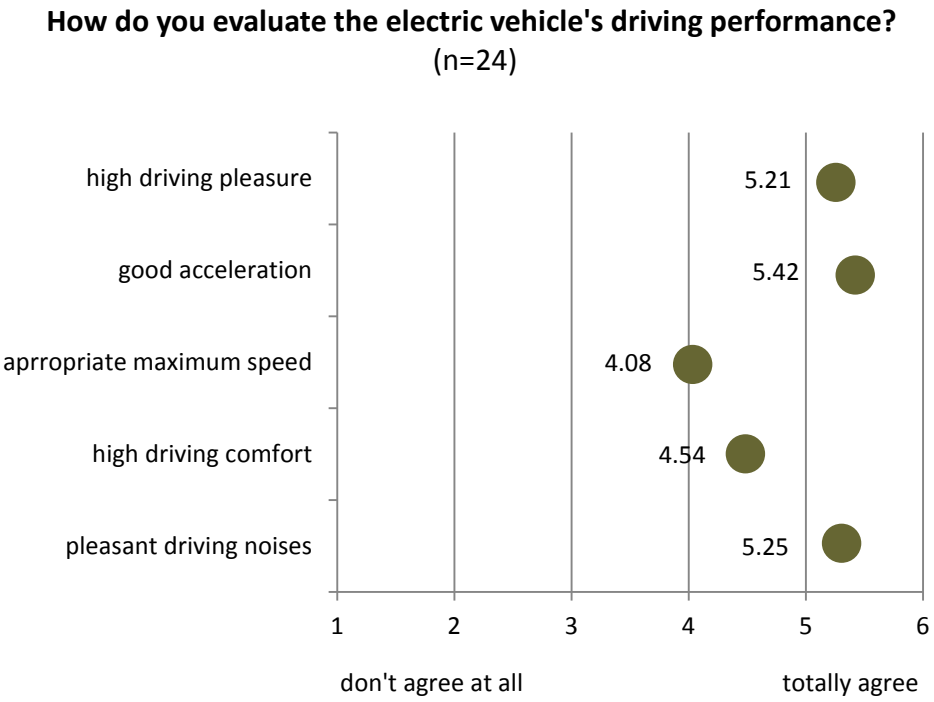

Figure 8: Driving performance (T1)

The same scheme was used for the question concerning the assessment regarding costs that arise from the EVS purchase and usage. An average grading with 3.54 out of 6 points got the current expenses (electricity costs, insurance and taxes). The maintenance and service costs were evaluated with 3.08 points. Low purchase costs (e.g. purchase price/lease payments) got evaluated with just 2.29 out of 6 points (T1).

For private businesses it is important, that the integration of new innovations doesn't have any negative influence on the operational processes. As seen in Figure 9, this issue didn't come up for 22 of 24 respondents after a long-term usage (T2).

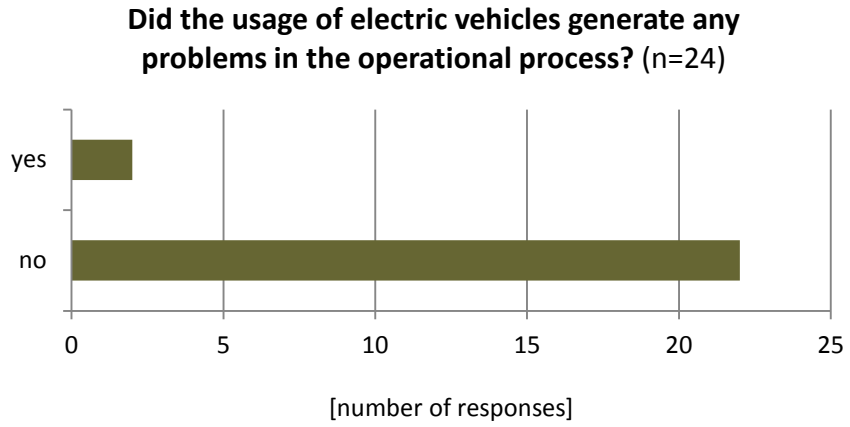

Figure 9: Problems in the operational process (T2)

In the subsequent recovery, users were able to elucidate their opinion about the problems which may occur during the usage. But for 33 out of 38 users, no problems with the vehicles occur.

During the whole survey period (DEV), no significant dissenting opinions where identified, where users could agree to some statements about purchasing an EV. The statement, where most of the users in the initial and interim survey agreed, was; "I would pay less for an electric vehicle, if I had to adjust my mobility behavior". The statement "electric vehicles are just a passing trend - the future is about other driving technologies" was not rated with more than 2 out of 6 points in any of the three surveys.

One of the most important factors is the purchase price, that potential users are willing to pay extra or less for an EV in comparison to a conventional vehicle. The development in that field didn't change significant during the three surveys; The majority is willing to pay the same price for both technologies. But comparing the willingness of paying more or less for an EV, a lot more people would spend more for an EV than for a conventional vehicle (Figure 10).

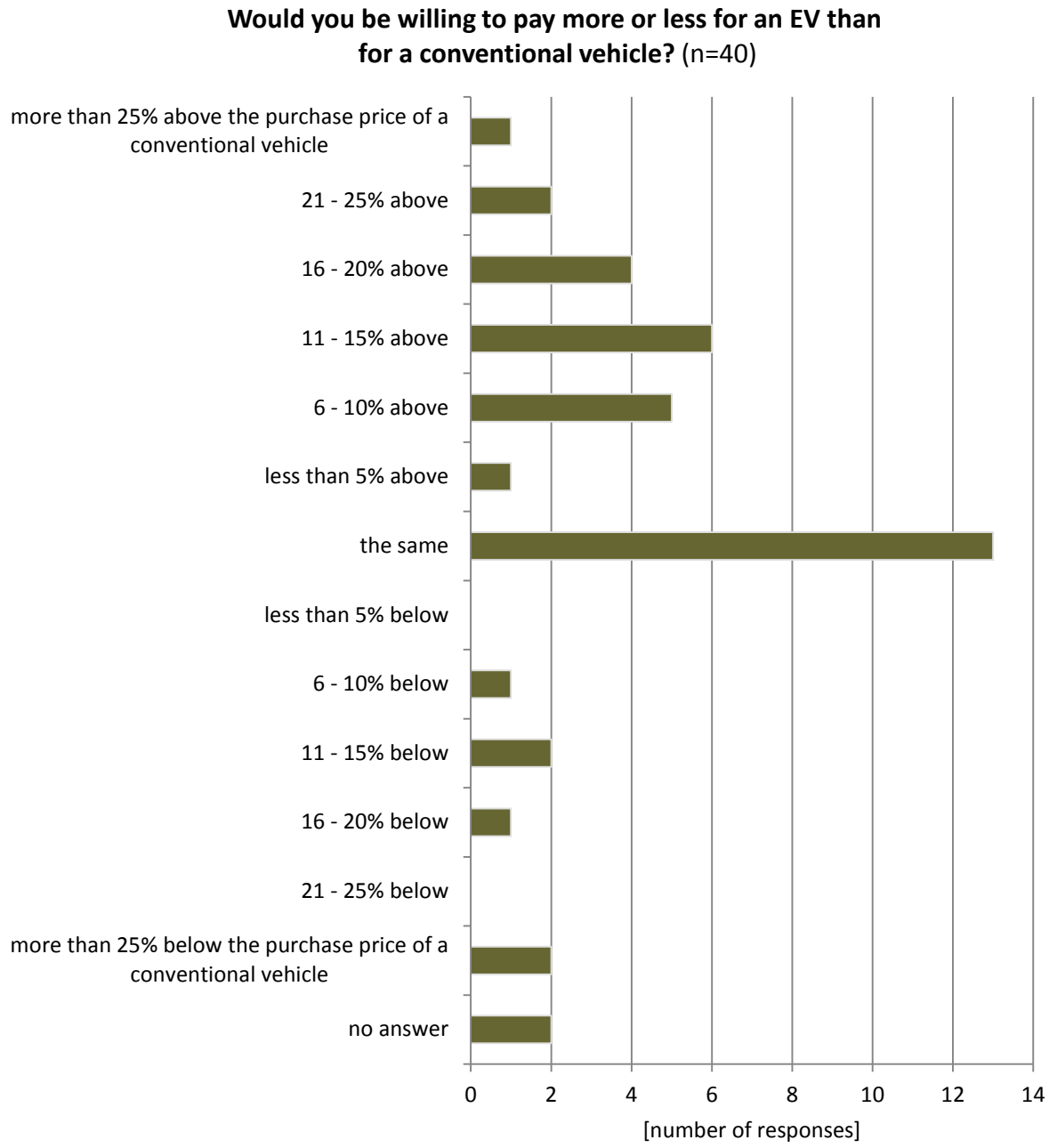

Figure 10: Willingness of the purchase price (T0)

>> The demographic data reflects the average person, working in that business <<

Demographic data is always important to show, which kind of people participated in a survey and how representative it is.

The handcraft sector is nowadays dominated by men. Same trend can be found in the question of the gender. 44 of 57 respondents are men and just eleven are women. More than half of them are between 41 and 60 years old. 13 respondents are between 21 and 40

and just two of them are younger than 21. Just 16 out of 57 respondents have an A-level degree. That is probably, why just ten respondents went to university. The position in the company of the respondents is very different. Starting from the management, down to employees without any management or personal responsibility, every level was mentioned in a more or less balanced way (CS).

The initial survey shows that most of the (T0)-respondents are working in the motor vehicle sector (9 out of 26 answers). Four users are working in the construction industry and the same amount in the electrical sector.

>> Various findings <<

In the initial survey, the users evaluated a list of driving purposes. The handcraft companies agree mainly with the “usage of the car for customer and on-site visits”. In private use, they would prefer an electric vehicle mainly for “commuting to the workplace” and “further shopping or leisure activities”.

A variety of incentives, that could make electromobility more attractive are being discussed. In the subsequent recovery, the users could rate a couple of incentives by their importance. The most important incentives are the direct purchase premium, followed by the lower or exemption of the motor vehicle taxes and discounted or free charging.

Users, who answered the subsequent recovery, have a lot of experiences with electro-mobility. It would be desirable that they share their positive impressions. Everybody communicated their experiences while most of the users (33 out of 38) talked about their experience in their professional and private environment (Figure 11).

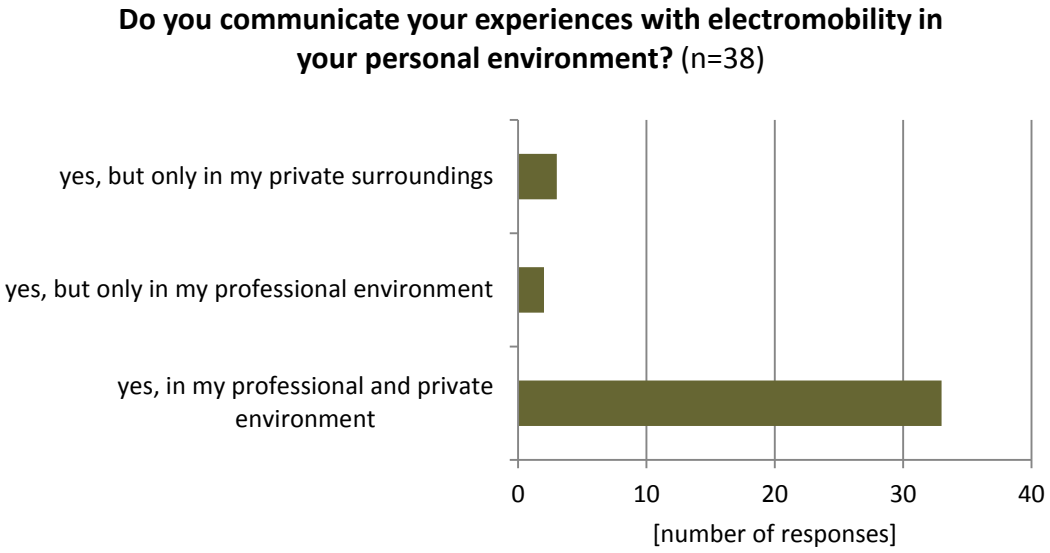

Figure 11: Communication of the experiences (T2)

Regarding the usage of the vehicle, 30 of 52 people answered in the questionnaire, that the car is a company car for internal use by several employees. Just eight persons use the vehicle for themselves as a kind of exclusive usage (CS).

Résumé

The “erster!”-survey shows, that the handcraft companies are a perfect target group for the usage of inner-city electromobility. Hard facts like problems with range, infrastructure and a negative influence on the daily operations could be disproved. The soft facts, like the attitude towards EVs or the communication of experiences, were all answered in a positive way. Of course, the participation could have been better to have a more representative result, but first trends can be seen even with a low number of respondents.

3.2 Survey “Klassikstadt” – First experiences with electric vehicles

Within the framework of the Frankfurt automotive-exhibition, the event “Elektromobilität in Frankfurt am Main – Erleben was die Zukunft bewegt!” took place on the 27th of April 2014. Guests of the event had the possibility, to test drive an EV. They could choose between different brands and models.

3.2.1 Objectives

The event was used to capture further experiences of EV drivers in Frankfurt.

3.2.2 Methods

Coordinated with the Frankfurt Economic Development, a questionnaire was developed, to capture the experiences of people, testing an EV. Overall, 30 people were interviewed. The survey was quite basic, because people had to be interviewed on the street, immediately after the test drive. The questionnaire contains eight questions plus socio-demographic data.

3.2.3 Results

27 out of 30 interviewed people were male and just three female. Almost half of the test drivers were between 41 and 60 years old. Just one person was younger than 20 years, ten people between 21 and 40 years and one person older than 60 years.

Most of the people choose a Tesla for their test drive. The Tesla is followed by the Volkswagen E-up and the Opel Ampera. For two thirds of the people, it was the first time they have used an EV. The other ten people used an electric vehicle several times for private reasons. Just one person used it for a business reason as well.

The main purpose for using an EV are shopping and commuting, followed by activities and the education of children (Figure 12). The most important conditions are the long range and short charging times. An easy use, safety and a high driving comfort got not rated as that important (Figure 13).

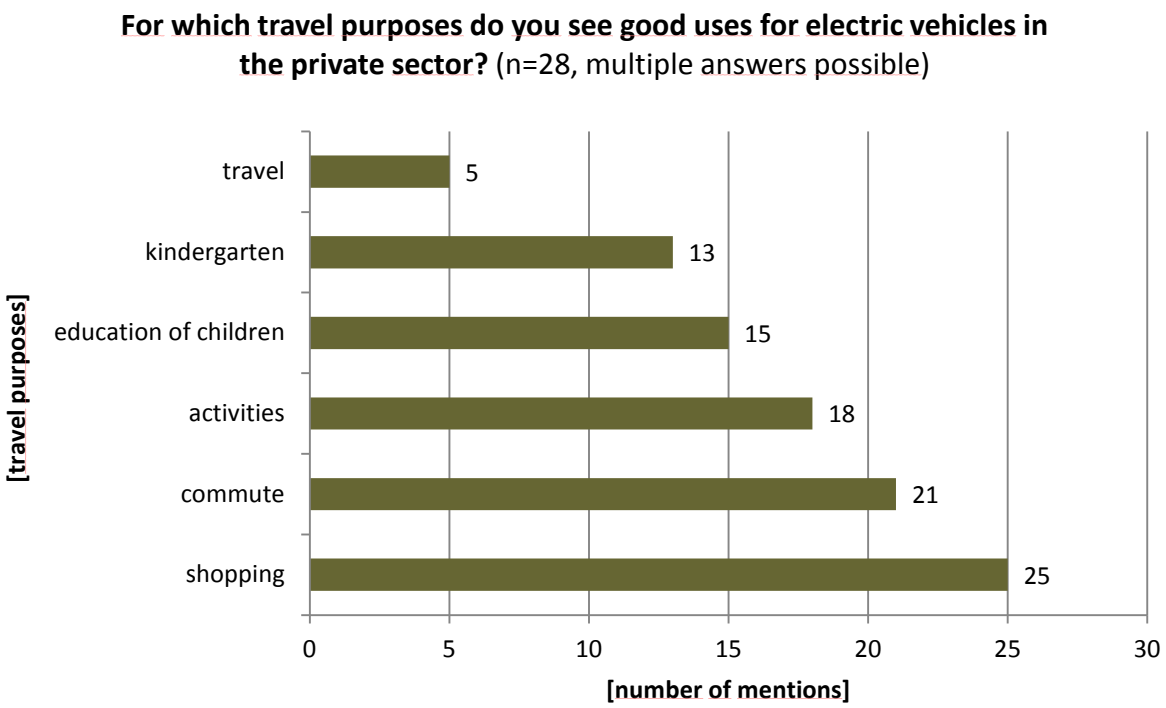

Figure 12: Purposes of travel

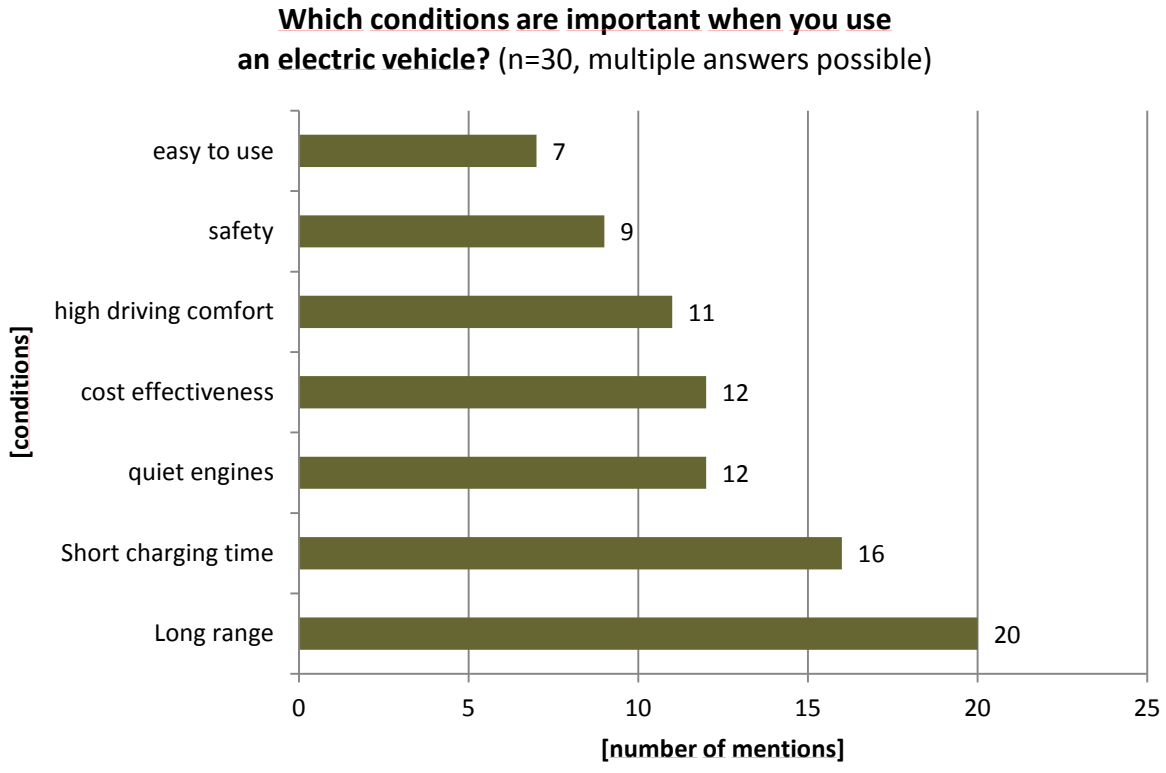

Figure 13: Important using conditions

As an overall conclusion for this survey, one can say that the test-drive at the event was a good idea, to bring guests in contact with the technology of electromobility. Furthermore, the experiences are mostly positive and the test drivers got a thought-provoking impulse to think about a purchase of an EV.

3.3 Survey “Arnhem” – Demand of public charging facilities

Together with the City of Arnhem, a further survey was carried out. In the Arnhem survey, the focus was on charging infrastructure. That issue was chosen, because the City is interested in the issues and challenges of charging infrastructure.

3.3.1 Objectives

The main objectives of this survey are, the identification of the problems and needs of EV users in Arnhem. Furthermore the City should get information about the main reasons for buying an electric car as well as basic socio-demographic data about the EV drivers in the city.

3.3.2 Methods

In coordination with the City of Arnhem, an online survey was developed. This online survey was justified for people, asked the city for a charging pole. That means that people, participating in the survey, are already users or future users of EVs. The survey was conceptualized in English language. With the support of academic colleagues and the City of Arnhem, the survey got translated into Dutch. Afterwards, the survey was integrated in an online survey tool and the link got distributed to the target group by the City of Arnhem.

3.3.3 Results

Unfortunately, just ten people took part in the online survey. Even several ways to generate and motivate new people to participate in that survey weren’t successful. Evaluating a quantitative survey with just 10 responses wouldn’t be scientifically correct. That is the reason, why this survey wasn’t evaluated during the period of this E-FACTS project.

3.4 Expert interviews

The overall objective of this work package is to identify the next generation users and their needs as well as general current issues concerning electric mobility. Next to the qualitative analyses, qualitative research methods have been applied as well.

3.4.1 Objectives

The goal of this survey was, to get an overview from international experts about the developments concerning electromobility. Common opinions and similar ideas should be detected and displayed in simple graphics.

3.4.2 Methods

Experts from all participating countries took part in a personal interview. Due to geographical distances, the interviews were made by telephone. With the support of the local project partners, a reasonable selection of representative experts from involved sectors was made. Finally, 24 experts from universities/research institutions, public administrations, free economy and consulting companies could be interviewed.

3.4.3 Results

Ten of the interviewed experts were from Germany, eight from Sweden and six from the Netherlands (Figure 14). That imbalance came about, because of the different amount of experts the local partners provided and because of some short-term cancellations of interviews.

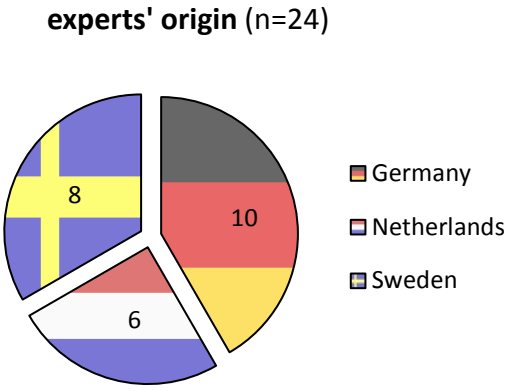

Figure 14: Experts' origin

Clustered by the type of institution, five experts are employed at a university or research institute, nine experts are working in a public administration (city administration, federal ministries or national authorities) and ten experts are employees of consulting or private companies. All experts are professional involved in projects or strategic decisions dealing with electromobility (Figure 15).

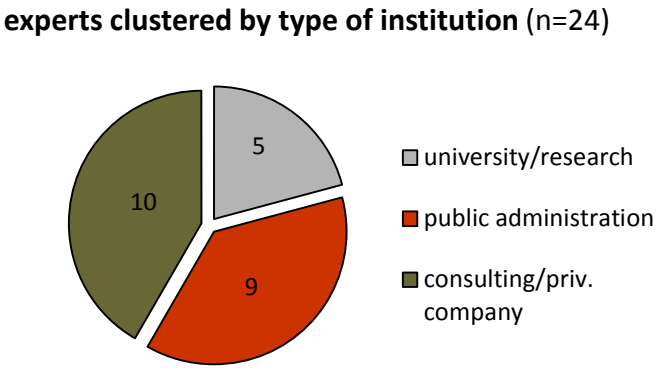

Figure 15: Experts clustered by type of institution

To get a meaningful comparison of interviews with experts from different countries with a varying professional background, the questions were conceptualized quite general and orientated to international issues. Electromobility has a very wide field of applications. The possible applications are always depending on technical processes and the social willingness of the society to adapt new innovations. Therefore, the first question of the interview was termed as follows:

Question 1: In which field of application, electromobility is a useful instrument?

The analysis of the answers shows that the spectrum of possible applications is not fixed at one certain mode or user group, but a certain trend can be determined. The most given answer was the integration of EVs in fleets of public administrations.

"On a local level, many actors interact with each other. Governmental bodies are a central actor in that local network. They know a lot of people and can contribute to the success of electric mobility." (Assistant professor of a Dutch University)

Furthermore, private companies with a predictable daily driving distance would be another focus group. Besides handcraft companies, health care services were mentioned as well. These companies would have the advantage, that most of them could charge the vehicle at

their company grounds. Also commuters with a moderate daily driving distance were mentioned in the private sector as one specific focus group.

Regarding the **mode of transport**, especially pedelecs (pedal electric cycles) were mentioned as one suitable mode, besides public transport. A lot of public transport vehicles are already electrified for a lot of decades. A head of an electromobility model region in Germany points out, that an improvement of electrified buses would be a good next step because most of the trains are already running by electricity.

An operator of one of the biggest German airport is already using electric vehicles for apron operations:

"I think that specialized vehicles are a promising chance to try out some experiments by switching from conventional to battery electric engines." (Representative of an international airport operator)

Looking at the **spatial relation**, all experts say that the focus of electromobility is on city traffic at the moment. Rural areas are important as well, but that should be focused at a later stage of development. A professor from a Dutch University noted that electric mobility should be applied where zero or low emissions are required. As a result, cities and their municipalities would profit by improving their air quality statistics.

Question 2: Which national incentives do you advocate? Why?

The second question was the question with the most variations of answers. The kinds of answer were not related to the type of institution or the origin of the expert. Taken that into account, to define a general trend for this question is not possible.

The experts have various opinions about financial incentives in their countries and in general. Tax refunds, purchase subsidies, road tax exemptions and support of research and development were evaluated and prioritized in different ways. The following statements represent the numerous varieties of responses.

German quotes

"I think that a symbolic national support could be purchase incentives. That could be expanded by tax reductions for example." (Representative of a German grid operator)

„National incentives should be invested for research and development as well as for commercialization of innovative mobility." (Representative of a Hessian ministry)

Dutch quotes

"I think, the incentives that we had, were quite interesting for a lot of people. Many people made use of that. That is the main reason why you can see a lot of electric vehicles or plugin-hybrids on the road here in the Netherlands." (Professor of a Dutch University)

"I heard somebody I know from a car producer and he said, […] that people should not expect electric cars to become cheaper because if the producers get improvements in batteries, they will use it to increase the vehicle range rather than decrease the price." (Representative of a Dutch Automobile Association).

Swedish quotes

"I think the Swedish government could copy-paste what they are doing in Norway, because it's really working." (Representative of a Swedish City Department)

"In Sweden we don't have a registration tax at all. So we cannot reduce it from electric vehicles. But we could do it the other way around. Not giving a benefit to the electric cars, like the Swedish government do it today, with a "super clean car premium", rather have a registration tax for every new car and take it away for clean vehicles" (Representative of a Swedish City Department).

Question 3: Which national measures do you wish to be implemented?

Charging infrastructure is the predominant answer for the third question. In all three countries, there is a need for a national strategy approaching the establishment of charging points. The general opinion is, that charging infrastructure is necessary in public space as well as on private territories. Citizens should be aware of public infrastructure to make sure that they have the possibility to charge their vehicle in public areas even if most of the charging operations are made at home. Nevertheless, there is no business model for charging infrastructure yet.

"Everybody wants it, but very few seem to actually need it or use it. So actually the business model is relatively complicated because you putting it up and very few are going to use it." (Representative of a Swedish City Department)

Due to limited resources and knowledge gaps, there is also the desire for guidelines and business perspectives the municipalities could use for implementing electromobility measures.

"This is a very diverse picture around the Netherlands. Arnhem has a very open and stimulating policy. Smaller cities in the Netherlands don't have structured ideas of charging infrastructure." (Representative of a Dutch Grid Operator)

A professor of a Swedish University emphasizes the importance of e-mobility in new housing areas. They should be prepared and equipped with charging infrastructure. He justifies it by the fact that the most important charging point would be at home for overnight charging.

A representative of a German grip operator points out, that they would profit by improving through electromobility courses in vocational schools in Germany. The trainees are the future engineers and they have to get a fundamental knowledge of the actual technical developments.

Question 4:

Do you think that it is necessary to promote electromobility projects on EU-level? If yes, which benefit do you expect out of it?

More than three-quarters of the experts have a positive attitude towards electromobility projects on EU-level. The most important elements of EU-projects are the exchange of knowledge and learning from good practice examples. The European wide standardization of charging infrastructure is another reason for supporting international projects. Some experts mentioned, based on their own experience, the complex application and implementation procedure as an issue for improvement.

"The other thing that you may gain is that you have a more critical mass and more research coordination." (Professor of a Dutch University)

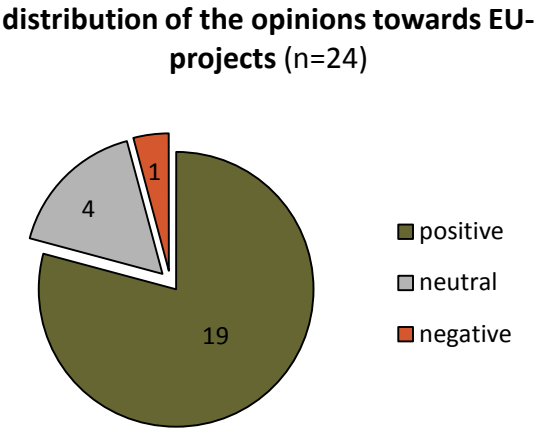

Figure 16: Distribution of the opinions towards EU-projects

A Representative of a Dutch city administration mentioned, that European-wide projects are necessary, because cars do not stop at the city or national border. He says that there is a nationwide system in the Netherlands, where one can use the same card to charge the car on all public charging points (located in a nearly all Dutch cities). But if you cross the border to Germany, you have to get another card to be able to charge your car and pay for it. International projects could help to solve those standardization problems.

"I think it is necessary to have both; regional/national projects with in the country and of course multi-national projects on European level. I think the best benefit for Sweden in the European projects is the exchange of knowledge, because Sweden is not a leader in electric mobility. Countries like the Netherlands for example are way ahead in charging infrastructure." (Representative of an organization for the Swedish power industry)

Question 5: What do you think of the future development of electromobility?

This question was asked very open on purpose. Nevertheless, the answers were more or less similar. Regarding the electric engine and the powertrain, most of the experts are convinced, that the hybrid technology will be the dominating system during the upcoming years. The predicted increase of EVs is supported by the integration of electromobility in fleets of public administrations and private companies.

The increase of cars will be reinforced by the air quality directive of the European Commission. Countries and cities are forced to improve the CO^2-emissions. This will have positive impacts on the development of electromobility.

"I think the main chances are of course that you need to reduce the demand of energy and also move for more sustainable energy and the electric vehicles have their advantages and you will need it in some way to reach the climate objectives and I think it will be very difficult to reach those objectives if you do not have electric vehicles." (Representative of a Swedish Transport Administration)

A German Professor for Sociology challenged that the future of electromobility should always be seen as a component of a complex multimodal and intermodal system. Future needs for mobility, this has been another argument of the professor, have to be seen as embedded in the dynamics of demographic change.

A German Expert working for a grid provider points out the importance of well-prepared electric grids. That would be the main challenge for companies working in that field.

A Dutch expert is worried about the various national subsidy systems which are triggering problems especially in the second hand market:

"The second hand electric cars are already at the market. And normally that would mean that now regular people like you and me would be able to buy these cars. Unfortunately what we are achieving now, is that second hand electric cars are leaving the country to Norway especially because they pay a lot for second hand electric cars in Norway. […] If Norway would not have those incentives, the car would stay in the country and the normal people like you and me could buy an electric car." (Representative of a Dutch Consulting Company)

An expert from a Dutch grid operator claims a current issue. He says that the European countries strive for an independency of energy production as well as for an independency of the leading countries in oil production. These developments would support the success of electromobility.

Question 6:

What will be the dominating engine in the future? Is the hydrogen engine a rival or more a complementary factor compared to the battery electric engine?

The majority of the experts see the two addressed technologies as a complementary factor (Figure 17). Both of the technologies could be successful in the future. If they will be successful, they would also profit from each other instead of being rivals. The battery electric technology will be preferred for short distance trips. The fuel-cell cars will be used for middle or long distance trips. A representative of the Hessian Ministry of Economics, Energy, Transport, and Regional Development, who advocates both technologies, mentioned that it is easier and cheaper to set up charging infrastructure for battery technology instead of hydrogen filling stations.

"I think it depends on whose perspective you take. For people working only on battery electric cars, like some small companies or people that promote electric infrastructure, any other alternative is a rival because it may be a rival for subsidies. But if you look at it from the perspective of the car industry, than these technologies can help each other."
(Representative of a Dutch electromobility association)

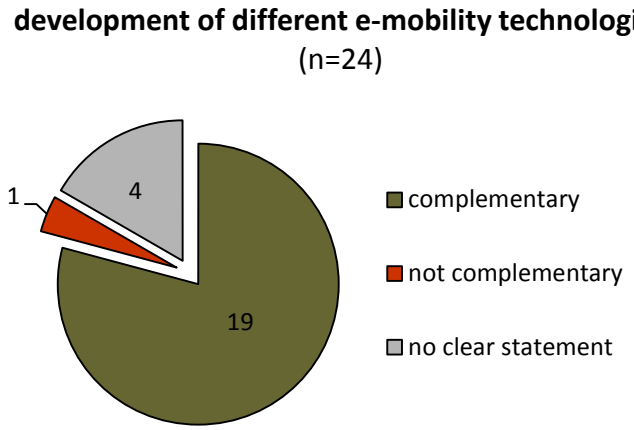

Figure 17: Development of different e-mobility technologies

Selection of additional comments

The experts had the chance to add any additional comments after the general questions. The following statements are the most relevant quotes;

"I wish that the funded projects are compatible with each other and sustainable in the future." (Representative of the Hessian Ministry of Economics, Energy, Transport, and Regional Development)

"Governments have to play an important role in the transition towards electromobility and stimulating it because of the air quality and fossil energy issues. But in the end electromobility is a task for the market. Governments don´t produce any cars, governments don´t produce energy or oil. It is completely marked driven: When people want to drive electric cars because it is cheaper or better, they will buy them and that is the final solution for electric mobility." (Representative of a Dutch city administration)

"What I think is very interesting, […] is the attitude of the society towards the mobility behavior, which is changing quite rapidly. Not only here in the Netherlands, it is a worldwide trend. That is something to take into account." (Professor from a Dutch University)

"It is interesting to know, if we are already coming to a market breakthrough or not. We had electric vehicles for the last 30 years and everybody said it is going to come in ten years and we still say that it is coming in big numbers in ten years. But it is still a niche product. Not everybody is committed. On the other hand, today more or less every OEM has an EV or a PHEV car model for sale; this has not been the case before. There is also a much stronger

push from governments and a climate concern and awareness that has not been seen earlier. I really hope that what we see now is the start of a breakthrough for EVs!" (Representative of a Swedish city administration)

"I think one of the most important things is […] that the users find the charging infra-structure. The systems or the databases for geographical and other information systems of the charging infrastructure are necessary." (Representative of an organization for the Swedish power industry)

"[…] pedelecs are already very popular in the Netherlands and that has also to do with the aging population. Electric assisted bicycles have already taken 16% of sales in the Netherlands and that is really very strong." (Representative of a Dutch electromobility association)

"If you would have interviewed me as an electric driver, I would have answered completely different." (Representative of a Dutch consulting company)

Combining analyses and résumé

Combining analyses, where all responses of the experts working at universities/research institutes compared with the answers of those working at a public administration e.g., did not show significant results. The individual opinions are independent from country and professional field.

To conclude, a positive and quite optimistic attitude concerning the actual developments and future expectations for the sector and technology of electric mobility can be determined. It was emphasized, that the technology establishment may take a longer time than the assumption couple of years ago. Almost every expert is convinced that electromobility will get a breakthrough earlier or later.

4 Conclusion and Outlook

The results of the survey identify the actual advantages, disadvantages and especially issues of different focus groups. The basic for the motivation of the participating country is the reduction of inner-city CO^2 emissions, which is based on the European GHG emission targets.

The “erster!” survey in Frankfurt is an analysis with a small target group, but it represents that the handcraft companies are one of the best inner-city commercial users for driving electric. Charging and range problems didn’t occur for the majority of the companies. Also the operational processes of the companies were not influenced in a negative way. The users are enthusiastic about their experiences and communicate their positive lessons learned to colleagues, families and friends.

The focus of the “Arnhem” survey would have been very interesting, because the focus group are private people, which are interested or already owning an EV. But because of the low number of responses, a scientifically correct analysis wasn’t possible.

The “Expert interviews” where the most comprehensive qualitative survey. They also convey a positive attitude of international experts about the future development of electromobility, even if the technology establishment may take a longer time than the assumption couple of years ago.

With all these surveys, potential user groups, their needs and behavioral aspects were identified. Especially the handcraft companies can be confirmed as perfect target group for electromobility.

E-FACTS was a project, with a lot of different local activities of the project partners. The local projects had different focuses and were even concentrated on different transport modes. That led to the decision, not directly link the accompanying research to all the local projects. The expert interviews were the best way, to gain international comparative results.

A further important outcome of the project is the international exchange of knowledge. Next to project related discussions, the project meetings were also used to share information about local standards and strategies handling electromobility issues and developments. During the meetings, local experts presented several projects and shared their knowledge with the project members. That was an enormous profit for all participating partners, to develop their international and professional network.

After the draft of the first project proposal, single project partners changed. The update of the proposal was postponed. The coordination between the partners and the communication of the local projects was neglected. After the approval of the project, the partners tried their best to round off the proposal, but unfortunately not all intentions of the proposal could be carried out during the project duration.

The idea of the project is an encouraging basis for further projects in the field of international electromobility projects. For the part of the accompanying research, it would be necessary that the local projects are more uniform and comparable.

University of Applied Sciences Frankfurt

The University of Applied Sciences Frankfurt (Frankfurt UAS) offers practice-oriented study programs of a high academic standard, opening the way to a broad range of attractive professions. The four faculties and over 30 study programs reflect the academic profile of the university. The application-oriented research gears education to the realities of professional life and the international orientation smoothes the way to the global job market.

The university is linked to the local and regional community in numerous ways: Links with industries mainly focus on research and development projects and on industry placements for the students. The university professors keep excellent relationships to companies. The university runs an extensive continuing education program for professionals and offers in-house trainings for companies and non-profit organizations. The university uses its close contacts to companies, institutions and associations to continually expand its political, economic and social dialogue.

Department New Mobility

The research group of Prof. Dr.-Ing. Petra K. Schäfer belongs to the Faculty 1: Architecture, Civil engineering and Geomatics of the Frankfurt UAS. The interdisciplinary team is staffed by traffic-, city- and infrastructure planners. The teaching part of the department is handling the topics of traffic planning and mobility. The research focus is on electromobility, traffic management and acceptance of new technologies in that field.

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