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Electric Vehicles at Public Organisations in Hamburg

Tobias Held[1], Rasmus Rettig[1], Mario Wegner[1], Jörg Oltrogge[2], Sabine Edelhoff[2]

1 – HAW Hamburg

2 – Landesbetriebe Verkehr Hamburg

According to the Hamburger Klimaplan, 50% of all vehicles in public fleets in the city of Hamburg are to run on electricity by the year 2020. For state owned enterprises, a reduced percentage of 35% is expected (Bürgerschaft der Freien und Hansestadt Hamburg, Drucksache 21/2521, 8.12.15). The purpose of this study, which was conducted from November 2015 to June 2017, was to gather the current state and forecast the percentage of electric vehicles in the respective public fleets and to identify conditions and enablers, that would support reaching the targets of the Hamburger Klimaplan. The study covers both the public administration and the public companies in Hamburg, as well as in the metropolitan region. Relevant data was acquired with an extensive pre-processing and analysis of existing motor vehicle registration data, followed by an online questionnaire and a management tool to monitor and plan fleet electrification on single vehicle level. Finally, expert interviews were conducted with the respective units. The study covers more than 70% of all city-owned vehicles. Based on the results of the study, the authors present scenarios for the future development of the percentage of e-vehicles in the respective fleets, including the expected progress towards the given targets. Further findings confirm the feasibility of the targets set under certain preconditions, like availability of specific types of vehicles. Best practices of successful units are summarized and include e.g. active management involvement with regular reporting of the composition of the vehicle fleet

Keywords: Electric Mobility; Electric Vehicle; Scenario; Hamburg

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1 Introduction

1.1 Background

The majority of climate changing gases are released in cities, in which more than half of the world's population resides. Because of this fact, Hamburg's Senate has decided to take a stand. As a result of the 2015 United Nations Climate Change Conference (UNCCC) in Paris, France the Free and Hanseatic City of Hamburg (FHH) has taken initiative on greenhouse gas reduction and developed a climate plan. Using the climate plan, the FHH targets 50% electric vehicles (e-vehicles) within public administrations' and 35% within public companies' fleet by 2020 (Hamburg, 2015).

Analyses in the context of electric mobility (e-mobility) usually cope with vehicles of private citizen or commercial enterprises and how to achieve a higher pervasion of e-vehicles (Ajanovic & Haas, 2016; IEA & OECD, 2012; Hall, et al., 2017; Spath, 2012; EAFO, 2017a; Taefi et al., 2016). As of today, no specific publication focusing on the use of e-vehicles within state-owned organisations has been published. However, public fleets can play a major role for increasing e-vehicles share.

This paper is based on a study, conducted in Hamburg between November 2015 and June 2017, covering knowledge and application of regulations for e-vehicles, as well as the usage and forecast for e-vehicles in public administrations' and public companies' fleets. The study consists of an online questionnaire and 24 expert interviews. It deals with the research question of the current status of e-mobility in the FHH and metropolitan region of Hamburg (MRH). It will be analysed whether the goals of the climate plan will be achieved by public organisations in the FHH and the MRH, and how to increase the percentage of e-vehicles in public organisations' fleets. [1]

1.2 Electric mobility

Significant changes in the Earth's climate have been expected for decades, but the pace has never been as quick as it is today, which is why the UNCCC draws

[1] In this paper the term "state-owned" is understood as synonymous to "public" and the term "enterprises" is understood as synonymous to "organisations". The terms "organisations" and "enterprises" are understood to describe the total of administrations and companies.

great attention to the fact (United Nations, 2016). Road transportation as one of many examples accounts for a large share of greenhouse gas (GHG) emissions worldwide. From 1990 to 2015 GHG emissions from road transportation within the European Union and Iceland increased by 142 million tonnes CO2, whereupon road transportation is responsible for about 20% of all Europe´s GHG emissions (approx. 10% globally). Simultaneously, the overall European GHG emission level decreased by 1,336 million tonnes CO2 (equivalent to 23.6%) (EEA, 2017). The numbers stated above underline that there is a severe need for vehicles with alternative drive trains, so called “green mobility” (Bekiaris, et al., 2017; Leal Filho & Kotter, 2015). A goal of the UNCCC is to ensure that actions must be taken now, as a way to further prevent the increase in global temperature in the years to come (United Nations, 2016). As conventional vehicles can no longer satisfy all future mobility, the number of e-vehicles has increased to nearly 1.3 million units worldwide by the beginning of 2016 (around 947 million passenger cars and 335 million commercial vehicles were in operation worldwide at this point in time) (Fornahl & Hülsmann, 2016; Organisation Internationale des Constructeurs d’Automobiles, 2018). From 2015 to 2016, the number almost doubled and surpassed the 2 million-vehicle threshold at the end of 2016 (IEA & OECD, 2017). Heavy subsidies account for a share in this increase (Statista, 2017).

1.3 Governmental responsibility

E-mobility is not only a field of scientific interest but is strongly promoted by policy makers. In the United States e.g. automakers must meet the carbon dioxide standards introduced by governmental agencies like the Environmental Protection Agency (EPA) or else they are penalized. Since 2018, the Chinese government has placed demands on the auto industry to have the production of e-vehicles make up for 8% of their total manufacturing (Bundesregierung, 2011; Statista, 2017). Several political decision-makers expressed the ambition to become leading in the area of e-mobility. London, (Greater London Authority, 2015), Amsterdam (Netherlands Enterprise Agency, 2017; Tietge, et al., 2016), Oslo (Transportøkonomisk Institutt, 2013; EAFO, 2017b; Eltis, 2014), Copenhagen (EnergiWatch, 2016; City of Copenhagen, 2012; Hall, et al., 2017) and Barcelona (EAFO, 2017a; City Protocol, 2017; ABM, 2016) are some examples.

Hamburg has been engaged in the development of e-mobility for years, which has resulted in a higher level of development compared to other regions in Germany.

The Hamburg Senate passed a masterplan of publicly accessible e-vehicle charging stations for users throughout Hamburg in 2013. This resolution stipulated that there would be 900 electric driven vehicles for the state-owned sector as well as 592 charging stations by mid-2016 (Hamburg, 2013). Through the development and compliance with the climate plan, with the gradual electrification of state-owned vehicle fleets, Hamburg's government is aiming to be recognized as a role model for e-vehicle usage. (Hamburg, 2015)

1.4 Hamburg´s climate plan

Basis of the climate plan is a guideline on procurement of vehicles with low CO2- and pollutant emissions, which was defined and implemented in 2011. In 2015 this guideline was included in the general vehicle regulations of the FHH, so that for the procurement of vehicles for public administrations those with an alternative drive train are to be preferred. The regulation has to be fulfilled, if the average daily distance is less than 80 km, charging stations exist or can be established at frequented destinations and e-vehicles or fuel cell vehicles are available in the required size and configuration (Hamburg, 2014).

In the following the term "e-vehicle" is understood to identify motor vehicles with a permissible total weight of less than 2,600 kg and with the following types of drive: Purely battery driven; Hybrid, externally chargeable with petrol engine; Hybrid, externally chargeable with diesel engine; or Fuel-cell drive. Other hybrid vehicles, e.g. non-externally chargeable are not to be considered as e-vehicles.

The goal of the climate plan is to achieve a 50% share of e-vehicles in public administrations' fleets and 35% share of e-vehicles in public companies' fleets by 2020. Public administrations are e.g. specialised authorities, district administrations and state offi es, public companies are legally independent entities with at least 50% shares of the FHH. The targeted percentages apply for passenger and commercial vehicles. Police, fire services and protection of the constitution are excluded from the climate plan. A divergent procurement of conventional vehicles is permitted for exceptions and with justification only, which leads to a reversion of the "exceptional-law-principle".

After this introduction (chapter 1), the research design of the study and the methodology of the study will be presented (chapter 2) and subsequent its results will be illustrated (chapter 3). The conclusion (chapter 4) will highlight main findings and critics, and finally the outlook (chapter 5) will present future prospects.

2 Research design

In this chapter the research design and methodology of the study will be explained – starting off with the timeline, followed by the structure of the study, ending with the methodology of the questionnaire and the interviews.

The goals of the study conducted are the following: a) To reveal findings about the development progress of e-mobility at public administrations and public companies. b) To help increase their percentage of e-vehicles of the overall fleet, according to specific forecasts by systematic and comprehensive data evaluation. And c) to assist funding bodies to identify and evaluate opportunities to increase e-mobility in public areas.

This study covers the analysis of the registration figures of the FHH. By systematically analysing questionnaires, it examines factors influencing the percentage of e-vehicles within the public organisations' fleets. Expert interviews were analysed, summarized and compared to identify best practices. Finally, a prognosis was created for the development of the percentage of e-vehicles within the public organisations' fleets, including different future scenarios.

Figure 1 illustrates the overall timeline of the study. Processing of the study took place from November 2015 to June 2017, with the data preparation starting July 2016 and the actual execution between February and May 2017.

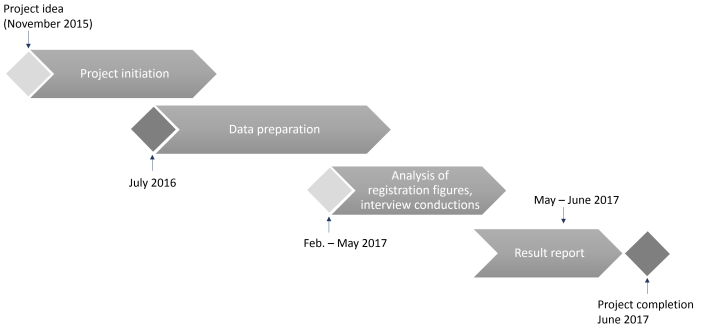

Figure 1: Timeline of the study

2.1 Analysis of the e-mobility share based on registration figures

Before the development of the study, registration figures have been analysed. It has proved to be difficul to ascertain involved cars, as neither the local, nor the central German vehicle registration index are designed for a systematic data analysis to screen out certain holder groups. The registration of the holder is a manual process and e.g. changes in organisations names can lead to different registration names for the same legal entity.

The total number of cars registered in the name of the city of Hamburg has been reduced to vehicles owned by public organisations. From all vehicles registered in the name of the city within one year, 8,400 relevant vehicles and the organisations owning these could be extracted. This was realised by firstly filtering the data by owner, secondly the application of further algorithms, and thirdly manual corrections.

Before the conduction of the interviews, the portfolios of e-vehicles of the total of public administrations and companies were analysed. The following Figure 3 and Figure 3 show the development of the number and share of e-vehicles for public administrations and public companies in the FHH respectively.

As the study had its closing date on June 30, 2017 this date has been selected as reporting date for the figures of the past three years.

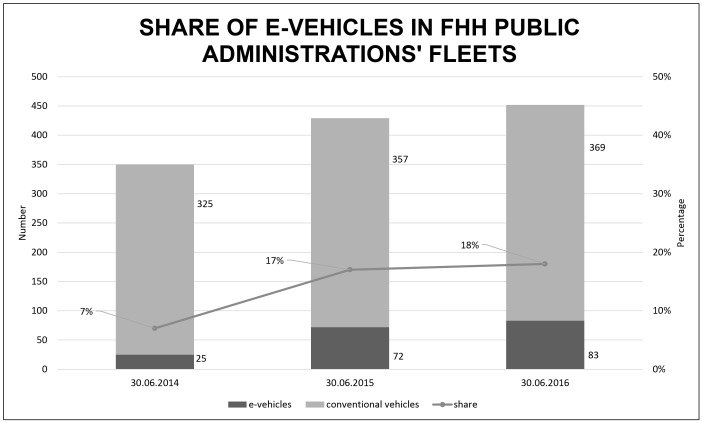

Figure 2: Number and share of e-vehicles within public administrations' fleets of the FHH

Figure 3 shows the development of the overall number of vehicles for public administrations within the FHH between 2014 and 2016. The overall number of vehicles and the percentage of e-vehicles rose. An increase from 7% e-vehicle share in 2014 to 18% in 2016 was achieved, with the largest development of 10% growth in 2015.

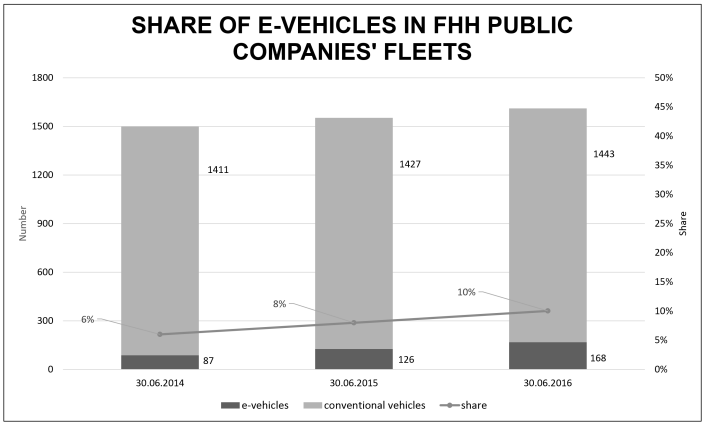

Figure 3: Number and share of e-vehicles within public companies' fleets of the FHH

Figure 3 demonstrates the development of the overall number of vehicles for public companies within the FHH between 2014 and 2016. Similar to the development of the public administrations' fleets, the number and percentage of e-vehicles of public companies rose: An increase from 6% e-vehicle share in 2014 to 10% in 2016 was achieved, with a continuous development of approx. 2% growth each year.

These figures reveal a difference between public administrations and public companies in the FHH. Apparently, the majority of public administrations was able to adapt to the higher e-vehicle percentages quicker than the public companies. The major increase for both groups took place in 2015, one year after the introduction of the procurement regulation. By June 2016, an overall share of 15,4% (2014: 6,5%, 2015: 12,5%) e-vehicles in public administrations' and public companies' fleets together has been achieved (including 79 e-vehicles operated without road registration).

Of all public organisations within the FHH and the MRH, those with a preferably large vehicle fleet were invited to participate in the next step of the study. On one hand participants with a high percentage of e-vehicles were invited in order to

study their motives and insights, on the other hand participants with an extremely low percentage were invited to share their insights on obstacles regarding the realisation of a higher e-mobility rate. Organisations with an average rate were not specifically addressed.

After the analysis of the vehicle portfolios of the surveyed organisations, opportunities for the increase of the percentage of e-vehicles for these organisations were assessed. These findings were integrated in the online questionnaire and the personal interviews. The approach of the interviews was designed with the following two steps: First, the top management of each examined organisation was addressed with the enquiry to take part in the study. Second, the interviews were conducted. Participation of the top management of the surveyed organisation was requested.

2.2 The questionnaire

The questions as indicated in Table 1 have been included in both the web-based questionnaire and the personal interview.

Hence, in total 24 public organisations, nine public administrations, and nine public companies in the FHH, and three public administrations, and three public companies in the MRH were analysed. Figure 4 illustrates the timeline of the events of the study.

Table 1: Overview of the questionnaire

Area addressed	Heading Three
Composition of the vehicle fleet	What is the number of e-vehicles in public organisations' car pools and the development of those? Are the registration numbers complete and accurate?
Special factors for vehicle acquisition	Which influencing factors exist and are they significant for former and future vehicle acquisitions?
Use cases / use profiles	How are e-vehicles used? Which usage profiles exist that facilitate or prevent the service of e-vehicles?
Future scenarios	Which scenarios could be created based on the above-mentioned issues?

Around two weeks prior to the interview date, a link for the web-based questionnaire has been send to each surveyed organisation via email. This questionnaire contained the number and models of vehicles registered on the name of the individual study participant.

A first evaluation of the questionnaire was carried out one day before the respective date of the interview. The summarised answers of the individual organisation were part of a presentation during the interview. In the course of the interview replies the questionnaire could be complemented. Replies could be amended by the interviewees for about a week after the interview date.

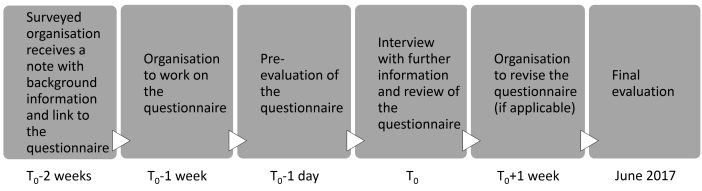

Figure 4: Timeline of the study

2.3 Content and methodology of the questionnaire & planning tool

The questionnaire has been divided in six sections, equipped with qualitative and quantitative parts, using closed and open questions, facilitating evaluation and comparisons. The first section dealt with the organisation, the second with the experiences with e-mobility and the third with guidelines and regulations. The fourth section has been divided in three subsections and asked the interviewee about the numbers of vehicles, actual ones from 2014 to 2016 and predicted ones for 2017 to 2020 in the first subsection. Causes for existing deviations have been treated in the second and the management process for the target attainment in the third subsection. Section five handled the vehicle usage and infrastructure. The sixth and last section has been split in two subsections. The first subsection asked about the perception of the effectiveness of potential measures. The second subsection of the questionnaire enquired about feedback. Processing the questionnaire could be paused at any time, following Dillmans (2014) guideline for mixing mode surveys giving the opportunity to back up in and continue the questionnaire at a later time.

With mixing mode survey design, as applied for this study, weaknesses of one mode can be overcome taking advantage of another modes' strength, thus minimising total survey error (Dillman, et al., 2014; De Leeuw, et al., 2008). Using a sequential approach for the mode change during the response phase improves coverage and responses while keeping costs down (Dillman, et al., 2014; De Leeuw, et al., 2008; Callegaro, et al., 2015). Within this study Dillmans (2014) "Type 4" of mixed-mode surveys, using two different modes to obtain responses from the same persons at different time points, was performed. As proposed by Callegaro (2015) the survey started with the less expensive mode, a web questionnaire building the ground, then proceeding with the more intrusive and expensive mode of face-to-face interviews enhancing a common understanding. The selected mixed-mode design provides the researchers with characteristic advantages such as lower costs and improved timeliness (Dillman, et al., 2014). As the answering of the questionnaire prepared the interviewees with an insight about the focus within the interview, effective face-to-face meetings were enabled. Specific mode effects which may be introduced by different modes within mixed mode surveys shall be minimised by dealing with the same content in both modes (online and face-to-face). Short intervals between the two applied modes, two weeks in this study, shall alleviate possible issues with data integrity within mixing-mode surveys. (De Leeuw, et al., 2008; Callegaro, et al., 2015) By having the web questionnaire as mandatory task before the interview an improved response rate was

enabled. With the interview subsequent to the questionnaire difficultie of understanding could be clarified. Afterwards room for amendments to reduce errors and inconsistencies was provided. (Dillman, et al., 2014; De Leeuw, et al., 2008)

3 Research results

Below an evaluation of the questionnaires and interviews, findings and best practices identified within a responder analysis are provided. This chapter concludes with a prognosis and the development of scenarios.

3.1 Evaluation of the questionnaires

The 18 interviewed public organisations of the FHH operate 72% of the vehicles of all public organisations within the city. This circumstance makes the survey significant for the analysis of the current state and furthermore permits the derivation of forecasts with high confidence and measures with great effectiveness. Only considering the number of e-vehicles, the surveyed organisations operate 81% of all e-vehicles in the FHH. A similar analysis for the MRH was not possible as the number of vehicles could not be determined with sufficien precision.

In the following text, the results of each section of the questionnaire will be explained:

Part 1 – Organisation

Central role for the procurement of vehicles and implementation of guidelines is the involvement of the management of an organisation. In almost half of the surveyed organisation (48%) within the FHH top management controls the purchase of vehicles. In about a quarter (26%) the second management level is in charge. The remainder delegate this task to other management levels such as fleet managers. The organisations in the MRH show a comparable allocation.

Part 2 - Experiences and acceptance of e-vehicles

Lower pollutant emissions, followed by strategic rules have been selected as most significant reasons for the use of e-vehicles. Less driving noise and staff requests were assessed with less importance. This ranking is the same for public enterprises of the FHH and the MRH.

The user acceptance of e-vehicles for public enterprises of the FHH is overall high (74%). 11% of the public enterprises declared a very high user acceptance of e-vehicles and another 11% a medium acceptance. Only 5% declared a low acceptance of e-vehicles. Public enterprises of the MRH show a comparable high acceptance of e-vehicles.

As possibilities for increasing the user acceptance of e-vehicles, an improvement in range and a reduction in charging times for the vehicles were frequently selected. Both possibilities are in the focus of the current technical developments for e-vehicles. A raise in the number of charging stations and information sessions for interested individuals were evaluated as less effective. This ranking is the same for public enterprises of the FHH and the MRH.

For the rating of arguments against the use of e-vehicles high acquisition costs and missing charging infrastructure were ranked high. Organisations from the FHH ranked vehicle range on average between medium and high. Organisations of the MRH designated the same major reasons but with range considered as most important, followed by charging infrastructure and acquisition costs. Please note that merely six organisations from three districts within the MRH could be interviewed.

The answers revealed an awareness of the importance of a strategic regulation for e-mobility and the desire to fulfil those. At the same time a conflict of goals due to potentially higher costs of procurement was disclosed. This demonstrates the significance of project funding to compensate cost disadvantages of e-vehicles.

Part 3 - Guidelines and regulations

Knowledge about guidelines is mandatory for their implementation. Not all organisations of the FHH know the climate plan and the vehicle procurement regulations in detail. The plan is known well in 79% of public enterprises of the FHH, in 5% it is known very well. 42% of public enterprises of the FHH stated that

they know the procurement regulations well, and another 42% that they know them very well. As there exist no comparable guidelines and regulations within the MRH, so no equivalent analysis was possible.

Part 4 – Figures and forecasts

Two of the surveyed organisations operate e-vehicles without registration on a large scale. For one, those account for 15%, for the other for 13% of their overall fleet. Please note that these vehicles are not included in the subsequent study forecast.

The information gained within this section has been used for the development of the prognosis and scenarios.

Part 5 – Usage and infrastructure

Three (two public administrations, one public company) out of 14 organisations in the FHH that operate e-vehicles are not provided with sufficien availability of charging stations for their e-vehicles. All surveyed organisations in the MRH that operate e-vehicles have adequate charging stations at hand.

3.2 Findings of the survey

There were four major findings from organisations with a high e-mobility percentage:

1. There are specific goals for the transition from conventional to climate-neutral vehicles
2. The top management is familiar with the topic of e-vehicles, communicated the objectives and regulation and aligned the profitability assessment accordingly. The status of the goal achievement is presented regularly
3. The fleet manager is well informed about e-mobility and puts his knowledge sustainably and consistently into practice. Impediments are critically questioned

4. Experience with e-mobility establishes confidence. Organisations that are using e-vehicles assess obstacles as lower than those without own experience

The following needs have evolved for many participants in both groups: a) A market offer for e-vehicles for transportation of up to seven passengers. b) A market offer for smaller, industrially used e-vehicles with a higher cargo load, in the following called “e-workshop van”.

Information sessions and briefings for the use of e-vehicles were reported as counteracting for concerns about e-mobility. The expert interviews on the issue of e-mobility were received positively by all study participants. The desire to continue an exchange on e-mobility was expressed consistently.

Best practices and potential identification

In both groups best practices were performed after early actions by top management and with sound understanding of the climate plan and the vehicle procurement regulations. For public administrations for instance acceleration of an early changeover to e-vehicles was crucial. For public companies for example a premature determination of individual goals for e-mobility was decisive.

One positive example within the public administrations almost already achieved the target of the climate plan (50% share of e-vehicles) in 2016. They exploited structural conditions to ensure sufficien infrastructure for their e-vehicle fleet and analysed the logbooks of their vehicles. The analysis revealed the opportunity of a cost-neutral extension of their e-vehicle fleet to fulfil their mobility needs. Two positive examples within the public companies almost already achieved or exceeded the goal of the climate plan (35% share of e-vehicles) by the end of 2017. They consistently used financial funding and systematic trial drives of new models. They made the strategic decision for using company-owned e-vehicles for officia trips only and made continuous analysis of mobility needs. Before an employee’s first use of an e-vehicle an individual briefing was performed each time.

Within public organisations with lower percentage of e-vehicles than the majority, the climate plan and its goals were known fairly and acceleration of an early changeover to e-vehicles by top management was lacking. Within those public administrations for instance the majority of mobility needs were fulfilled

with private cars and employees had concerns about e-vehicles. Some of those public companies for example acquired gas-vehicles a few years ago, which are not considered as e-vehicles as defined in the climate plan Hamburg. For other companies, higher overall costs spoke against the procurement of e-vehicles due to their performance targets and no strategic budget for the transition towards e-mobility was allocated. These characteristics revealed potentials for an increase in percentage of e-vehicles.

3.3 Prognosis

Based on the estimations of future fleet planning of the interviewed organisations, a forecast for the development of the percentage of e-vehicles was designed. According to this forecast, the surveyed public companies within the FHH will possess overall 1,340 vehicles and will reach a share of 26% e-vehicles until 2020. The surveyed public companies within the MRH will possess overall 173 vehicles and will achieve a percentage of e-vehicles of 28% until 2020. Neither the public companies within the FHH, nor the ones within the MRH will achieve the target percentage of e-vehicles of the climate plan (35%) without additional measures.

According to the forecast, the surveyed public administrations within the FHH will possess overall 296 vehicles and will reach a share of 36% e-vehicles until 2020. Taking into account all trips, where private cars have been used, another 13% can be obtained. For this it was assumed that for all these trips company-owned e-vehicles would be purchased and used from 2018 on. The number of e-vehicles needed has been calculated assuming that each e-vehicle accounts for 8,000 km per year. The total distance performed in private cars for public administrations within the FHH in 2015 was used and it was assumed that the percentage of distances in private cars will be stable over time. 70 additional e-vehicles would need to be purchased to fulfil the distances driven in private cars. 100% additional expenditure compared to conventional vehicles has been applied. In this way the public administrations within the FHH could achieve a percentage of 49% e-vehicles, of overall 366 vehicles, until 2020.

The surveyed public companies within the MRH will possess overall 115 vehicles and will achieve a percentage of 22% e-vehicles until 2020. Neither the public administrations within the FHH, nor the ones within the MRH will achieve the target percentage of e-vehicles of the climate plan (50%) without additional measures.

3.4 Constructing scenarios

In the following text, only organisations from the FHH are taken into account as the figures for the total of organisations from the MRH are not considered to be sufficientl accurate.

To construct scenarios, firstly scope and objectives were defined, which for this study is the development of percentage of e-vehicles within public organisations' fleets in Hamburg (Schoemaker, 1995; Axson, 2011; Ogilvy, 2015). Guidelines and regulations have been identified as key factors. The implementation of the climate plan in 2015 arose to have had a major impact on the development of the percentage of e-vehicles within the public administrations' fleets. This becomes apparent comparing the figures from 2014 and 2015. 2014 the surveyed public administrations together had a 7% share and 2015 a 17% share of e-vehicles within their overall fleets. The vehicle engineering of car producers was identified as major external force. The critical uncertainty is seen within the speed of the engineering processes of the car producers and the implementation rate and enforcement of new regulations (Schoemaker, 1995; Axson, 2011; Ogilvy, 2015). The following three measures were revealed as most important from the conducted study and are basis for the development of scenarios:

1. E-vehicles with seven passenger seats.
2. E-vehicles for the use as workshop vans.
3. *Public administrations only:* Ban of the usage of private cars for business trips and simultaneous procurement of e-vehicles for car pools. Public companies only: Increase of e-vehicles as company cars with private use; i.e. changed/ improved tax treatment of electric company cars.

Public administrations within FHH

In scenario one for the public administrations of the FHH it is assumed that the above stated measures one, two and three are fully effective. Figure 5, left side shows that in this scenario the public administrations within the FHH would be able to achieve a 76% share of e-vehicles. The ban of the usage of private vehicles for business trips is responsible for the major effect (19% e-vehicles share) (measure three), e-vehicles with seven passenger seats (measure one) for 18% and e-workshop vans (measure two) for another 10% e-vehicle share of the

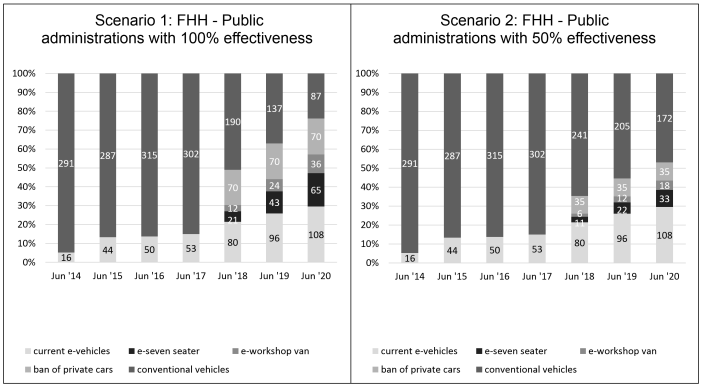

Figure 5: Scenarios for the share of e-vehicles within Hamburg's public administrations' fleets

overall fleets. In this scenario the share of e-vehicles would surpass the 50% target of the climate plan.

Scenario two assumes a 50% effectiveness of all measures. Figure 5, right side, shows, that in this scenario the public administrations would be able achieve a share of e-vehicles of 53% by 2020, which would surpass the 50% goal of the climate plan Hamburg. The ban of the usage of private cars for business trips, accounting for the major effect (10% e-vehicles share) (measure three), e-vehicles with seven passenger seats (measure one) for 9% and e-workshop vans (measure two) for another 5% e-vehicle share of the overall fleets.

Public companies within FHH

For scenario one for the public companies of the FHH it is assumed that all above stated measures are fully effective. In this scenario the share of e-vehicles within public companies within the FHH could be increased to 77% in 2020, as shown in Figure 6, left side. The use of e-vehicles as workshop vans (measure two) has the major impact (29%), e-company cars with private usage (measure three) accounts for 18% and e-passenger carriers (measure one) accounts for another 4% e-vehicle

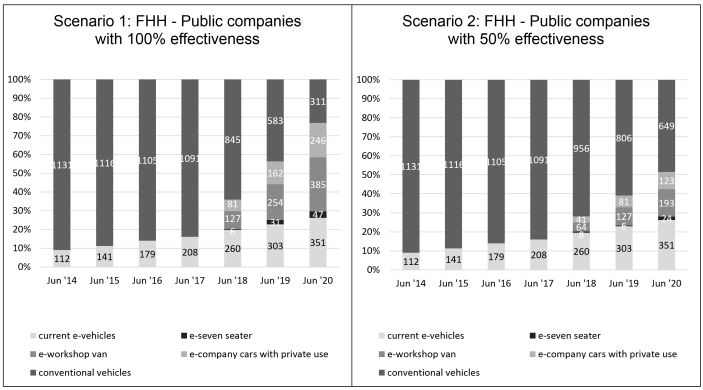

Figure 6: Figure 6: Scenarios for the share of e-vehicles within Hamburg's public companies' fleets.

share of the overall fleets. In this scenario the goal of the climate plan Hamburg (35% e-vehicles share) would be exceeded.

The second scenario has been constructed with the identified measures to be less effective. Scenario two assumes a 50% effectiveness of all measures. In this scenario the public companies would be able to achieve a share of e-vehicles of 52% as shown in Figure 6. This would surpass the 35% goal of the climate plan Hamburg. The use of e-vehicles as workshop vans (measure two) has the major impact (14%), e-company cars with private usage (measure three) accounts for 9% and e-passenger carrier (measure one) accounts for another 2% e-vehicle share of the overall fleets.

Without further amendments, neither the public administrations as a whole, nor the public companies in their entirety would be able to achieve the goal of the climate plan outright. Above identified measures will be needed to make use of existing potentials. The two constructed scenarios (100% and 50% effectiveness of measures) reveal the impact of the potentials for the surveyed groups.

4 Conclusion

The study conducted illustrates, that an increase of e-mobility percentages within public fleets is feasible. In order to identify the current percentages of e-vehicles within a certain public organisations' fleet, a consistent database and registration process for the central vehicles registration would be helpful.

To increase the e-mobility percentage in Hamburg systematically, the following actions have been taken by Hamburg Senate in 2017: A modified procurement approach so that e.g. public organisations need to provide more firm reasons for the purchase of a conventional vehicle instead of an e-vehicle.

It has become evident that organisations achieved the goals of the climate plan Hamburg, if they hold the following characteristics: They possess a certain "electric vehicle affinity and the top management is personally involved. The development of mobility is regularly reported and economic disadvantages are compensated.

Further potentials have been revealed including fleet cars without registrations in the study. Adopting best practices from other cities, like Amsterdam could also help achieving the defined goals.

5 Outlook

The following actions were identified to exert a positive influence on the percentage of e-vehicles at public administrations and companies in Hamburg: The further (technical) development of e-vehicles with attention to specific models and range is a must. Electric company cars with private use should see a reduction in the "1% taxation" to make them as attractive as their gasoline- or Diesel-based counterparts. Available e-vans should be extensively introduced and used. Vehicles owners and fleet operators should be personally addressed by a professional contact to enable the exchange of experiences. An explicit and repetitive reporting system for policy-makers directing to quicker and secured attainment has to be introduced, which could include a structured database containing information on driven distances and consumptions of (e-)vehicles. This would allow a rapid and sustainable examination of proposed (non-)usability of different drive-trains.

With the above stated actions, the e-mobility percentage of public organisations in Hamburg could be increased by about 50%-points within about two years' time. These actions might also have a positive impact on the percentage of e-vehicles in public organisations in other German cities.

The larger number of vehicles in Hamburg's public fleets is operated by public companies, which make up for three and a half times the number of vehicles in public administrations. Further effects for e-vehicles in public companies could influence the number of e-vehicles at non-public companies in Hamburg and Germany and therefore the overall vehicle stock in Germany (23% of all registered vehicles in Hamburg are registered to a corporate entity). The reduction of the 1% taxation for privately used company cars and the extensive usage of industrially usable electric vans could have an effect on the number of e-vehicles in non-public companies. More research and further development for e-vehicles, as well as the reduction of 1% taxation is expected to encourage a further increase of the overall e-mobility percentage in Germany and to affect the entire German car fleet.

A consistent database and registration process for the central vehicles registration would be helpful for other studies of this kind. With such database a full-featured listing of vehicles of public administrations and public companies could be created, which would ensure more accurate data and an easier collection for comparative studies.

A study with a probability sampling of all public administrations and public companies e.g. at European level would produce other interesting research results. With the opportunity to analyse the total of public organisations, e.g. with obligated attendance of all organisations, such sampling could be realised. This might lead to more adequate comparable and representative research results.

Further goals of the climate plan Hamburg are by 2030 for the public administration to act CO2 neutral and to reduce CO2 emissions in Hamburg by 50% compared to 1990. By 2050 Hamburg wants to achieve a reduction in CO2 emissions by 80% compared to 1990. (Hamburg, 2015) Whether these goals will be achieved is dependent on the actual increase of e-mobility in Hamburg within the next years.

References

Agency, N. E. (2017). *Electric transport in the Netherlands 2016 highlights*.

Agency), E. (E. (2017). *Annual European Union greenhouse gas inventory 1990–2015 and inventory report 2017*. en.
Ajanovic, A. and R. Haas (Nov. 2016). "Dissemination of electric vehicles in urban areas: Major factors for success". In: *Energy*. Towards low carbon energy systems: engineering and economic perspectives 115, pp. 1451–1458.
Authority, G. L. (2015). *Mayor unveils London's Ultra Low Emission future*. en.
Axson, D. (Mar. 2011). "Scenario Planning: Navigating Through Today's Uncertain World". In: *Journal of Accountancy* 211.3, pp. 22–27.
Barcelona), A. (M. de (2016). *Metropolitan commitment to clean mobility*.
Bekiaris, E., M. Tsami, and M. Panou (Jan. 2017). "A "Greening Mobility" framework towards sustainability". In: *Transportation Research Procedia*. 3rd Conference on Sustainable Urban Mobility, 3rd CSUM 2016, 26 – 27 May 2016, Volos, Greece 24, pp. 131–136.
Bundesregierung (2011). *Jahresbericht der Bundesregierung 2011/2012*.
Callegaro, M., K. L. Manfreda, and V. Vehovar (May 2015). *Web Survey Methodology*. en. London: SAGE (Publications Ltd.)
Copenhagen, C. of (2012). *CPH 2025 climate plan*.
De Leeuw, E. D. d., J. Hox, and D. Dillman (2008). *International Handbook of Survey Methodology*. en. EAM series (European Association of Methodology Series). New York, NY, USA: Taylor & Francis Group.
Dillman, D. A., J. D. Smyth, and L. M. Christian (Aug. 2014). *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*. en. 4th ed. New Jersey: John Wiley & Sons.
Economic Cooperation and Development), I. (E. A. Õ. (for (2012). *EV City Casebook - a look at the global electric vehicle movement*.
Economic Cooperation and Development), I. (E. A. Õ. (for (2017). *Global EV Outlook 2017 – two million and counting*.
Eltis (2014). *Oslo: electric vehicle capital of the world*. en.
EnergiWatch (2016). *København vil satse på elbusser*. dk.
Fink, A. (2017). *How to Conduct Surveys: A Step-by-Step Guide*. en. Thousand Oaks, California: SAGE Publications.
Fornahl, D. and M. Hülsmann (2016). *Markets and Policy Measures in the Evolution of Electric Mobility*. en. Springer.
Hall, D., M. Moultak, and N. Lutsey (2017). *Electric capitals of the world*. en.
Hamburg (2013). *Masterplan Ladeinfrastruktur*. de.
Hamburg (2014). *Leitlinie zur Beschaffung von Fahrzeugen mit geringen CO2- und Schadstoffemissionen*. de.
Hamburg (2015). *Klimaschutz und Klimawandel: Senat beschließt Hamburger Klimaplan*. de.
Institutt, T. (2013). *Norwegian transport towards the two-degree target*.
Leal Filho, W. and R. Kotter (Apr. 2015). *E-Mobility in Europe: Trends and Good Practice*. en. Springer.
Nations, U. (Sept. 2016). *The Paris Agreement: FAQs on its affect on climate change*. en-US.
Observatory), E. (A. F. (2017a). *Cities*.
Observatory), E. (A. F. (2017b). *Norway*.
Ogilvy, J. (2015). *Scenario Planning and Strategic Forecasting*. en.
Protocol, C. (2017). *Logistics for the Implementation of the Electric Vehicle (LIVE)*.
Schoemaker, P. J. H. (1995). "Scenario Planning: A Tool for Strategic Thinking". English. In: *Sloan Management Review; Cambridge, Mass.* 36.2, pp. 25–40.

Spath, D. (2012). *Strategien von Städten zur Elektromobilität. Städte als Katalysatoren auf dem Weg zur Mobilität der Zukunft.*

Statista (2017). *eMobility 2017*.

Taefi, T. T., J. Kreutzfeldt, T. Held, and A. Fink (Sept. 2016). "Supporting the adoption of electric vehicles in urban road freight transport – A multi-criteria analysis of policy measures in Germany". In: *Transportation Research Part A: Policy and Practice* 91, pp. 61–79.

Tietge, U., P. Mock, N. Lutsey, and A. Campestrini (2016). *Comparison of Leading Electric Vehicle Policy and Deployment in Europe*.