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The customer perspective of a user-oriented public charging infrastructure

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Abstract

In the public discussion the development of charging infrastructure is one of the most important requirement for the market penetration of electric cars. Different initiatives and approaches are in preparation and the German government has announced a funding program for public charging infrastructure with a budget of 300 Mio. Euro.

In the last 4 years in many projects and research initiatives gained a lot of experience with construction, operation, function, reliability and roaming of charging infrastructure. However in discussion with experts and drivers of electric cars it was obvious, that the current charging infrastructure is principally working, but there is still a lot potential for improvements.

To identify the most important action fields a big study in Germany among experienced electric car drivers and emobility interested people in 2016 was conducted with the question, how the user oriented charging infrastructure looks like from a customer point of view. This survey is part of the government founded “parallel research into effectivity within the German federal program "Electric mobility Showcase".

In this paper the results of the survey will presented. In the survey there were following categories investigated: Usage of charging infrastructure, locations, Access, Payment, costs and tariff modelling. The result clearly showed that the current infrastructure overall was rated quite bad by the users and there is a big need of action in many issues.

This survey is the most detailed survey concerning the user perspective of charging infrastructure and gives the relevant stakeholder a lot of information, how to improve the charging experience in future.

The results of this survey is were published in March 2017 and the study is only available in German language. So the EVS 30 is be the first event, where the results will be available in English Language

Keywords: charging, consumers, fast charge, infrastructure, user behaviour

1 Introduction

In the past few years, the “Chicken or Egg Discussion” on electric cars and charging infrastructure dominated the electromobility. Since establishing the National Platform for Electromobility (Germany) in 2010, in which the key players from industry, science, politics, trade unions and associations have joined forces to form strategic dialogues, a lot has happened regarding both the vehicles and the charging infrastructure.

Promotion programs by the Federal Ministries – such as model regions, showcases and ICT for electromobility – have helped gather many important findings, establish and technically upgrade the first public charging stations, while the vehicle manufacturers have gradually developed series electric vehicles. In addition to the research projects, more and more early adopters have decided to buy those battery-electric vehicles and use them on an all-electric basis in their daily lives. These pioneering users have gained important experiences in everyday life apart from promotion projects, forming a vivid and deeply committed electromobility community. These users can provide first-hand information on both the actual suitability of electromobility in daily life and its challenges. The know studies concerning electric car drivers and charging infrastructure are mostly quite superficially or more based on theoretical approaches to the demand for charging infrastructure than on the daily experience of users.

To identify the most important action fields’ bridgingIT conducted a big study in Germany among those experienced electric car drivers and electromobility interested people in 2016 with the question, how the user oriented charging infrastructure looks like from a customer point of view. In this paper the results of the following investigated categories will be presented: Usage of charging infrastructure, locations, Access, Payment, costs and tariff modellings.

1.1 Method of survey

The target audience for this survey are the decision-makers concerning electromobility in politics and economy, especially ministries, municipalities, car manufacturer, energy suppliers and provider of charging solutions.

To get a meaningful study there were a quantitative and a qualitative method used to collect input. On the one the online survey generated 590 experiences electric car drivers and interested people for electromobility. The participants were 229 interested persons, 23 Plug-In Hybrid drivers and 338 electric car driver that corresponds approx. 1% of the battery electric cars in Germany. On the other side the qualitative information was gathered with 4 focus-group interviews with overall 26 persons (21 male, 5 female).

1.2 Facts of participants of online survey

The electric driven car participants are mainly very experienced in electric driving 70% of them have driven more than 10.000km, 54% more than 20.000km, 25% more than 50.000km and 7% more than 100.000 electric kilometres. So concerning the experience with electromobility and charging infrastructure it is a representative sample.

The sample was mainly evaluating from a private customer point of view, as 65% of them the electric car is private and further 20% the electric car is a company car with the possibility of private use. The others were company cars (3%), research project cars (3%), Carsharing cars (6,3%) and others (2,1%).

Concerning the used cars it is obvious, that the Renault Zoe with 23% and the Tesla Model S with 22% were disproportionally represented towards its market share of 18% or rather 9%. Those are especially the cars with the possibility of 3-phase AC-Charging and Superchargers/AC-43 chargers that might influence some results in this survey. Other relevant cars have been Nissan Leaf (11 % / 8 % market share), BMW i3 with and without Range Extender (11 % / 16 %), Smart Fortwo ED (3 % / 13 %), Renault Twizy (15 % / 10 %) and the Volkswagen eUp! (3 % / 6 %) und e-Golf (2 % / 13 %).

2 Results

2.1 Usage of charging infrastructure

First the current usage of charging infrastructure was analysed (Table 1).

Table 1: Charging demands of electric car drivers in percent

	private		public		Car Manufacturer	
	home	company	semi-public	public	All manu-facturer	Tesla
Not available	2,7	27,5	5,7	1	15,7	0
Never	5,4	26,5	7,7	4	34,4	4,5
Less than 4 times per year	4	4	14,4	11,1	13,7	3
quarterly	3	2,7	15,8	13,8	8,4	6,1
Monthly	8,4	5,4	29,5	27,2	13,4	36,4
Weekly	30,9	12,1	23,8	35,6	11,4	37,9
Daily	36,2	19,5	2,7	6,4	2,3	9,1
Several daily	9,4	2,3	0,3	1	0,7	3
total	100	100	100	100	100	100

Currently, most early adopters cover their charging demands through private charging infrastructure at home or at the employer´s. However 24% of users charge the car at their home only monthly or even rarer, that means it is possible to drive a electric car, even if you can´t charge at home. So the charging at company, the public charging infrastructure and the Tesla Supercharger infrastructure have become all-important.

As expected the private charging is the most important for the daily life of electric drivers, as more than 46% are charging at home daily or several daily and further 31% weekly. However the public infrastructure is used by 70% at least one time per months and for 30% of charging cases overall.

The deeper analysis of the interested persons showed, that their estimation for necessary charges is between 50 and 80% higher than the real experience of the drivers. This implies that the regular recharging of the electric car and an available charging infrastructure is very important. Therefore, a visible public charging infrastructure is particularly important in the market launch in order to gain the trust of potential electric vehicle buyers.

During investigation for typical user groups of charging infrastructure there were 4 types identified, which have significant different charging behaviour. The “on-street parker”, commuters, occasional users and long-distance travellers.

Concerning decision criteria for usage of a (semi-)public charging infrastructure an easy authentication is for 82% of persons the most important criteria. Further 70% enjoy free charging and generally the charging duration should be minimum 15min with an electric power of 22kW minimum, how the question concerning decision making parameters resulted in.

The use of green electricity at public or semi-public charging stations is self-evident to most users of electromobility.

The statements and enthusiasm of the Tesla drivers impressively demonstrate that a manufacturer‘s fast-charging infrastructure is a suitable means for OEMs to upgrade long-distance vehicles and thus sell vehicle and charging infrastructure as one system. One can also tell that the Tesla strategy, according to which the users shall recharge either at home or at their destination and whereby the supercharger shall ensure the mobility on long haul, seems to work out.

2.2 General assessment of charging infrastructure

The study found that the general satisfaction of the customers with the semi-public and public charging infrastructure still shows significant need for action and obvious potential for development in all topics surveyed (Fig. 1).

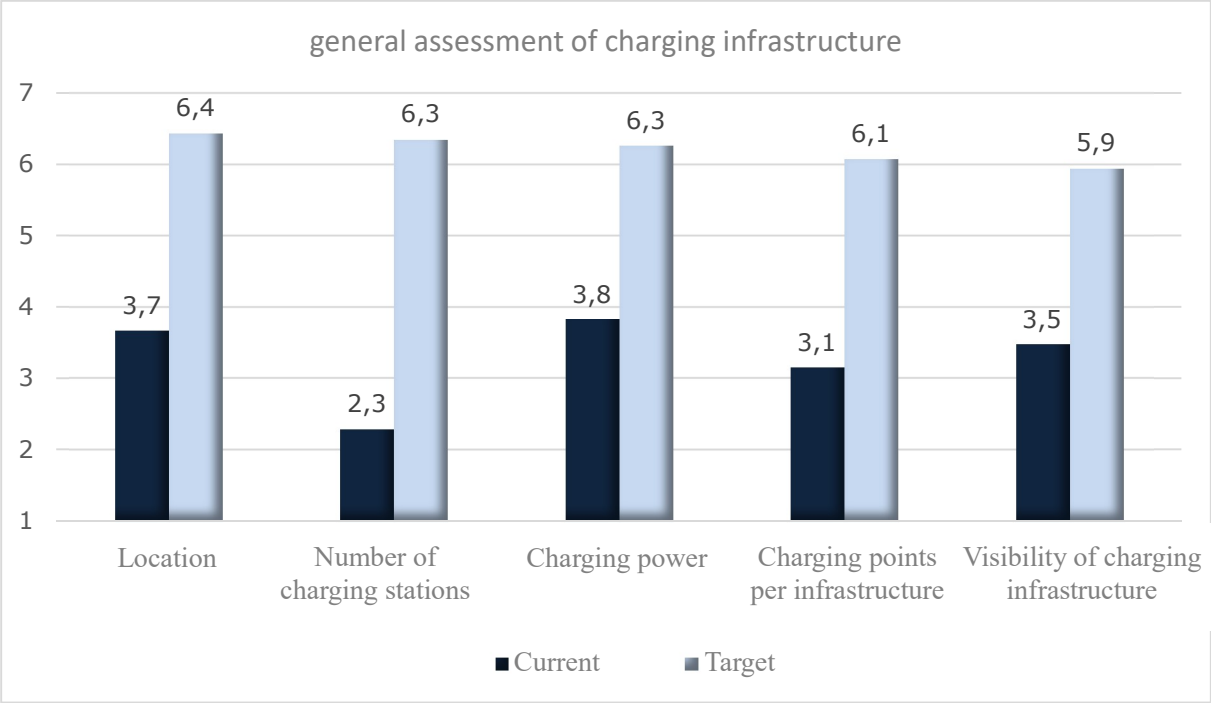

Figure 1: general assessment of charging infrastructure, [N_Target = 306, N_Current=159]

Rated on a scale of 1 [Not at all fulfilled] until 7 [completely fulfilled] for the Current state and of 1 [completely unimportant] until 7 [very important] for the Target assessment

The main reason for the dissatisfaction is that there are far to less charging stations and charging points per station available. Also the location of charging stations has big potential to improve.

The suitable charging power depends from the location. General the statement of the drives was, that as faster the road is, the faster the charging station has to be.

The most required action to raise the number of charging stations is to build up fast chargers at highways and main roads.

Another big issue today is the search and finding of charging infrastructure. The users stated clearly, that today there are they need a central platform with all necessary information of the charging infrastructure.

2.3 Locations, charging capacity and charging standards

In addition to the attractiveness of the electric vehicles, a large number of available and reliably usable charging infrastructures must exist to serve a mass-efficient use of electric mobility. There are three different charging scenarios, whose relevance depends on different influencing factors such as individual usage scenarios, housing situation, charging technologies, range of the vehicles and availability of charging infrastructure:

- Express charging with power outputs of at least 50 kW is directly comparable with today‘s refuelling. The drivers need as much energy as possible in the shortest possible time to be able to continue their journey quickly.
- Public or semi-public standard charging with up to 22 kW at places where the vehicles usually park anyway, thus using the standing time for recharging the vehicles.
- Private charging at home or at the employer´s is currently most prevalent, but possible only for those users who have the opportunity to establish a charging point at home or whose employers offer it.

All the users of the focus groups agreed that the number of charging stations across Germany has to be increased many times over in order to still prospective buyers´ range anxiety and to open up new groups of buyers (Fig.2).

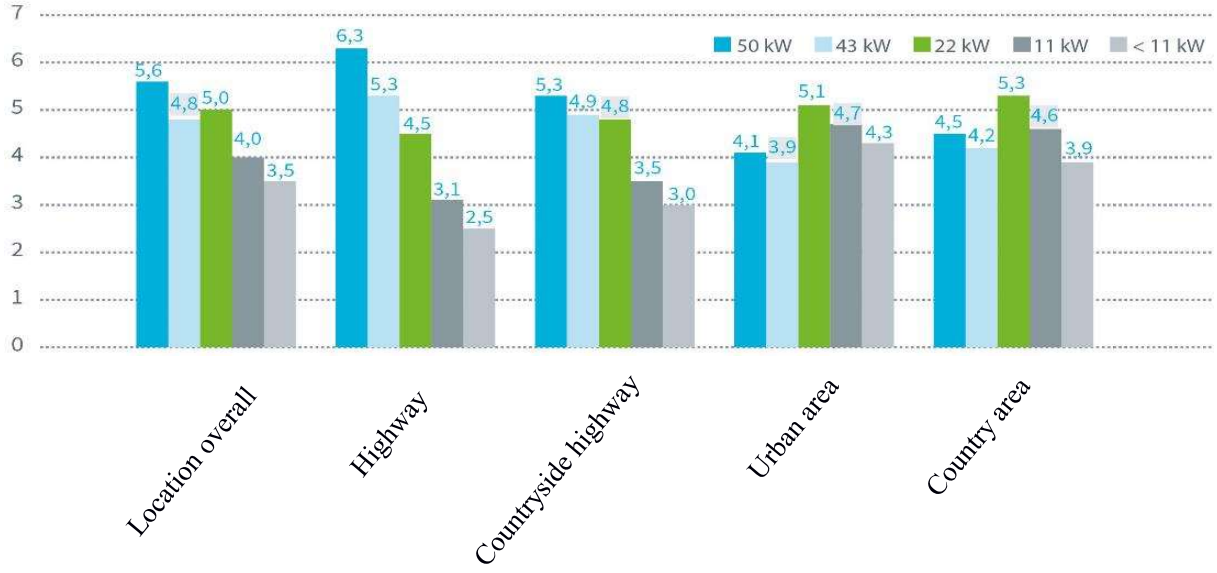

Figure 2: Roll-out demand of charging infrastructure based on location [N=152]

Rated on a scale of 1 [very low importance] until 7 [very high importan]

Standard charging infrastructure should be built at locations where people spend longer time on stopping and parking such as trading companies, recreation facilities, tourist destinations and parking lots or car parks. Charging infrastructure must be visible and easy to find, but without placing it too prominently directly next to entrances or at top-quality locations. Otherwise, there may be a counterproductive effect causing drivers of non-electric vehicles get the impression they were defrauded of parking space or the charging station may often be blocked in by non-electric vehicles.

The provision of semi-public charging infrastructure offers great potential – particularly in retail and catering – to attract new customer groups, since most electric powered car drivers would change the point of sale (PoS) owing to charging infrastructure. It should be noted that the duration of the stay at the PoS must be at

least 15 min., making it worthwhile for electric powered car drivers to start a charging process. The prevailing effective charging capacity depends on the resting time at the PoS.

In this context, the uniphase AC charging technology of many vehicles has been heavily criticised: For example, a VW e-Golf may be charged at a 22 kW AC charging station in one hour for a range of only up to 20 km due to its low charging capacity of 3.7 kW, whereas a Renault Zoe may be charged six times the range with more than 100 km in same time. Here, the OEMs are required to offer three-phase chargers with at least 11 kW charging capacity in electric cars.

For long periods of several hours (hotels, stations, airport etc.), low AC charging capacities are sufficient, but must be available in larger numbers, as in these cases the vehicles cannot be removed immediately after completion of the charging process. In the interaction of charging capacities and charging standards between vehicles and charging stations, an unnecessary diversity still exists today. To make the system of electromobility more comprehensible for a broad group of customers, reducing this complexity to an AC version and a DC version would be most helpful. Most vehicle manufacturers come under the lash with regard to the charging technology of their electric cars. In many vehicles, only a uniphase AC charger is installed while three-phase AC chargers are usually not even available for sale at an extra charge. Partly, manufacturers even still offer their vehicles with a type 1 socket, although in Germany only type 2 charging infrastructure has been built up for years now. Users also do not understand why DC-charging technology is not available as standard equipment for many OEMs, and if available at all, only at a significant extra charge.

Customer wishes regarding the charging technology of electric cars are thus quite obvious: three-phase type 2 AC charging with at least 11 kW and a standard CCS express-charging socket as well as a charging capacity adapted to the battery size.

2.4 Availability and accessibility

There is a great need for action with regard to the availability and accessibility of charging infrastructure. Frequently, the few charging stations are either already occupied, blocked in by unauthorised parking non-electric vehicles or blocked with already fully loaded electric cars, (Fig. 3).

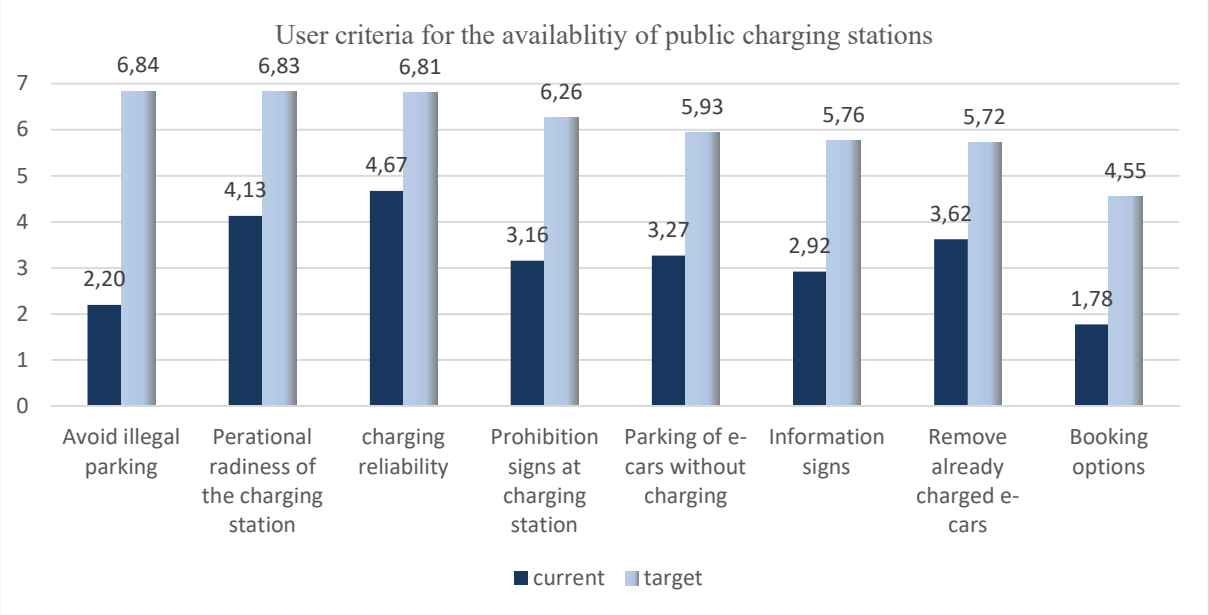

Figure 3: User criteria for the availability of public charging stations [N_Target=307, N_Current=157]

Rated on a scale of 1 [Not at all fulfilled] until 7 [completely fulfilled] for the Current state and of 1 [completely unimportant] until 7 [very important] for the Target assessment

To this, there are two promising options. On the one hand, charging stations have to be made more visible by "no stopping" signs and coloured road markings, and any infringements should be penalised with more substantial fines or by means of fee-based towing.

On the other hand, it is necessary to increase the perception of charging stations also among those not using electric powered vehicles. They must realise that blocking in a charging station results in significant problems for those affected, including even complete standstill.

Negative effects on the availability of charging stations can be expected with increasing sales numbers of plug-in hybrid vehicles (PHEV). PHEV charge slowly and thus occupy a charging station for hours to gain only a few electric kilometres and no risk of break down with no energy. Motivated PHEV drivers trying to drive as many kilometres as possible in all-electric operation, other PHEV drivers using the charging station as a cheap parking spot thereby occupy one of the still sparse charging facilities BEV drivers are depending on.

The technical serviceability of the charging infrastructure has significantly improved in the last few years and has now reached a good level, though problems still exist with the functionality or with the authentication from time to time. In these cases, it must be ensured that the customer is quickly and competently helped by a qualified 24-h hotline.

2.5 Information, searching and finding of charging infrastructure

Searching and finding of charging stations is not that easy for users of electric powered vehicles, especially on unfamiliar terrain, since the stations are partly designed discreetly and thus are hard to visually perceive. In order to increase the visibility and perception of charging stations, there are two concrete recommendations for action:

- Charging stations need a recognition factor, such as drivers are used to recognition values of service stations.
- A uniform signposting must be established in order to point to charging infrastructure both on motorways and in cities.

Table 2: Information about a charging station should be made available completely and standardized

	Static information		Real-time information		Booking options		Integration into vehicle´s navigation system	
	Interested party	Users of electric powered vehicles	Interested party	Users of electric powered vehicles	Interested party	Users of electric powered vehicles	Interested party	Users of electric powered vehicles
On the part of the operator	4.6	4.4	5.3	4.7	4.4	3.7	6.3	5.9
On central platform	6.2	6.5	6.5	6.5	5.4	4.7		

In order to be able to use charging infrastructure in everyday life, the users of electric powered vehicles need information in advance. Information on a charging station should be made available completely and on a standardised basis via a central database (Table 2), analogous, for instance, to the fuel price information published by the market transparency office of the cartel office since 2013. If charging stations were organised via a central database, the vehicle manufacturers could easily integrate them into their navigation systems. In terms of content, basic information such as location, access and restriction, opening times, authentication options, roaming networks, operators, tariffs, plug types and number of plugs as well as charging capacities are important. This basic information must be of good quality and always up-to-date. Ideally, these static data are supplemented by further information such as the availability status in real-time as well as information on the station´s surroundings (restaurants, toilets etc.) and user feedback. Currently, databases of user communities and internet forums offer about the most complete solution.

2.6 Authentication and payment

Another important topic is the process of authentication and payment for charging. The question which authentication methods and how to pay for charging users prefer and if they would do a contract to get access to charging stations were discussed in this chapter.

The resume is, that also in this topic there is still a lot of work to do to get customer satisfaction (Fig. 4).

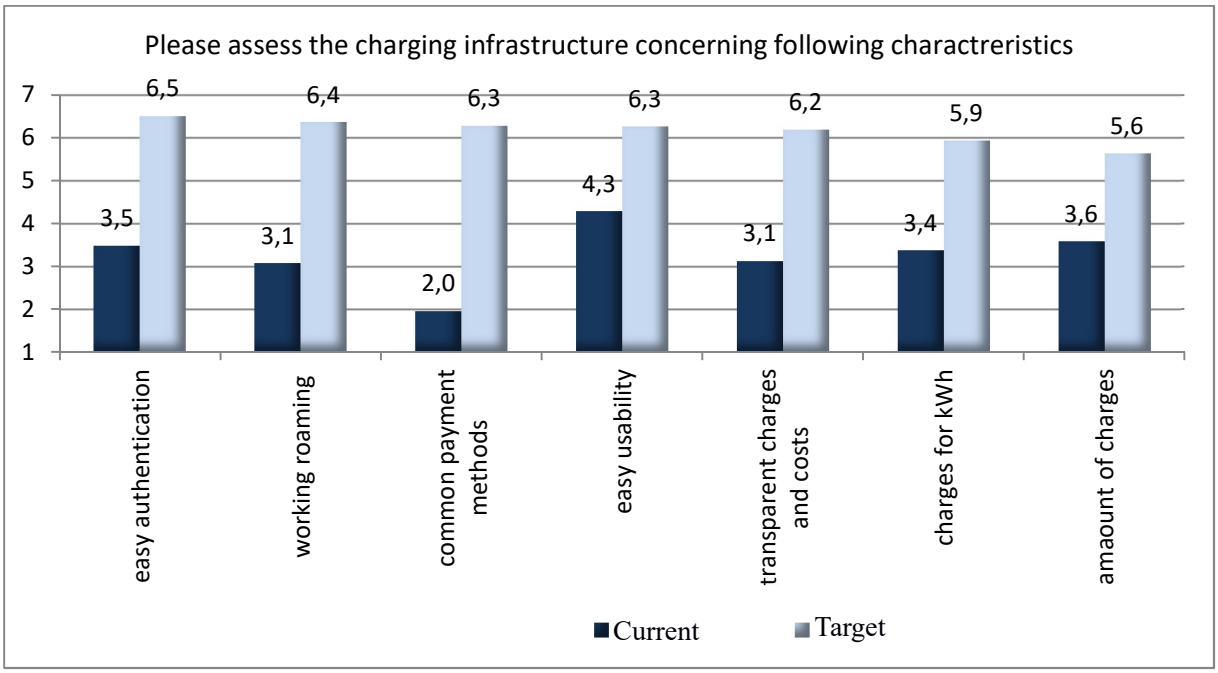

Figure 4: Rating of customer friendliness of public charging [N_Target=158, N_Current=307]

Rated on a scale of 1 [Not at all fulfilled] until 7 [completely fulfilled] for the Current state and of 1 [completely unimportant] until 7 [very important] for the Target assessment

The participants stated, that concerning medium for authentication the RFID card is the best of all “crutches”. The payment for charging the great majority expects common Adhoc payment methods with credit and debit cards, how it is the frequent practice at every other shopping and paying for services.

The combination of many different card solutions and the requirements of registration for each provider of charging infrastructure makes the customers very unsatisfied. Also contracting with base fees is not appropriate for the daily use.

The so-called “charging card chaos” has hit the headlines in recent years. This chaos has to be ended urgently and the revised regulation for charging stations also sets the right course here, by enabling Adhoc-charging on an obligatory basis at each publicly accessible charging station in the future.

User-friendly sign-in and payment procedures, standard payment methods as well as connection to roaming networks play an essential role in the suitability for daily use. A registration or contract commitment would only be acceptable to the users if this would allow a barrier-free, transregional use of charging infrastructure by means of a central account. Such an account would mean a simplification to users, who today often get a variety of different payments. Usually just acceptable for private users, this diversity is more of a hindrance and extra effort when it comes to payment of commercial charging procedures. Such an account would be highly preferable for company cars analogous to current fuel cards, thus simplifying the use of electric powered cars in company fleets or of personally assigned company cars.

A user requirement would thus be an automatic log-in via vehicle identification number or by a card inserted in a card reader unit, once the car connects to the charging station, thus passing the charging costs automatically to the related account.

Whether the user requirement for an authentication and payment via EC or credit cards right at the charging stations can be met, is at this point uncertain. So far, most of the charging station operators rely on Adhoc payment options via smartphone by entering credit card data, paypal or roaming using RFID cards. As for roaming, a lot improved in the past few years and the vast majority of charging infrastructure has now joined roaming networks with the result that electric car drivers can get along with just a few roaming charge cards. The downside of roaming is that roaming rates may become a costly affair for users.

2.7 Using fees for charging infrastructure

Finally the amount of charges for usage and the willingness to pay for the usage was analysed (Fig. 5). So it was very obvious that great majority of customers expect to get charged for the energy product by kWh and not for time. However the users are also aware, that in some cases the power is not the main good the get. Sometimes the parking lot or only the availability of the charging station is rated higher than a few kWh.

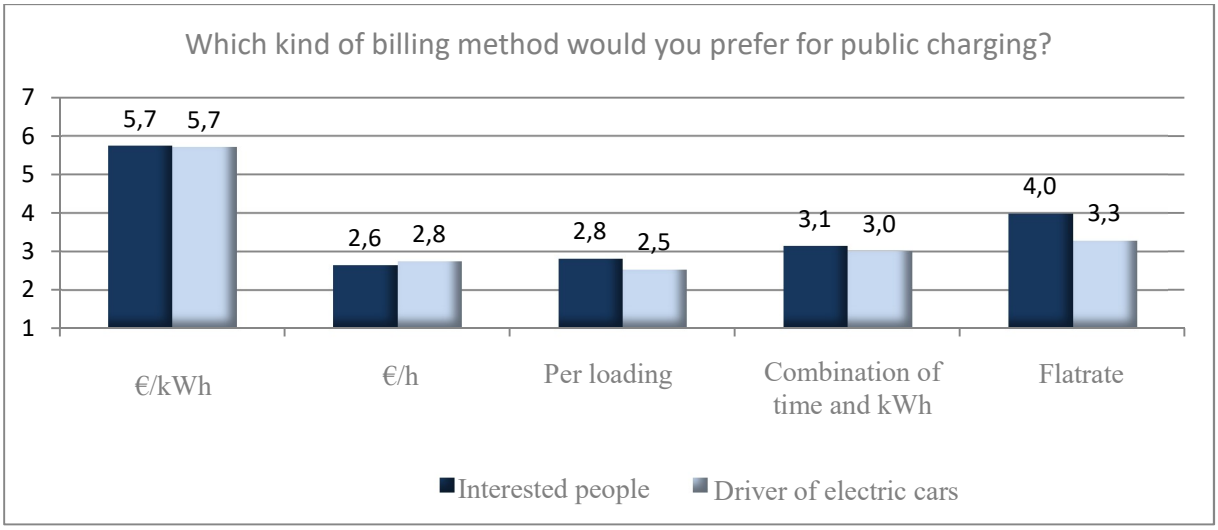

Figure 5: Preference of billing methods for public charging [N_E=292, N_I=142]
Rated on a scale of 1 [no preference] until 7 [very high preference]

Concerning the willingness to pay it is noticeable, that the customers have a basic willingness to pay additional costs for charging. Especially for fast charging and if the trip was not really planned. Customers compare the price on the one side with the charges for the energy at home and on the other side with the costs for driving 100km. There the costs may not be higher than driving 100km with a combustion car.

Drivers are accustomed to paying fuel per litre and that prices are visible from afar at the service station. As soon as you want to drive an electric vehicle, you have to break with the practice of transparent pricing: The number of different tariff models, usage fees and technical influences is immense. There exists billing on kWh or time, start fees, roaming surcharges, service fees etc. Cost transparency hardly exists, at least before starting the charging process or can usually only be provided at huge research efforts. In some cases, the operator does not even provide price labelling at the charging stations. However, users expect to have easy access to pricing before charging. In many cases it is doubtful that the current situation actually meets the price regulation for quotation of prices (PAngV). At least it is not suitable for the mass market, since consumers have hardly any simple option to receive reliable information on pricing. Ideally, this information is made available in advance via a central charging station database.

Users primarily want to pay for the charged electricity, just as they are accustomed to paying the fuel at the gas station or the charged electricity at the domestic house connection. This is considered the fairest billing method, since it corresponds best to the understanding of a certain price for the respective quantity of a certain product. A general willingness to pay for charging capacity is definitely available among the users of electric powered vehicles, but the users make a careful distinction as to where and for which charging technology they are willing to accept higher pricing.

3 Conclusion

As conclusion of the study of a user friendly charging infrastructure following topics describe the perfect charging infrastructure from a customer point of view:

- Even if electric cars are mainly charged at home, a public charging infrastructure is important for the market success of electromobility
- The amount of charging infrastructure has to increased very much
- The locations of charging infrastructure has to orientate, where customers park and spend time
- The charging power has to suit to the kind of travelling. As faster the road, as faster the charging
- The availability of charging infrastructure has to get improved a lot. Unauthorised parking cars has to get prevented.
- A central platform with information of charging points would help a lot for searching and finding the infrastructure.
- Adhoc payment is strongly required, low willingness to do contracting and registration
- Charges have to get transparent and fair amount of costs
- In case of any problems there has to be an qualified 24/7 Hotline available

So it may be pointed out that for a breakthrough of electromobility much more charging points will be necessary, whilst the diverse user groups – kerbside parkers to field manager – need precisely fitting charging solutions for their daily life. In addition, the range of electric vehicles will increase and at the same time the acquisition costs will drop. Many challenges such as tariff models, charging technologies and payment options will be regulated by the market as more electric cars are available and a fair competition has developed. For vehicle manufacturers, it will be crucial not only to focus on vehicles and their range, but also on appropriate charging technologies of the vehicles, thereby considering customer requirements more intensely. Those affected should perceive the chance and use this development potential to take action immediately.

Authors

Matthias Vogt was born on September 09, 1975. Following his studies at the Stuttgart University of Applied Science in mechanical engineering Matthias started his career as a service engineer for Passenger Cars at Daimler AG. For more than 14 years, he worked on reliability issues, customer experience, R&D and product management of passenger cars and buses at Daimler AG.

In 2013 Matthias switched as senior consultant to bridgingIT and is responsible for innovations in the smart mobility market. At this, Matthias Vogt advises large companies and corporations as well as governmental organizations on aligning their strategy concerning mobility and electricmonilizy issues..

In the monitoring and impact research for the German showcase program for electric mobility Matthias is responsible for the core-topic „User“ and is aggregating the findings concerning electricmobility users of more than 145 projects in the German showcase program.