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Battery-Electric Demonstrations in Early-Adopter-Fleets

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Short Abstract

From the years 2009-2012 about 330 battery-electric passenger cars (M1) and light-duty vehicles (N1) were operated in a large-scale demonstration project in Hamburg, Germany´s second largest city (pop. 1.8m). The vehicles were used in commercial fleets and businesses with half of the vehicles being deployed in large enterprises and the other half at authorities and public enterprises as well as SME. Currently, further fleet trials are under way in Hamburg with nearly 900 vehicles (M1, N1) which are eventually expected to be deployed in both business as well as closed fleets for neighbourhoods.

1 Introduction

From 2009 to 2012 nearly 330 battery-electric passenger cars (M1) as well as light-duty vehicles (N1) were deployed in a large-scale demonstration project in Germany´s second largest city, Hamburg (1.8m inhabitants). Aim of the trial was, amongst others, to acquire a deeper understanding of how these novelty cars are being used in comparision to conventional, petrol-fuelled cars in their commercial deployment.

The activities were part of a much larger initiative by the German federal government to boost electric mobility as a new technology strand and a first step towards a wider sustainable transport in Germany. The political goal of one million electric cars by the year 2020 were successively often quoted in the media and public [1]. This particular programme as other initiating programmes in other areas of Germany were funded from a stimulus package which was set up to counteract the large, upcoming recession in Europe beginning 2008.

The vehicle models were chosen as a selection of what was available on the market at that time and what was already used (as a conventional engine) in the commercial sector. Table 1 shows the number of vehicles for each model and their general specification. It becomes clear that the driving range is much below what conventional versions of these cars can offer.

Table 1: Types of vehicles used in the large-scale field trial in Hamburg from 2009-2012.

Vehicle model	Karabag New 500E	Daimler Smart Fortwo Electric Drive	Karabag E-Fiorino	Mercedes-Benz A-Class E-Cell	Renault Kangoo Z.E.
Numbers of vehicles in use	200	50	20	18	15
Battery capacity	11 kWh	16.5 kWh	21 kWh	36 kWh	22 kWh
Power	28 kW	30 kW	60 kW	70 kW	44 kW
Range (NEDC, *manufacturer)	100 km*	135 km	100 km*	255 km	170 km

The vehicles were used in commercial fleets and businesses with half of the vehicles being deployed in large enterprises and the other half at authorities and public enterprises as well as SME (table 2). Although the term fleet is used it does not necessarily implies a minimum number of subsituted vehicles. In fact, many of the participating companies have only a few conventional vehicles at all and used only a single electric car within this demonstration project.

Table 2: Types of vehicles used in the large-scale field trial in Hamburg from 2009-2012.

Large Commercial Enterprises	54 %
Public authorities incl. State-Owned Enterprises (SOE)	27 %
Small and Medium Enterprises (SME)	19 %

2 Survey Methodologies

Milages at the time of recharging were drawn from autonomous built-in data-loggers in the vehicles (n=50; Oct 2010 - Sep 2011). Times of recharging as well as the amount of electricity for each charging operation were monitored through the charging spot meters (n=50; Oct 2010 - Sep 2011). User feedback on the driving experience as well as the main reasons for travel with the electric cars were retrieved using online-questionnaires and pen-and-paper surveys (n=64, Feb-Sep 2011).

3 Findings

In this paper three main areas of interest are depicted as results. These are trip lengths, the amount of electricity dispensed in each charging operation and the general user acceptance. The latter is especially interesting since in the current market-phase, where there is strictly speaking no noteworthy market at all, user´s early impressions and opinions will influence the further ramp-up of sales in the forthcoming years.

3.1 Trip Length

The average trip length between two charging operations was 26 km. Unfortunately, the automated logging-devices in the vehicles could not log the daily trip length, but only the milage at each charging operation.

Since the vehicles were on average recharged after 2.5 days, the single daily trip lenght must have been below this value. The vehicles were mainly used for inner-city travel to meetings or miscellaneous pick-ups and smaller deliveries. Other uses included the transport of goods, customer service and passenger transport (table 3). It needs to be noted, though, that individual user feedback and the experience and knowledge gained during the trial it became clear that there is a wide variance in this average value and some companies were at the upper limit of the maximum distance the vehicles could provide.

Table 3: Main reasons for usage of the vehicles (n=64, multiple answers possible).

Meetings	69 %
Misc. deliveries	30 %
Transport of goods	19 %
Customer service	16 %
Passenger transport	11 %
Others	17 %

3.2 Amount of Electricity per Charging Operation

Most of the vehicles were charged on company ground where a charging spot as well as a parking space was reserved for the project cars. The average charging time at these charging spots was not more than 1.5 hours, because due to the average (short) trip length the vehicle´s batteries were hardly ever depleted from their use.

This does not mean, that the vehicles were in use the rest of the time. Usually, the cars were connected to the charging infrastructure at the end of the day until shifts started next morning. The 1.5 hours are the time the cars were actually receiving electricity. This has, similar to chapter 3.1, to do with the way the data were retrieved from the infrastructure. The meters would only recognize a charging operation when electricity is dispensed, not when the cars are only plugged into the infrastructure and running idle.

During the charging operation the average of 5.7 kWh electricity was dispensed to the battery cars. This is a plausible value with an infrastructure that dispenses roughly 3.5 kW power per hour. Fig. 1 shows the distribution of charging operations. It can be seen that there is only a small number of users that takes up larger amounts of electricity on a regular basis. Again, with a low average trip length (cf. chapter 3.1) and only a few companies using the cars to their limits this distribution seems plausible.

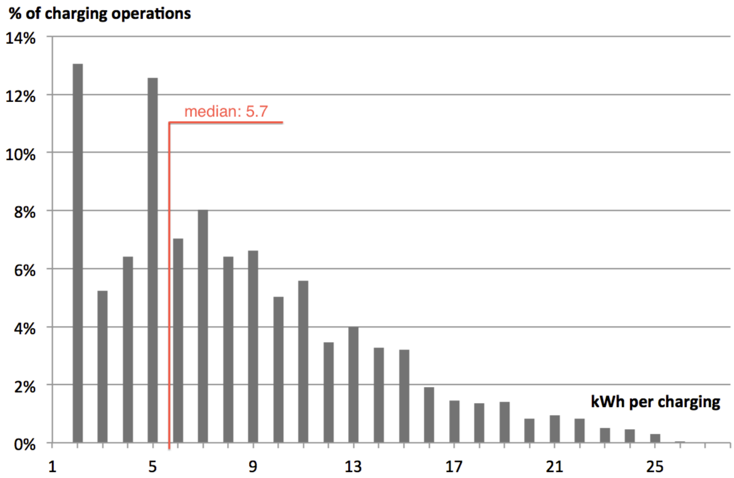

Fig. 1: Distribution of dispensed amount of electricity per charging operation on the private grounds of the companies using project cars. Median is 5.7 kWh (n=50).

3.3 User Acceptance

Users of the vehicles were asked once in the last third of the project, using online-questionnaires or paper-forms, about their impressions of the cars, problems they experienced or advantages they see for themselves as drivers or for the company and its operations.

Although with n=64 there is a valid basis for the survey results, the general response rate could be improved. Reason is that especially in large enterprises the contact person for project related questions is not driving the cars himself, but often is only responsible for the administration of the vehicles, while in the different business units and departments varying drivers are hard to get hold of for evaluation purposes.

The vast majority of the users gave positive feed-back about handling and use of their battery-electric vehicles. Less noise inside the driver´s cabin was emphasised by many as a positive improvement in contrast to the conventional cars in the respective company fleet. Accelaration was seen as positive or at least satisfying by a majority.

Scope for improvement was seen in regard to driving range and recharging speed by 70 % of the interviewees. It is impressive that, although plugs, cables and high-voltage systems are used in the battery cars, none of the respondents feared getting hurt while charging. However, nearly 50 % expected vandalism of the accessible charging cable at some point in the future.

4 Conclusions and Outlook

The 330 battery-electric vehicles operated in this field-trial were mostly used for short inner-city trips, like driving to meetings or accomplishing various pick-up or delivery tasks. Reasons for an emphasis of these travel patterns could be the size of the vehicles (small, partly two-seater) and also that the vehicles, the first of their kind in the fleets, were preferably used by the management or marketing department, for example on occasions were the engagement of the company in green technology could be shown best, like business appointments. As a result, the overall milage was lower than expected for a commercial environment with 26 km on average in a 2.5-day period, after which the cars were then recharged.

Based on a survey by the German Federal Ministry of Transport [2] the average trip length of a commercially registered passenger car in Germany is considerably higher with 72 km. This suggests that the cars in the project were not deployed in a representative manner. Also, it needs to be pointed out that the total number of cars in the project was too low to generate statistically firm results.

With that little milage of the project vehicles the average amount of electricity dispensed during each charging was only 5.7 kWh. This is a very low number and hence recharging times did not pose any problems to the majority of the users. Again, this might be a good first impression in the debut of a new technology but does not suffice for a mass-market application and needs to be taken into account when judging the maturity of the technology in public.

In the recently started (2013) successive field-trials in Hamburg with nearly 900 vehicles for the commercial sector the focus will be on a stronger real-life deployment of the cars. Rather than on a „first come, first serve" basis the vehicles will this time be given to companies following a representative distribution in the various commercial sectors [3]. The aim will be to focus more on the actual use and impact of the substituted vehicles. Censuses have shown that there is still a large share of older diesel vehicles in commercial fleets in Hamburg [4]. Urban air-quality can be substantially improved by first substituting those vehicles. Furthermore, in order to lower emissions and the operational costs per kilometer of the new technology, routines with high daily milages should be chosen since this will, yet not fully but partly, pay off the considerable higher purchase prices of the battery cars.

References

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Author

Sören Christian Trümper is an Environmental Scientist by training. After working several years in the field of hydrogen and fuel cells as a project manager and consultant to the European Commission´s research policies division he became engaged in electric mobility. As part of a public-private partnership he co-ordinated the vehicle based R&D projects on behalf of the city of Hamburg (Germany) and supported the strategy development together with the local authorities. Recently, he has returned to academic research where he focusses on the potential of electric mobility to reduce the carbon footprint of the city´s commercial fleets as well as the energy consumption of battery electric cars in dependence of their driving patterns.