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E-vehicles for urban distribution – why is it not happening yet? – requirements of an innovative and sustainable urban logistics concept

Anika Lobig [1], Verena Charlotte Ehrler [1]

[1] *German Aerospace Center, Institute for Transport Research, Berlin, Germany*

Abstract. In order to reduce emissions within urban areas, a shift from conventional vehicles for distribution and commercial transport would be desirable. Analysis has shown that this shift would be possible, yet it has not happened. The paper describes, based on the analysis of various pilot projects carried out in Germany, which developments are needed in order to facilitate a swift roll-out for e-vehicles for urban distribution. It is described, what the strengths of electric vehicles for urban distribution are, which challenges are still existing, the user acceptance encountered and the requirements towards innovative e-distribution concepts beyond the vehicle itself. Three pilot projects, carried out with logistics providers and commercial users in the Berlin area in the period from 2010 to 2016, as well as findings from a major quantitative research carried out in Germany with over 1,100 participants build the basis for the research. The paper closes in an outlook on how a spread of e-mobility for urban distribution can be supported and improved.

1 Introduction

Air pollution and noise constitute a major challenge in urban areas and are mainly caused by transport. Electric vehicles (e-vehicles) can reduce air pollutant emissions, noise and even greenhouse gas-emissions, if power is produced by renewable energy sources. Therefore, the German government aims for 1 Million e-vehicles on Germany's roads by 2020 [1]. A sector especially suitable for such a replacement is the commercial transport which is characterized by a highly recurrent transport pattern and usually tour lengths of less than 100 km with predefined stops [2, 3]. However, despite rising numbers of newly registered e-vehicles (see Figure 1), in 2016 only about 25,000 electric passenger cars and about 4,400 electric commercial vehicles were registered in Germany [4].

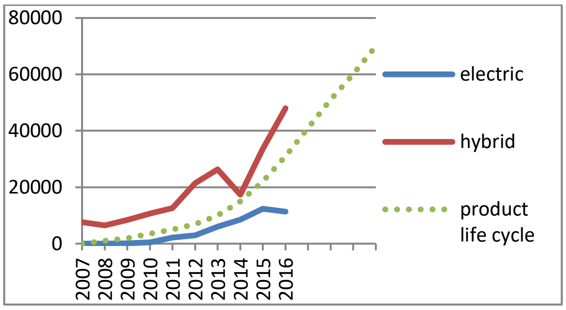

Figure 1: Number of newly registered electric and hybrid vehicles in Germany 2007 - 2016 [2]

This contribution shows existing challenges for a broader usage of e-vehicles in urban distribution and develops actions fields in order to foster e-mobility in commercial transport.

2 Method

The empirical research applied combines the following two analyses:

First, the status quo of the e-vehicle models of OEMs was examined in order to analyse the development of e-vehicles in the past. Additionally, an example is given for a specific vehicle development of a logistics provider.

Second, guideline-based expert interviews were conducted with drivers and decision makers of three urban logistics carriers in Berlin in the context of the [5] to analyse the introduction of e-vehicles in urban distribution. They introduced each between one to three light duty vehicles to their vehicle fleet. The interviews were held with ten interviewees at the beginning of the test phase before the e-vehicles were delivered to the logistics carriers and with 14 interviewees at the end of the test phase. The interviews aimed to ascertain the expectations and requirements on the usage of e-vehicles as well as acceptance aspects.

3 Results

Based on both analyses, the following major results can be stated:

3.1 Status-Quo in e-vehicle technology

First e-vehicles developed by OEMs were characterised by the fact, that the vehicle in itself remained unchanged and only the powertrain was replaced by electric propulsion. Furthermore, most vehicles developed were small passenger cars or vehicles for niche applications such as tractors etc. As a consequence, these e-vehicles could not be applied easily – if at all – for commercial transport or cargo. They were not developed as part of logistics concepts and presented isolated technical developments. The lack of offering of e-vehicles suitable for deliveries was so massive, that logistics providers started to develop their own transporters or trucks [6]. Therefore, the market penetration of e-vehicles is hampered.

3.2 Lessons learned from expert interviews

The expert interviews show, that the early adopters in commercial transport use e-vehicles mainly for image reasons, out of personal interest in innovative technologies of the business owners. Further reasons are a forward-looking business orientation or a reduction of local emissions. A possible cost reduction turned out to be subordinate. Still, as empirical research showed, on a mid-term perspective, e-mobility must not cause additional financial or organisational effort [7].

The utilisation of e-vehicles turned out to be very reliable. The range of the vehicles was usually sufficient for the length of daily delivery tours and there were no outages of the vehicles due to the electromotor. Furthermore drivers were positively surprised by the comfort offered by the e-vehicles, mainly the reduction of noise and fumes, and they enjoyed the acceleration and driving “fun” of the e-vehicles [8].

The interviewees also confirmed that the integration of e-vehicles into existing fleets requires a higher effort of tour planning compared to the experience-based tour planning with conventional vehicles [8]. Trip lengths, driving times, stops’ timing and locations in combination with long charging times and a thin net of charging points resulted in the requirement of a more detailed tour planning compared to the experience based planning. As a result, tour planning has to be optimized in order to avoid a loss of transport efficiency.

Furthermore it can be stated, that the charging and discharging behaviour of the e-vehicles differs between the vehicle models and depends also from the individual driver’s driving, acceleration and breaking behaviour. Therefore drivers must adapt their driving behaviour to the e-vehicles. That such an adaptation can be successful is shown by the example of one pilot project driver, who managed to achieve a maximum range of about 190 km by monitoring the energy consumption, the remaining range and by optimising his break behaviour to maximise the recuperation energy [8]. This example shows the importance of a change of the driving behaviour for a successful application of e-vehicles especially in commercial transport.

Pilot projects also showed that loading volumes and capacity of electric commercial vehicles need to be reviewed, especially for KEP services where heterogeneous shipping volumes with strongly fluctuant shipment sizes and volumes collide with the space occupied by batteries at the moment [8].

3.3 Challenges for the usage of e-vehicles

From the drivers and decision maker’s point of view, the following challenges are seen [8].

First, a high density of charging points is crucial for a rapid recharging and a flexible vehicle use. Currently, the density of charging points in Berlin is rather low. Additionally, power connections and payment clearing processes aren’t standardised yet, which complicates the operative usage of the charging stations and limits the actual availability of charging points for the individual user.

Second, the battery capacity is strongly dependent of extern influences (e.g. weather) as these require the use of secondary energy consuming units (e.g. wipers or ventilation) which leads to massive variations in range. As the remaining range displayed is not precise this can cause uncertainty and stress for the drivers [8]. For a range comparable with conventional vehicles and today's transport patterns a range of approximately 200 – 250 km is required.

Third, current e-vehicle models are not convincing. The investment costs are still twice as high as for conventional vehicles and for some routes ranges of about 150 – 200 km are insufficient. Additionally, the choice of e-vehicle models is still very limited, especially for higher payloads and volumes. As a consequence, for several applications there is still no suitable vehicle available or those on offer are not financially attractive.

Fourth, a concept is missing for the transition from urban distribution based on conventional vehicles to urban delivery based on e-vehicles and it is up to the individual organisation to adapt their logistics to the limited vehicle offering in the market.

4 Action Fields

A targeted development of an e-vehicle based urban distribution requires the development of innovative distribution concepts supported by improvements in the vehicle technology, smart route planning systems, charging infrastructure and legal framework.

First, innovative multistage distribution concepts need to be developed and tested jointly by logistics providers, OEMs, municipalities and ICT developers. These concepts shall be suitable with the range and charging times of alternative vehicle concepts.

Second, e-vehicles need first and foremost to be able to compete with conventional solutions regarding the total cost of ownership. Furthermore the operational capacity needs to be oriented towards the distribution concept with increased higher payload and volume, longer ranges and battery life, easy-to-use display of remaining range and a demand-oriented design of the cargo area. Additionally e-vehicles need an interface to route planning systems to deliver real time energy consumption and state of charge.

Third, smart route planning system is needed, which represent the connecting link between the innovative distribution concepts and the e-vehicles. As the experiences from the DisLog-Project show, the use of e-vehicles reaches the limits of the experience-based route planning and requires a more complex route planning [8]. Therefore, an assistance of route planning is needed, which optimise the route dynamically in accordance with e.g. required ad-hoc-, same-day- or on-time-delivery tours, required recharging during a tour, energy consumption, remaining range and all incoming receivers to be delivered to.

Fourth, the expansion of fast-charge infrastructure is required to enable a more flexible route planning for users. A charging pole location concept especially for the commercial transport is needed. Furthermore, standardised power connections and clearing processes contribute to an easier charging and payment.

Fifth, regulations could be adapted further to help increase the market penetration. The current disadvantages of e-vehicles shall be reduced by incentives e.g. road user charges for conventional vehicles. Furthermore, logistics areas close to the city centre should be ensured to implement e-vehicle suitable distribution concepts.

5 Conclusions

The introduction of e-vehicles is more than just a replacement of power train and energy source: it requires adapted distribution concepts due to the special characteristics of e-vehicles, improvements in vehicle technology, development of smart route planning systems in order to integrate the e-vehicles to the distribution concept, a fast-charge infrastructure and a supporting legal framework. The implementation of these measures is a prerequisite for a shift from conventional to e-vehicle based delivery systems. Otherwise conventional vehicles will remain the preferred option, as time and financial costs for e-vehicles will be too high for economically sustainable solutions for commercial users.

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