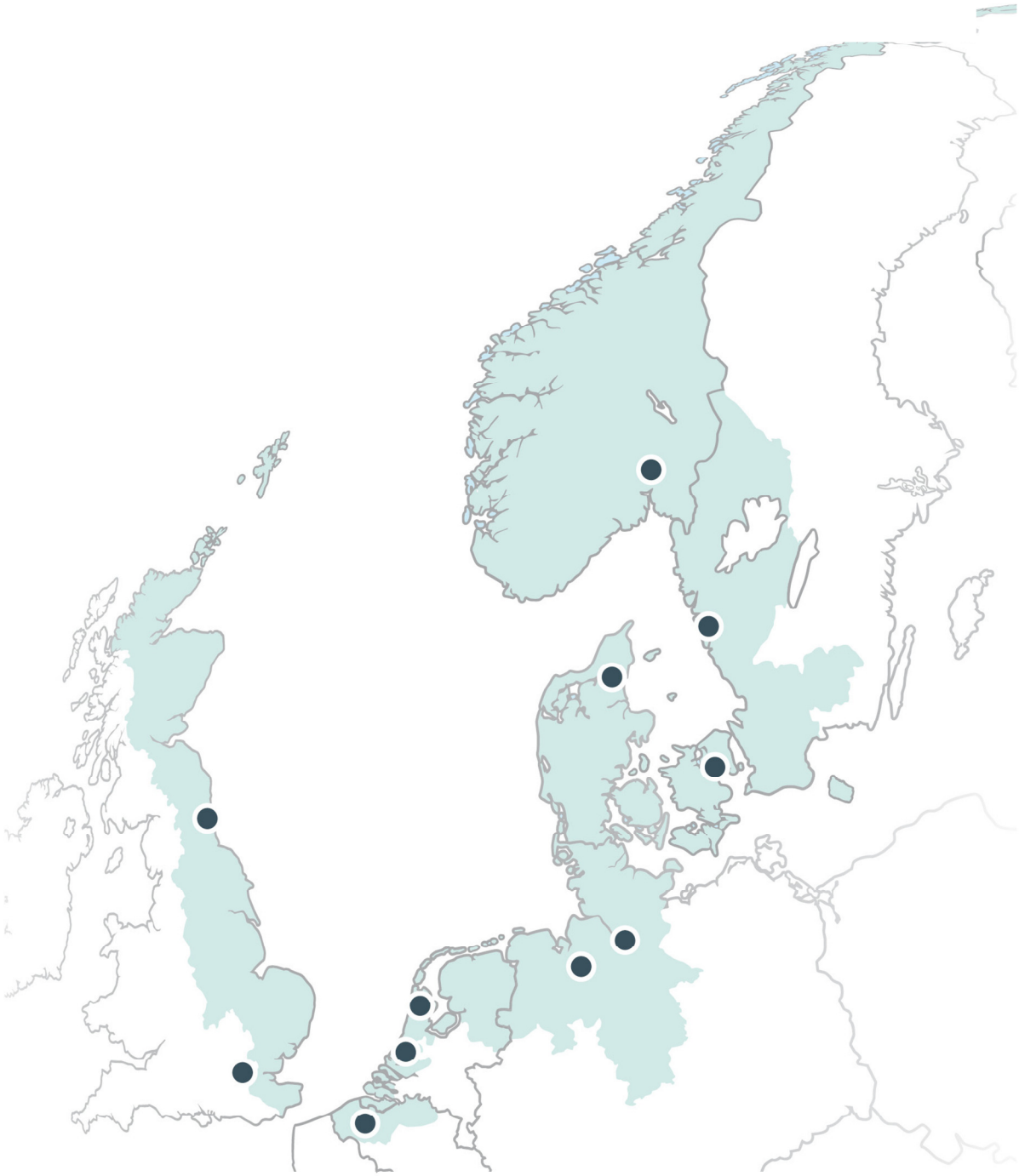
NORTH SEA REGION ELECTRIC MOBILITY NETWORK

e-mobility NSR

Experience Electrical Vehicle

The case of fast charging

Maria Nilsson | 2012.11.01 | Lindholmen Science Park



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Executive Summary

Objective, goal and results

This report details research activities carried out by the Viktoria Institute within the project "Test Environments for Fast Charging".

The report describes the user study evaluating the two installed fast chargers. In detail, the goal of the user study is to investigate the effect of having access to fast chargers on the drivers' attitudes and experience of electrical vehicles (EV). In addition, recommendations on how to evaluate these kinds of test environments are provided. The study includes interviews and questionnaires before (test occasion 1) and after (test occasion 2) a trail period of using the fast chargers to capture any changes in attitudes and behaviour. Two test site were included in the study. A total of 5 individuals, accessing one of the two test sites, participated in the study. The overall objectives of the report is to:

- Present an evaluation of the two test site in terms of method and results and recommendations
- Provide conclusions regarding the effect of fast chargers

SCOPE
It should be noted that due to technical problems at one of the test site, only 5 participants are included in the study. In practise, only one of the two test site could be used during the trail period, thus, excluding test occasion 2 from one of the test site.

MAIN FINDINGS
The ability to *quickly fully charge* the vehicle were emphasised as opposed to the flexibility and ability to use the vehicle more often. This is contradicted by chargers only being filled to 80%. Also, the fast charger takes longer in winter (45 min as compared to 20 min). All of this lowers the appeal and usage of fast charging.

The participants that *did experience an added value* of the fast charger were those that would use the charger to increase the efficiency of the vehicle, in e.g., a car pool.

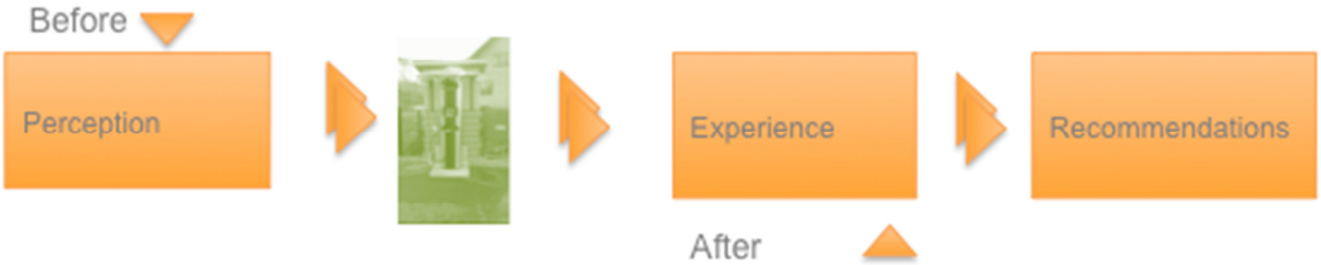
The participants that *did not experience an added value* of having access to a fast charger at the test site were those that (1) not represent the correct user group (2) have had access to the EV for a long time and they already match their daily routine according to the range of the EV, (2) do not have a need to drive long distances, (3) do not have a natural placement of the fast charger for it to play a significant role in their driving; (4) the amount of extra energy the fast charger provides does not play a significant role in their daily driving.

However, some interesting (significant) changes in attitudes and behaviour were identified in the survey that needs further investigations (participant alternated from completely agree to completely disagree).

The following aspects were identified as influencing the use of the fast charger: Location, amount of charge, cost of charging, time, current battery level, driving distance, safety of the place, and timing.

In particular the *location* of chargers was highlighted as determination of behavioural pattern. General public location may have a limited effect on individual EV users. However, from a company perspective, fast charger may be useful as it directly influence the efficacy of the usage of EV.

RECOMMENDATIONS
Improvements highlighted by participants focused on the handling of the fast charger. It included changes to the handle and the weather shield built at the test site.



Introduction

Background

The present study is part of the "Test Environments for Fast Charging" project at LSP. The aim of the study is to analyse user aspects related to the fast charging points provided within the project. More specifically, the perceptions and expectations of the users will be investigated. The goal of the project is to provide initial conclusions regarding the effect of the product.

DEFINIG FAST CHARGING

Fast charging can be defined as "any scheme other than slow charging "(Botsford & Szczepanek, 2009) or "a general term for charging at higher power than the usual" (Zero, 2012). That is, it is related to time and the effect used. A more technical definition is provided by ChaDeMo: "a charger which provides electricity to the battery of the EV up to 500 voltage and 125 ampere, resulting in an effect of 50kW".

It is commonly argued that fast charging will (1) increase the range, (2) increase operation time of the vehicles, and (3) make drivers feel more confident about getting where they want. (Zero, 2012). In particular, fast charging is often presented as being the cure of, e.g., range anxiety (the fear of running out of charge while driving an EV). Indeed, research point out that fast charging may have a higher symbolic value compared to practical usage. That is, the ability to fast charge has a large psychological effect (as compared to practical usage) (Botsford & Szczepanek, 2009). Indeed, Boulanger (2011) argues that "if batteries had the ability to be fast charged without impacting their life or adding significantly to the system cost, then when coupled with widespread charging infrastructure, drivers would be less prone to range anxiety " (Boulanger, 2011).

In addition, studies have shown that public chargers are sparsely used but at the same time seen as necessity. In Berlin (the BMW Mini E experiments), the installed public chargers were seldom used, however, 80% of the interviewees in the survey alleged that they consider public charging infrastructure 'absolutely necessary' (Bakker, 2011). This is similar to findings from studies performed in Japan, in which Tokyo Electric Power Company (TEPCO) conducted a year-long study of fast charging infrastructure that began in October 2007 (Botsford & Szczepanek, 2009). That is, it can be argued that public fast charging infrastructure has largest effect in the early stages of deployment to encourage EV usage (Bakker, 2011).

There are however open questions regarding its effect, their placement and possible usage pattern. It is, for instance, believed that fast charging could play a significant role for when drivers are outside the normal daily commute. However, today, the location of fast chargers are typically influenced by the discretion of the involved partners in terms of physical and practical boundaries (space, ownership, and power availability) rather than based on the user's perceptions and usage patterns (Zero, 2012). Indeed, if usage patterns were considered, alternative placement of the fast charger may be preferred. For instance, if the charger is placed along a highway, for people to extend their range, they will want a full charge, and perhaps something to eat. If the charger is located in an urban centre and the user wants a quick boost, the charging time is likely to be shorter (ZERO, 2012).

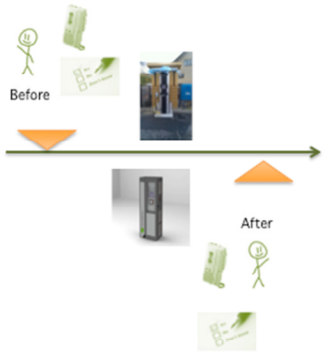
The negative impact of fast chargers is however yet unknown. One concern is the limited knowledge of its effect on the battery itself. In addition, its potentially negative impact on the grid (Botsford & Szczepanek, 2009).

Fast charging
Test environment


Figure 1: description

Brand: Delivered and produced by ABB
Placement: Agnesberg
Location: Enclosed area of a company
Access: Unlimited access to ONE company
Payment. free of charge
Users: a small size enterprise with long experience of using electrical vehicles as part of their daily work. Meetings and transport between sites.

Brand: delivered by Turning Point Cleantech and produced by DBT
Placement: Ringön
Location: outside the entrance to the companies having access to the charger.
Access: unlimited access for everone
Payment: free of charge
Users: local transports of goods or people within the city



Study Desing

Data collection and data anaysis,

To capture the effect of fast charging points, a qualitative study (Patton, 1990) consisting of two test occasions were designed.

DATA COLLECTION

The data for this qualitative study (Patton, 1990) was gathered during two test occasions. The two test occasions included group interviews and questionnaires. The two test occasions occurred "before" and "after" a trail period of using the fast charger. Group interviews were used to gather in-depth data regarding the usage of the fast charger. Group interviews are an effective way to gather qualitative information as users can be triggered by each other. Questionnaire was used to complement the group interviews in term of capturing individual reflections and minimise "group effect".

Table1. Study design

Test occasion id	Date	Case site	Company
T#1	20111129	A	Z
T#1	20120109	B	X
T#1	20120119	B	Y
TRAIL PERIOD- WINTER CLIMATE			
T#2	20120403	A	Z
T#2	20121024	B	X
T#2	20121030	B	Y

DATA ANALYSIS

The interviews was analysed by using the first stage of the grounded theory analysis, i.e. "open coding" (Strauss & Cobin, 1998). Open coding analyses qualitative data by extracting concepts from the data in which similarities and differences were identified across the respondents. Text passages were coded line-by-line with conceptual codes. Memos were written at several instances of the coding process. A condensed structure of conceptual dimensions and their relations to users' expressions emerged.
The questionnaire were analysed using descriptive statistics to contrast the two groups and test occasions.

MATERIAL

The interview and the questionnaire were based on previous findings regarding usage of fast charging (cf. Section 1.1). In particular, its higher symbolic value compared to practical usage was investigated by contrasting the drivers' expectations and experiences. It also aim at confirming/rejecting what is generally believed about fast charging.

Interview

Two interview guides were developed to provide consistency across the interviews (cf. Appendix 3-4). The interview guides consisted of 13 open-ended interview questions to be used either before or after the trail period. Specific and general questions were alternated to prompt the participants' memory. In addition, the participants were asked to provide examples from their daily life to make the question concrete.

The interview during test occasion 1 focused on capturing the dimensions and impacts of the future hypothetical situation in which they can use a fast charger (cf. Appendix 3). More specifically, the current situation with no fast charger and the upcoming situation (using fast charger) were contrasted in terms of its possibilities and opportunities, problems, worries, expected results.

Test occasion 2 focused on capturing the experience from the trail and any changes in attitudes towards fast chargers (cf. Appendix 4). By starting from specific events (critical and non critical) that had happened during the trail period, the participants' opinions were explored. In particular, its suitability as well as its psychological and practical effect was investigated.

Questionnaire

The questionnaire focused on capturing the participants' level of experience and their

attitudes towards fast charging. The questionnaire consisted of three main parts: (A) background, (B) experienced situations, (C) attitudes. The background section included categorical questions such as, gender, age, and level of experience. The second section explored the level of experienced limited range incidents. The section included categorical questions in which the respondent indicated the amount of times the situation have occurred. Section C investigated the respondents' attitudes towards fast charging. The section included statements that the participant were asked to rate the level of agreement on a 6-point scale. The scale used labels as opposed to numbers. Two open questions were added at the end of the questionnaire to captured the respondents comments.

The questionnaire were similar between the two test occasions, only the wording were adjusted from present to past, and from expectations of to experienced situations.

PARTICIPANTS

A total of 5 people participated in the survey. 3 of the participants had access to Case Site A (cf. Section 2.5) and 2 of the participants had access to Case Site B (cf. Section 2.6). Table 2 list the background of the participants in the study.

PROCEDURE

The participants were recruited at the companies having access to case site A or B. These companies actively participate within the project, however, the participants, per se, were not necessarily directly involved in the project. Email contact was made with the representative at each of the companies to identify participants for the study. The amount of people involved was determined by the participants' availability and constrained by the accessibility to the test site. The first test session included interviews at the location chosen by the participant. The questionnaire was provided at end of the interview session. A trail period for about 3 months allowed the participant to experience the fast charger. This was followed by a second test session, in which the same format as the first test session was used. The instructions for the test session were noted in the interview guide for consistency between test sessions (cf. Appendix 3 & 4).

Table 2. List of participants

Respondent id	Case site	Company	Gender	EV experience	EV usage / week	Experienced need of fast charging
R#1	B	X	Male	1-4 weeks	> 90km	2 instances
R#2	B	Y	Male	1-2 months	30-60km	2 instances
R#3	A	Z	Female	[no data]	[no data]	1 instance
R#4	A	Z	Female	2-4 months	10-30km	1 instance
R#5	A	Z	Male	> 6 months	> 90km	0 instance
R#6	B	X	Male	4-6 months	>10 km	1 instance
R#7	B	Y	Male	>6 months	> 90km	0 instance

CASESITE A:AGNESBERG

A prototype charger developed by ABB was installed at Angnesberg, Gothenburg, Sweden. The charger is situated at an enclosed area attached to the company. One company had unlimited access to the charger. The electricity was free of charge as the energy company chose not to test specific payment procedures. The company using the charger is a small size enterprise with long experience of using electrical vehicles in their daily work

CASESITE B:

The charger installed at Ringön located in Gothenburg, Sweden, were delivered by Turning Point and produced by DBT. The charger is situated just outside the entrance to the company using the charger. The company work with local transports within the city. Unfortunately the charger has had technical problems and could not be used within the time of the study.

Result and analysis

Data collection and data anaysis,

Respondent id and test occasion id are used to track statements from the interviews. The analysis focuses on contrasting the expectations with the experience of fast charge.

EXPECTATIONS OF FAST CHARGE (T1)
Prior to the study the participants' expectations were explored.

Expectations of fast charging
The interviews show that one of the more prominent expectations is that it will go *quick* to charge[R#1-R#5]. Having accessibility to fast charger is believed to make a difference [R#2]. The EV can be used more *effectively* as the EV is fully charged more often [R#1]. Also, the respondents expected that fast charger would allow the EV to be fully charged [R#1-R#5].

Possible concerns
The respondents showed concerns not only for the technology itself but also regarding its future role for the success of EV. First of all, respondents were uncertain of how the battery is affected by fast charging [R#2-R#3-R#4-R#5]. The safety was also questioned. Respondent #2: I would not like to leave the vehicle while charging [R#2]. The respondents showed surprise when finding out that the fast charger only charge up to 80%. The respondents expressed worry as it may have a huge impact during winter [R3-R4-R5]. In addition, the placement of the fast charger was reflected upon. One respondent argued that when you are in need of a fast charger, at the edge of your range, you do not have access to it as it is located at you home/base destination [R#1]. Also, you may need more than 1 charger (if they are placed at work), everyone comes back at the same time to have lunch which limit its accessibility [R#2].

Moreover, respondents reflected upon the fact that they will have easy access to the fast charger during the trail but in future, the fast charger will be located at public spaces, which may impact their accessibility [R3-R4-R5]. However, it is difficult to ensure infrastructure that allow you to have fast charger always on the edge of your range [R3-R4-R5]. Respondents argued that there is a need for more fast chargers at public places [R3-R4-R5]. This may indeed be important. One respondent reflected upon the fact that fast chargers are a necessity for people to start buying EV [R#2].

Moreover, there are some concerns that the impact of fast charger may not be as great as one would expect. The respondents argued that EV drivers have already established a routine by having charging during night (at home) and at daytime (at work)[R#3-R#4-R#5]; "one has learnt how to drive the EV without the use of fast chargers" [R3-R4-R5]. Indeed, they argued "if you are a real EV driver, then you do not have that much use of fast charging, instead you make sure the EV is fully charged before leaving home " [R3-R4-R5].

Moreover, one can question the need of fast charging if it will cost a lot of money; "if I charge at home for small money, why should one pay to use the fast charger. Maybe free parking could be an incentive. [R3-R4-R5]

Expected situations when one need fast charger
It was believed that the fast charger would be useful in the following situations:

- when you have been driven a longer distance during, e.g., the morning and you need to use the vehicle again in the afternoon [R#1-R#2]
- when there are meetings at other offices [R#2]
- when you drive at the edge of your range [R3-R4-R5]
- when you want to fill up a little, but you may not necessary need a full tank [R3-R4-R5]
- when you need some extra because you utilise the full range of the EV [R#1]
- when you need a buffer to handle unexpected events [R#1]
- when you do not have time for a utilising a longer/normal charging time [R3-R4-R5]
- when you need a buffer to for extra comfort of making it to the final destination [R#1]
- when there is a natural time to use the fast charger, e.g., during lunch time or during breaks [R#1]
- when you need the EV to be fully charged [R#1]
- people without a permanent parking spot [R#3-R#5]
- "but maybe if there were one at Torp, then it might be useful" [R3-R4-R5]

Also, most people in a city may not have access to a parking space, then maybe they need to fast charge. But I would not think that you would buy a EV is you did not have access to charge over night [R3-R4-R5]

Expected changes of usage pattern
In principle, the EV has a limited range and the access to fast charger could allow for a significant change in driving patterns or in the state of the mind of the driver. Actually, some respondents think there will be a difference due to the possibility to drive longer distances/day [R#1-R#2], while others think that there will be no change (due to the placement of the charger at home/base location) [R#3-R#4-R#5]. This highlights, the difficulties of finding right placement. However, respondents also argued that

"you get a larger effect if you change your driving style compared using an fast charger" [R3-R4-R5].

Negative aspects
Respondents highlighted the fact that the vehicle only charges up to 80 % [R#2-R#5], on an already limited range. Surprisingly, it was argued that fast charging takes to long time to fully charge a battery [R3-R4-R5]. In addition, the unknown effect of the battery is considered as a negative aspect [R3-R4-R5]. Also,

Positive aspects
The fact that it takes less time to charge the EV is considered as something positive [R#1-R#5]. With fast charging, one can make unexpected changes to the daily routine [R3-R4-R5]. For instance, one can go shopping or collect a friend along the way [R3-R4-R5]. Also, you can use the EV more often and drive longer distances [R#2]. It is also environmental friendly [R#1].

Important aspects
Respondents argued for an easy *access*; you should not need to revers into the spot [R#1,R#3-R#5]. Also, the cord should be long enough to be reached from the parking spaces [R#2]. In addition, it is important that that it is *reliable* (always functioning) [R#3-R#5]. If the station does not work, then you get stranded, and you cannot do anything [R#1]. In addition, it is also important that it is easy to *use* [R#2].

It was argued that the placement of the fast charger is important [R#1]. It should be placed at *strategic places*, e.g., between cities, or at the outer boundary of the city (shopping mall): [R3-R4-R5]. That is, a more peripheral placement of the charger is emphasised [R3-R4-R5]. It is also argued that they should be locate at work [R#2]

Improvements
A number of improvements were suggested:

- the cord was to thick to be easy handled [R#1]
- the cord was difficult to take out [R#1]
- the connection to the vehicle was cumbersome [R#1]
- the placement of the charger, not all parking places have access to it [R#1]
- ability to fully charge the EV, e.g., that you have the option of having two fast charging automatically after each other [R#3-R#5].
- notifications when the vehicle is fully charged or when the charge is cancelled (sabotage, power cut) [R3-R4-R5]
- make the charging time shorter, it takes more than 15 min [R3-R4-R5]

EXPERIENCE FAST CHARGING
After a trail period, the participants' experiences of fast charging were explored. Only case site A (respondent R#3-R#5), is considered in the analysis.

Handling the fast charger
The fast charger had some technical issues at the start that were resolved at the beginning of the trail period. Yet, there are some incidents that affected their attitudes towards the fast charger.

For instance, the respondents noticed that if the vehicle were cold, it took longer to charge. It normally takes 25 min to charge, and when cold it takes about 45 min to charge. However, the respondents attributed the longer charger time to the cold battery of the vehicle rather than limitations of the charger. Yet this severely affected the charge time and their concept of the fast charger being "fast/quick".

The handle of the connector to the charging cord was also difficult to handle. The respondent experienced that it took several times before there were any connection between the cord and the vehicle; "I never know if I should pull or push". In addition, you could not attach the cord to its connector at the charging station either. The respondents compared to the ease of the connector to the slow charge.

The respondents had also difficulties during evening times with the darkness. They need to use a flash lamp, however, they needed their hands to connect the charger.

Furthermore, it is difficult for the respondents to accept the fact that the fast charger only fills the vehicle up to 80 %. The participants want to make a choice: the amount of time compared to how much the battery is charged. One participant argued that "you rather have a bit longer and get 100% than use the fast charger and get 80%".

The respondents also reflected upon the fact that the charger did not behave differently when it rains or snow. Also, no electrical power cut occurred.

Respondent said that most of the charging is done in the evening when one are done with the driving of the day. The fast charger were used sparsely, by one of the respondents and one of them used it as a parking space (as opposed to charging when you actually are in need of more energy).

The main reason for using the fast charger is to increase you driving range, hence, it is most important to provide a longer driving range.
If you are dependent on the fast charge to reach a place, you will use it.

One of the reason for having an electric vehicle is because it is cheaper, hence, why should one pay more to fast charge.

If I were to pay, it has to be simple. If you fast charge, do you need to move your vehicle after 20 min. does this mean that you need to go back again in the middle of your shopping, food etc., if there is slower charger next to it, you may take that instead.

The behavioural effect of fast chargers
The concept of fast charging is appealing for the respondents [R#3-R#5] in this study: "If I drive a lot in the morning, then I can charge the EV, an drive the same distance in the afternoon". However, the respondents do not experience a great difference in usage pattern of the EV having access to a fast charger.

Possible explanations include (1) they have had access to the EV for a long time and they already match their daily routine according to the range of the EV, (2) they do not have a need to drive long distances, (3) they do not have a natural placement of the fast charger for it to play a significant role in their driving; (4) the amount of extra energy the fast charger provides does not play a significant role in their daily driving. One respondent explains: "It has not affected me at all; often you stay an hour but you do not get enough energy anyway, hence, I do not use it". Similarly, "I would not use the EV if I did not know that I had enough energy from the start". However, at the same time, the respondents argue that the effect of winter is huge when deriving the EV; " At winter you need any bit of energy in your vehicle".

Moreover, the users did not let the fast charger determine the use of the EV. "I have never experienced a wait for the fast charger to be done. The fast charger does not dictate the length of the stop".

Possible role of fast chargers
The belief is that fast charger is most useful when one have a *primary* reason for visiting the home office in the middle of the day. Charging the vehicle becomes the *secondary* task. One respondents argues that its possible role depends if the driver have something to do during the wait. This implies the driver does not want to wait for the vehicle to charge.

The respondents acknowledge that it can be useful in case of unexpected incidents. However, no unexpected event occurred during the trail period. It can also be used when you have to drive longer distances. As it is now, EV is to be used for short distances. However, this need did not occur during the trail period.

Moreover, respondents' reflected that how much you have to pay affect the use of the charger. If it cost more to fast charge than to use the overnight charge at home, then the fast charge needs to add something extra. In addition, its design could influence the usage of it. If it is difficult to use, people would not use it.

Interestingly, one respondent reflected "I am not convinced that it will be used if you have it at shopping centre or at like IKEA". She continued to explain, "If people would have access to a fast charger, I would recommend them to use it however, I would not recommend anyone to buy a fast charger".

In the end, the respondents explain that they would never make themselves dependent on fast chargers.

Recommendations and Improvements
A number of improvements were suggested [R#3-R#5]:

- The display is difficult to read (needs higher contrast at direct sunlight)
- The way of connecting the cord to the vehicle is difficult to handle and understand.
- The cord get stiff during winter when it is cold
- An inbuilt lamp would be good in the vehicle or in the charger so be able to see in the dark.
- A more weather resistance charging station would be beneficial (e.g., roof for protection against rain). It takes time to connect the cord and start the charging (and this does not include paying procedure).
- To short cable, it could have been longer.
- Good to have a SMS sent to you when the charging is finished.

Positive
The respondents highlighted that it is quick to charge as the most positive aspect.

Negative
A number of practical issues of handling the fast charger were noted by the participants. However, that was outshined by the fact that the vehicle only gets filled up to 80% were highlighted. The respondents describes the concept of fast charging as getting a vehicle that is fully charged. However, when they tried the fast charge they noted that it only fills up to 80%.

COMPARATIVE ANALYSIS

In the proceeding section, the descriptive statistics from the questionnaire are presented.

Section C: attitudes towards fast charging
In Table 3 it is seen that there are a large difference between the two test occasions on some statements (cf. Statement: 1,3, 5, 6, 7) . However, today, there is to little data to make strong claims. However, it can be determined that there may be a difference of attitudes when experienced fast charging to be further investigated.

Comparing individual statements participant 3 changed attitude completely on statement nr 4 (from completely agree to completely disagree). Participant nr 5 changed opinion on 2 occasions. Statement 5 and 7 (from completely agree to completely disagree). Their attitude stayed consistent on 2-3 statements; unfortunately, not overlapping statements.

Furthermore, 3 instances changed from completely disagree to completely agree. This means that the experience were so strong that the respondent changed their opinion.

Interestingly, 5 instances did not change between the two test occasions. This could imply that they are consistent in their attitude and their experience did not change this.

Moreover, at the first test occasion an even distribution between positive and negative aspects were identified. However, at test occasion two a majority of negative aspects were identified. This means that the experience made them reflect, and they became more sceptical.

Out of 9 instances, 7 changed more than 20 %. More specifically, that it would be faster to charge were lowered with 80% and that it would be simple lowered with 30%.

4 instances differed between their expected use and their actual usage. 1 driver used the fast charge less than expected and had also not experienced as many critical incidents.

Table 3. Positive levels were clustered. Comparison of attitude (section C in questionnaire)

Statement	T#1 % agree	T# 2 % agree
1. I am attracted to its *cheap* fuel	60%	100%
2. I am attracted to the *flexibility* fast charging provides	20%	25%
3. I am attracted to the *comfort* of being able to fast charge	40%	25%
4. I am attracted by the fact that the vehicle can be *fully charged* more often	60%	75%
5. I am attracted to the fact that it will be faster to charge	80%	25%
6. I am attracted to the *simplicity* of fast charge	80%	50%
7. I believe it will *be time consuming* to fast charge	40%	0%
8. I believe it will cumbersome to fast charge	0%	0%
9. I believe it will be constraining to fast charge	20%	0%
10. I believe it will be uncomfortable to fast charge	0%	No data

Section B: experienced incidents
In addition, the questionnaire explored typical situation that can occur while driving the EV. The number of incident prior to using fast charge is compared to the trial period. This can provide insight in the effect of fast charging. The results is presented in diagrams, cf. Figure 1- 6. It should be noted that the trail period does not match their previous experience of using EV.

Interestingly, Figure 1 indicate that after accessing the fast charger, none of the participant experienced situations in which they could not take the EV because it was not charged enough.

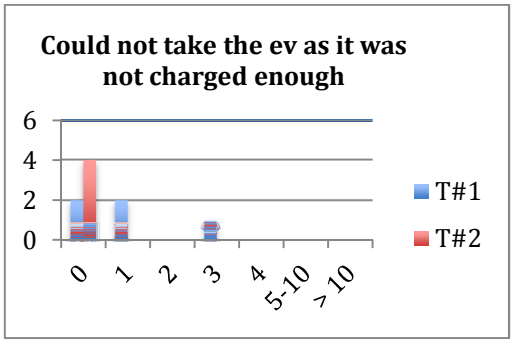


Figure1. Comparison of experience situations before (T1) and after accessing the fast charger (T2).

In addition, the questionnaire investigated if they had made an active choice not to take the EV (cf. Figure 2). No major difference between the occasions can be seen.

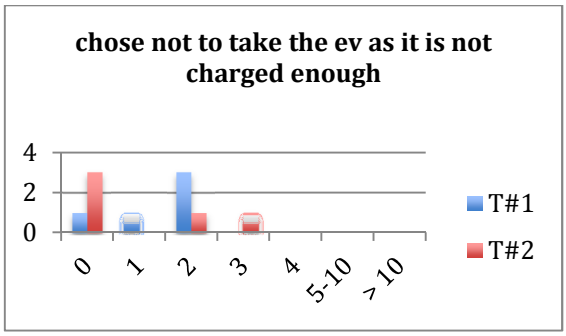


Figure 2. Comparison of experience situations before (T1) and after accessing the fast charger (T2).

Also Figure 3 shows no major difference between the occasions.

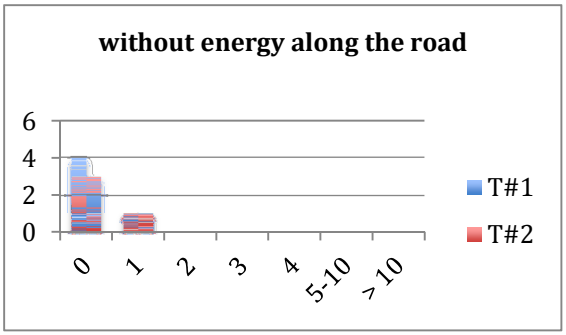


Figure 3. Comparison of experience situations before (T1) and after accessing the fast charger (T2).

Figure 4, on the other hand, show that they had pervious experience of aborting a trip due to limited energy, however, no trips were aborted during the trail period.

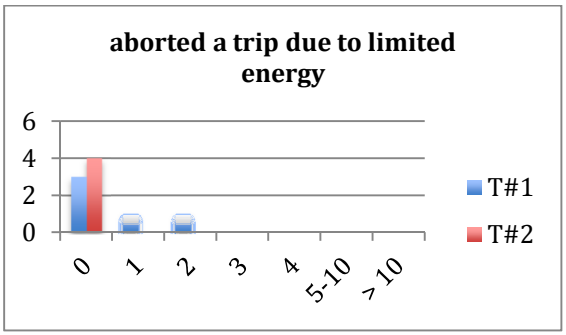


Figure 4. Comparison of experience situations before (T1) and after accessing the fast charger (T2).

Interestingly, there is a difference between test occasion 1 and test occasion 2 in Figure 5. In figure 5, it is indicated that there were more incidents of the type "I have been close to become out of energy". This may indicate the symbolic value of fast charger and their ability to drive on the border.

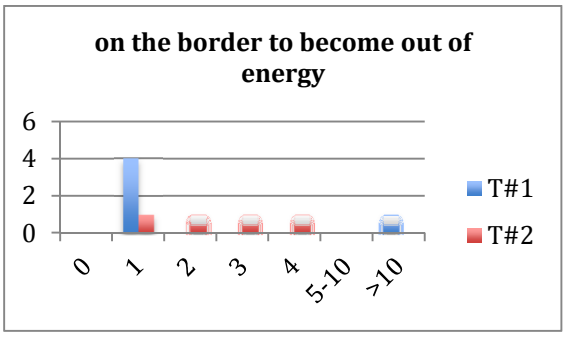


Figure 5. Comparison of experience situations before (T1) and after accessing the fast charger (T2).

In Figure 6, it is shown that the participant expected to use the fast charger much more than they actually did during the trail period.

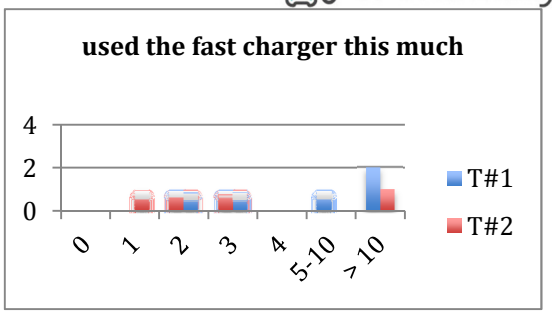


Figure 6. Comparison of experience situations before (T1) and after accessing the fast charger (T2).

Conclusions and Recomendations

Initial findings

It should be noted that these conclusions and recommendations are based on a limited sample. The conclusions/ recommendations are restricted by the characteristics of this test site and users that participated in this study. Further investigations are needed to verify the findings.

Initial conclusions
It is shown that fast charging is a good concept but one need to consider the possible user groups.

Indeed, this study indicates the importance of identifying the correct user group for fast charger.

It can be identified that for those that did experience an added value, the fast charge would play a significant role in the daily use of EV. In particular, an added value for car pools were identified that want to increase their daily use of electrical vehicles.

For those that *did not* experience an added value of having access to a fast charger, the following is possible explanations (1) they do not represent the correct user group (2) they have had access to the EV for a long time and they already match their daily routine according to the range of the EV, (2) they do not have a need to drive long distances, (3) they do not have a natural placement of the fast charger for it to play a significant role in their driving; (4) the amount of extra energy the fast charger provides does not play a significant role in their daily driving, (5) they do not know about the existence of the fast charger.

The ability to quickly charge the vehicle were emphasised as opposed to the flexibility and ability to use the vehicle more often.

The fast charger loose effect in winter and takes longer which lower the appeal of fast charging.

There is a larger effect for people that have not driven EV that long. Experienced driver have already learned to drive without the use of a fast charger, hence, they do not need them.

One should think of the location of chargers. General public location may have a limited effect on individual EV users. However, from a company perspective, fast charger may be good to increase the efficacy of the usage of EV.

Aspects which determine the use of the fast charger includes:

- location
- cost
- time
- current the battery level
- safety of the place
- timing, are you at the edge of the range
- Private/commercial use
- Driving distance
- Ease of use
- That people know it exists

THE TRANSITION from
NIGHT charge to FAST charge

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About E-Mobility NSR

The Interreg North Sea Region project North Sea Electric Mobility Network (E-Mobility NSR) will help to create favorable conditions to promote the common development of e-mobility in the North Sea Region. Transnational support structures in the shape of a network and virtual routes are envisaged as part of the project, striving towards improving accessibility and the wider use of e-mobility in the North Sea Region countries.

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