Abstract
The city logistics system faces serious challenges in the near future, such as zero-emission transport in city centers and the decarbonization of urban freight transport to meet the climate agreements. The city logistics system is in itself a very heterogenous system with many different types and forms of logistics operations. The use of battery electric freight vehicles (EFVs) could be a solution to make urban freight transport more sustainable. However, the relatively high procurement costs for an EFV – especially for the vehicles heavier than 3.5 tons – in comparison to the currently often used diesel vehicles, the lack of availability of OEM-produced vehicles, and the relatively short range compared to the currently used diesel vehicles, are challenging in actually using EFVs on a large scale in daily city logistics operations. This paper identifies the main trends and developments influencing city logistics and breaks down the city logistics system in six main segments. Using a TCO comparison between conventional and electric freight vehicles, we identify for which segments battery electric freight vehicles can be expected to be feasible alternative on the short time (and what barriers should be resolved in order to increase feasibility. The analyses follow from real-life demonstrations, of EFVs in city logistics operations in the project FREVUE.

Keywords: low emission transport, urban and regional vitality, policies and vision, zero emission city logistics
1. Introduction

City logistics, or urban freight transport, is mainly recognized from its unsustainable impacts. It contributes to both local and global emissions. It adds to traffic safety issues, as urban freight transport takes place in densely used city areas, where freight transport movements actually use the same infrastructure as vulnerable road users. Besides, it causes nuisance, e.g. visual but also from vibration and especially noise. And finally, many time windows, both regulatory as well as due to recipient requirements, force urban freight transport activities to take place during already crowded peak periods. However, city logistics activities are absolutely necessary for cities to function as a junction of goods and people. Without a good functioning city logistics system, cities and city centers are not equipped to, for example, serve shopping, recreating, residing as well as working people. Therefore a good operating city logistics system is essential for a city and its (local) economy (see Quak, 2008).

1.1 Challenges for the city logistics systems

However, the city logistics system faces serious challenges in the near future, such as the required zero-emission transport in city centers in the next decade (EC, 2013; GDZES, 2017) and the decarbonization of urban freight transport to meet the climate agreements by 2050 (Topsector Logistiek, 2016). This requires for the Netherlands a sixfold more efficient transport system in terms of transport performance per unit of CO\(_2\) emissions emitted, accommodating the expected growth of transport demand while at the same time reducing its carbon footprint (Smokers et al., 2017). This carbon productivity increase should be made in all transport sectors, including the urban freight transport. CE Delft (2016) estimates that city logistics operations in the Netherlands cause 33% of all freight transport related GHG emissions (air transport not included). To make matters more complicated: there is no silver-bullet solution that can solve these city logistics problems, as well as address other issues like increasing congestion in and around urban areas, as well as contribute to the livability of modern cities. The use of zero emission vehicles, such as battery electric vehicles, to operate in cities could contribute to achieving both zero emission freight transport in city centers, as well as partly decarbonize transport.

1.2 Battery electric freight vehicles still uncommon

The use of battery electric freight vehicles (EFVs) could be a solution to make urban freight transport more sustainable and answer the challenges mentioned earlier. And although EFVs are often considered to suit urban operations very well, as the trips are relatively short the short range is not an issue and no local emissions or noise is emitted and air quality and noise nuisance are especially an issue in cities, the EFVs’ share in city logistics is still quite low. For example, in the Netherlands 2,365 electric commercial vehicles of less than 3.5 tons and only 84 electric commercial vehicles over 3.5 tons were registered in April 2018 (RVO, 2018). This means that the total registered commercial EV fleet in the Netherlands, just to put it in perspective, is about as big as a quarter of the new commercial vehicle registrations in a month. So, although technical the EFV might be an ideal vehicle for city logistics operations, the uptake does not come easily. We can list several arguments (which we will do in the this contribution’s remainder), but to start: the relatively high procurement costs for an EFV – especially for the vehicles heavier than 3.5 tons – in comparison to the currently often used diesel vehicles, the lack of availability of OEM-produced vehicles (and as a result the extra trouble / efforts it causes for operators to procure EFVs), and the relatively short range compared to the currently used diesel vehicles, are a challenging in actually using EFVs on a large scale in daily city logistics operations (FREVUE, 2017).
1.3 Paper objective and outline

Although the technical solution of using zero emission vehicles seems obvious, the (large scale) uptake of electric freight vehicles is relatively slow for several reasons. This contribution aims at identifying the segments in the city logistics system for which the use of battery electric freight vehicles are feasible from an operational and financial point of view within the next years. This contribution is mainly based on outcomes and results from two studies, i.e.: Connekt (2017) and FREVUE (2017). First, this contribution examines the external drivers for change in the city logistics system and subdivides the city logistics system into different segments (in section 2). Next, section 3 provides a short introduction of FREVUE, in which several electric freight vehicles (EFVs) were used in different city logistics segments. Then section 4 discusses the TCO comparison for different size EFVs in relation to the segments these vehicles were used. Finally we look at future developments (section 5) and come to the conclusions (section 6).

2. Changes in the city logistics system

The city logistics system has to change in order to deal with the big challenges. However, experiences from the past years show that the system is very difficult to change and modernize (see e.g. Dablanc, 2007). The system is very heterogeneous with respect to the actors involved (e.g. for transport already varying from self-employed truck-drivers, to large logistics service providers and from small parcels delivered by vans to full truckloads delivering supermarkets), the various product-market segments, the logistic requirements, its organization and number of different stakeholders playing their role. Operations have only in common that it concerns the movement of goods from, to or in a city (see e.g. Allen and Browne, 2010).

2.1 External developments in city logistics

We first identify the currently already existing trends and developments in the city logistics system, as actually making changes in the system is expected to be easier, as these follow either market-requirements or business opportunities. We shortly present the main trends and developments that we derived in Connekt (2017) using the DESTEP method identifying the demographic, economic, social, technological, ecological, political developments influencing the city environment in which city logistics operations take place (for further elaboration see Connekt, 2017 or Quak et al. 2018):

- Societal developments: increasing pressure for reduction of GHG emissions, increased pressure for liveability of cities, transition in direction of more circular economy; and as a result a more performance based regulation (to regulate entrance to the specific sections in the city in time, place and for vehicle types).
- Technical innovations (ICT related): connecting the physical world (IoT applications), the physical Internet and universal labelling, robotization and automation
- Technical innovations (vehicle related): vehicle drivetrain technology
- Societal developments: more demanding customers (enabled by technical ICT innovations) and a further drive for customer intimacy are expected, first in home deliveries but later also in other city logistics deliveries, and as a result more receiver-steered logistics.

2.2 Heterogeneity

How the different identified external developments affect the city logistics system, and if these developments offer opportunities or the opposite for the uptake of EFVs, depends on the
specific type of city logistics operations. The city logistics system is itself a very heterogeneous system with many different types and forms of logistics operations. These different forms vary in e.g. the logistics organization and requirements, typical drop-sizes, vehicle types used, and many other characteristics, and therefore require specific solutions to meet the zero emission as well as decarbonization challenge (Connekt, 2017). We classify the city logistics system in six main segments, i.e. general cargo, temperature controlled, parcel and express, facility logistics, construction logistics, and waste collection (see also Figure 1 that shows the segments and the corresponding vehicle kilometres estimated by the share of van kilometres and truck kilometres). The footprint depends on the used definition of urban freight transport, here it includes the transport from the (final) warehouse to the receiver in the city and first mile from the city (back) to the warehouse. Many of the mentioned segments have (in the Netherlands) hubs or warehouses close to the cities (e.g. parcel companies, as well as many food deliveries – in temperature controlled), and need only a limited number of kilometres, whereas for example general cargo comes from a few regional or national hubs.

![Estimated CO2 emissions city logistics per segment in the Netherlands](image)

**Figure 1 – GHG emissions per segment in 2015 in the Netherlands (Connekt, 2017)**

The City Logistics Outlook 2017 (Connekt, 2017) decomposes these six segments in smaller subsegments, as the operations can vary considerably in the segments. This is subdivision is relevant, as for some smaller segments, EFVs might be a feasible solution, as for others it is not. Just to illustrate that, in the segments temperature controlled, we distinguish: i) the supply of large supermarket retail chains, ii) wholesaler foodservice to HoReCa, iii) high-value specialist supplies to restaurants and SMEs and iv). home deliveries of fresh products (online-groceries) and meals (B2C). All these subsegments are organized very differently and the related trips vary from large trucks carrying full truckloads, to small vans making home deliveries (or even bikes to make meal deliveries). We take the different subsegments in account, if relevant for the changes to use EFVs. The segment-distinction is relevant (as the segment characteristics determine the feasibility), the exact type of operations and classification are not this contribution’s core. Connekt (2017) and Quak et al. (2018) provide more information on the city logistics (sub)segment division, this contribution’s remainder focusses on the possibilities to use EFVs in daily city logistics operations.

3. **Demonstrating electric freight vehicles in urban areas**

The FREVUE project (2013-2017) demonstrated the use of electric freight vehicles in city logistics operations in eight European cities. The project was co-funded by the European
Commission under the Seventh Framework Programme, Theme 7 Sustainable Surface Transport. It answered the call “Demonstration of Urban freight Electric Vehicles for clean city logistics”. Within the project the demonstration of 127 EFVs was planned, covering a variety of urban freight applications that are common across Europe, including:

- Goods deliveries (including food, waste, pharmaceuticals, packages and construction);
- New logistics systems and associated ICT;
- Organisation with a focus on consolidation centres to enable minimalisation of trips in urban centers;
- Vehicle types (from small car-derived vans to large 18 tons goods vehicles);
- Climates (from Northern to Southern Europe);
- Diverse political and regulatory settings that exist within Europe

The FREVUE project has deployed nearly 80 fully electric freight vehicles (EFVs), from light vehicles under 3.5 tons to 18 tons trucks for various logistics operations across eight European cities, i.e.: Amsterdam, Lisbon, London, Madrid, Milan, Oslo, Rotterdam, and Stockholm. The number of vehicle deployed was less than planned, as especially large vehicles (i.e. heavier than 3.5 tons) were more difficult to acquire, both from financial perspective as well from availability from vehicle suppliers. FREVUE aimed to prove that the current generation of electric vans and trucks is able to offer a viable alternative to diesel vehicles in city logistics operations. FREVUE examined the main findings on technical performance of the EFVs, economic feasibility of replacing electrification of urban logistics fleet and environmental impacts from vehicle operations. The full project results are available via the project website (see FREVUE, 2018). In this contribution we further focus on the economic feasibility of the EFVs in city logistics (based on FREVUE, 2017), as the FREVUE demonstrations showed that the technical performance of the electric freight vehicles are technically suitable for the logistics operations that were performed in the demonstrations. Notice that within FREVUE, as is often in demonstration projects, the electric freight vehicles were typically planned to replace diesel vehicles on short roundtrips, so that the limited EFV range is not an issue in the operations. This implies that within these demonstrations several issues were not tested: all demonstrations used overnight charging at a depot, so opportunity charging during the vehicle operations (planned in a vehicle roundtrip) was not considered. Only (limited) parts of vehicle fleets were replaced, so no new solutions were developed to deal with charging larger fleets or to plan also for inconvenient trips (i.e. ad hoc deliveries and pick-ups, or for trip-lengths that run the risk to be longer than the allowed range by the battery). Experiences in FREVUE (2017) showed that logistics operators who decide to procure an EFV or more EFVs face several challenges, next to the high procurement price of EFVs (as will be discussed in the TCO (total cost of ownership) comparison in the next section). First, the logistics operator needs to establish new relationships as especially large vehicles cannot be procured from OEMs and charging infrastructure is not as widely available as fuel stations. In other words, for a logistics operator to currently switch from the existing diesel-powered vehicles towards electric powered vehicles, requires more than just buying another vehicle, as the logistics operator has to explore many new and uncertain areas. These extra elements turned out to be a barrier for operators in moving to EFVs. The development that OEMs will start producing these vehicles will be removing one barrier in the transition to more EFVs in city logistics, as the operator can then use the regular maintenance network and buy the vehicles from familiar suppliers.

4. Comparing the TCO of electric and conventional freight vehicles

The total cost of ownership (TCO) comparison between an EFV and a CFV (conventional freight vehicle) is an important purchasing decision criterion for logistics operators. The TCO
comparison results differ per vehicle type and usage. The TCO also depends on many other elements that can be country or even company specific. This contribution discusses general TCO comparisons based on the demonstration that have taken place in FREVUE. We distinguish in comparisons for small vans (lighter than 3.5 ton), large vans (between 3.5 and 7.5 tons) and small and medium rigid trucks (of 12 tons, respectively 18/19 tons).

We used the data from FREVUE partners (see FREVUE, 2017 section 2.2 for more information) for more details on the costs used in the TCO comparisons. The data in the presented TCO calculations do not represent one operator and are based on averages from the different FREVUE operators. The results are generalized to one TCO comparison (which means for example that some country specific elements are not included anymore, or company specific characteristics are left out). Also for prices (diesel, electricity, etc.) we use averages, although these differ considerably in Europe.

In FREVUE (2017) we varied in depreciation times and (average) kilometers driven per day in the TCO comparisons between the EFVs and CFVs. In this contribution we only present the most represented case per vehicle category, based on the way the FREVUE demonstrators would consider the EFV business case. For more detail and information, we refer to FREVUE (2017).

4.1 TCO comparison small vans

The small sized electric vans used in the FREVUE demonstrations were active in various types of urban logistics activities, varying from postal deliveries and pick-ups (and some parcels delivery and pick-ups), medicines, general cargo, and maintenance operations of parking meters. The market for conventional vans is dominated by relatively low-cost products, as there is no market for luxurious vans (in contrast to passenger cars and trucks). Therefore, the comparatively expensive electric van has to compete with a value-for-money vehicle. For this segment OEM-produced vehicles are available and used (in contrast to the other vehicle segments discussed later), i.e. Nissan eNV200 and Renault Kangoo ZE. These small vans have limited loading capacity and can therefore mainly be used for operations with relative small units, such as home deliveries of parcels (in the postal and parcel segment), of groceries (see for example Dutch online supermarket Picnic) and meals (in the temperature-controlled segment) and for service related trips (in facility logistics). But even in these segments most often larger (diesel) vans are used nowadays by the operators. Typically, these vans were used in the direct surroundings of a depot to make many small deliveries or stops (in case of service operations). For ad hoc services, or longer trips the operators planned CFVs, so the limited range of the EFVs was no problem (the average distance driven in the demonstrations is slight operator dependent, but mainly varies between 60 km per day to about 90 kilometres per day.

The vehicle price is by far the largest cost-driver for an EFV, but does not differ that much from the purchasing price for CFVs (especially if one considers that many of the today operating EFVs are purchased with a subsidy). Since operating costs are lower (fuel vs. electricity and maintenance) for an EFV and investments for charging infrastructure are in this category relatively low, there is a break-even point quite early. Note that, although from a TCO point of view the EFV performs quite well, operationally it still has some limitations (in for example range), which can be a barrier for large-scale uptake.

Figure 2 shows the TCO comparison with a depreciation time of five years and an average of 60 kilometers per working day. The purchase price is by far the largest cost driver for an EFV.
Since operating costs (fuel versus electricity and maintenance) are lower for an EFV and investments for charging infrastructure are relatively low for small sized EFVs, there is a break-even point quite early for an small van EFV.

![Figure 2 – TCO small sized vehicle (5-year cross-section - 60 km / day)](image)

Note that, although from a TCO point of view the EFV performs quite well, operationally it still has some limitations, such as range and the limited loading capacity of these small vans, which can be a barrier for large-scale uptake in many city logistics segments. Note that the maintenance costs are relatively high in the TCO comparison for small CFVs; the values we received from FREVUE partners varied considerably for maintenance contracts and repair costs. This is striking for the TCO comparison for small vehicles, as the vehicle procurement costs are – in comparison to the medium and large trucks – relatively low and therefore the maintenance and repair costs are a relatively large proportion of total costs in the TCO for small vehicles. As the operational costs for EFVs are lower than the CFVs’, the TCO is even more favourable for the EFV when an operator uses the vehicle for more kilometres per day.

### 4.2 TCO comparison large vans

The large vans (between 3.5 tons and 7.5 tons) were mainly used for parcel deliveries and pick-ups (both express services and home deliveries in as well the B2B as the B2C segment). These large vans differ from the small vans as – at the end of 2017 – there were no OEM produced vehicles available. Therefore, for the FREVUE demonstrations the large vans were converted diesel vans. As a result, the difference in purchasing price is much bigger than for the small vans.

The average distance driven is higher for the vehicles in this segment (from about 60 km/ day, to about 120 kilometres / day. Per roundtrip far more stops are made using these vans (over 100 per day), than in the demonstrations with the small vans, as the loading capacity of these large vans is much higher. This type of diesel-powered van is used in many other city logistics segments, for example in construction logistics. However, since many of these kilometers are also from commuting constructors from home to the construction sites (and to visit e.g. the wholesaler) in between, who also use the vans for personal usage, the limited range is an issue. The availability of this type of EFV also makes it more difficult to procure it, as OEMs only start offering these vans from 2018, 19.

As the operational costs for EFVs are lower than the CFVs’, the TCO comparison shows that the difference between the CFV and EFV gets smaller as the operator can make more...
kilometers. This is limited (at this moment) to maximum 120 kilometers, due to range allowed by the battery and the time it takes per day to make the over 100 pick-ups and deliveries. The loading capacity is not limiting it. Although, fuel (CFV) and electricity (EFV) make up for a limited part of the total costs of owning the vehicles, the procurement price difference between the OEM-produced CFV and the converted EFV is too big, so currently there is no positive TCO situation yet for the medium sized electric freight vehicle, without subsidy in ten years. However, with subsidy a positive business case for an EFV is possible after six years.

The FREVUE demonstrations for this vehicle category allowed us to vary more in the TCO comparison. As Figure 3 shows the TCO breakdown comparison for the case the large van runs (on average) 60 kilometers and is depreciated in 5 or 10 years. There is a break-even point in case of a 10 year depreciation time and 60 kilometers per day, and if (as is the case in London) the EFV exempted from paying a congestion charge (and we do not consider the differences in expected residual value). This implies, that without this tax advantage for the EFV, there is not yet a positive business case for operating large electric vans. The gap is smaller if the vans make more kilometers, but can be bigger if an operator has to invest in the electricity grid (in case of charging a large fleet at the depot), see FREVUE (2017).

For the large van we can say that the EFV’s TCO is in most cases currently worse than for a comparable CFV. However, the TCO comparisons do show that with financial support (as in some cases currently exists) from subsidies, or other financial incentives (such as the exemption of London’s congestion charge) there can be a comparable TCO around five years. Next, many uncertainties still exist around the residual value and the lifetime of the battery. The current generation of EFVs are tested and demonstrated in daily city logistics operations, but not yet long enough to say more about the actual residual value at the end of life, or the actual deterioration (or not) of the batteries. As long as battery lifetimes cannot be guaranteed, in most procurement decisions (i.e. TCO calculations by operators) the operator calculates with a smaller depreciation period than the 10 years we used in this TCO comparison. Finally, the TCO calculations show that increasing the number of kilometres driven does have a positive impact on the EFV’s TCO. In the end, the TCO depends – next to the number of kilometres – on the cost advantages due to lower costs for operating per kilometre with an electric vehicle than with a conventional vehicle. These cost advantages come from lower
costs per kilometre (diesel versus electricity) and lower maintenance costs (although this is not always the case yet, as OEM CFVs compete against converted and one of a kind EFVs).

4.3 TCO comparison rigid trucks

We also demonstrated the use of electric rigids in FREVUE. This included the distribution towards hotels, restaurants and cafes in the Dutch cities of Rotterdam and Amsterdam, using 9 trucks in total. These trips typically start from depots close to the cities, so range is not an issue. Next, also deliveries to fashion retail stores were considered; here the limited range was a problem. Therefore, the trip from the national depot of the fashion retailer was made by a CFV carrying two detachable swap bodies, that were unloaded at the city border. From there a EFV picked up one swap body to make a roundtrip to fashion stores, followed by a trip with the other body. Empty swap bodies (of the day before) were collected by the fashion retailer’s CFV at the border of the city. These demonstrations showed that operational and technical also trips by rigid trucks could be (partly) replaced by EFVs (although, in one case logistical reorganization was required). The demonstrations showed that the EFVs operationally and technically performed well for the planned trips.

OEMs did not yet produce large EFVs, so the FREVUE vehicles were converted vehicles. Within this category we distinguish between small rigid vehicles (12ton and 13ton vehicles) and medium rigid vehicles (18ton and 19ton vehicles). In FREVUE (2017) we present two different TCO comparisons for the large EFVs, i.e. a TCO comparison for 12ton/13ton trucks (i.e. small rigids) and a TCO comparison for 18ton/19ton trucks (i.e. medium rigids). As the the break-down in costs is comparable for these rigids, we only present the TCO comparison for small rigids here. From the data provided by the operators we learned that insurance costs for the majority of the EFVs are higher. Insurances are a fixed percentage of the vehicle price, and as the EFV purchase price is higher, this implies the insurance costs are higher as well. The vehicle price is by far the largest cost-driver for an EFV, the required charging infrastructure and other variable costs are much lower. The maintenance costs are estimated to be lower for the EFVs than for the CFVs. Note that the initial issues that were reported with the converted vehicles are not explicitly taken into account here, as these costs were not specified in detail due to the fact that these were on the account of the converting company and part of the service costs. However, vehicles that do not operate also lead to an increase in costs for the logistics operator. After the initial teething issues experienced during the first few months, the large EFVs were reliable and operated as expected.

Figure 4 shows the difference in the TCO comparison between the EFV and CFV (both for 5 and 10 years depreciation and 120 kilometres per day). Obviously, in case more kilometers are made (which is possible with the batteries in these vehicles), the gap is slightly smaller and if less kilometers were made the gap is bigger. However, the big gap between the TCO for an EFV and the TCO for a CFV is mainly due to the high vehicle purchase price and the small TCO variations in the variable cost hardly matter. Note that the current EFV purchase price is (with 10 years depreciation) higher than the total cost of ownership for a comparable CFV (see Figure 4). Obviously, this high purchase price is partly due to the fact that a new CFV truck is converted into an EFV. As a result, one has to pay for the original CFV including the diesel engine. The diesel engine on its own is often sold for a low price (as there is no good market for it) and an electric drive line as well as a large battery pack have to be added to the vehicle. The gap in the TCO comparison between the large truck (i.e. the small rigid) CFV and the EFV is big, also when compared to the comparison for small vehicles and medium sized vehicles. The differences are even bigger for the comparison of 18/ 19 tons rigids. Note that the 10-year depreciation comparison assumes that the battery of the electric
vehicle will perform good during this period (i.e. expected cycle life of over 2500 cycles). If a new battery has to be put in, the comparison will be even more unfavorable for the EFV/

![TCO small rigid vehicle (including estimated residual value - 120 km / day)](image)

**Figure 4 – TCO small rigid vehicle (including estimated residual value - 120 km / day)**

5. **Short term future developments supporting the take-up**

The demonstrations in which EFVs were used to operate (for more than one year) in daily city logistics operations showed that these vehicles could perform the job, both technically and operational. However, the TCO comparison showed that for the large vehicles, which are needed to actually transport goods / volume, operating an electric freight vehicle is still more expensive. In this section we discuss to outcomes (that follow from an in-depth analysis in FREVUE, 2017) that could support further EFV uptake in city logistics in the near future, as this would be in line with several external developments, as well as the (logistical) requirements in several (sub)segments. Especially for home deliveries, including parcel deliveries, grocery home deliveries, food / meal deliveries battery electric vehicles are expected to perform well. Both due to the relative small roundtrips, as local depots from which the vehicle trips start are usually close to cities for these logistics segments, as due to the relatively small drop sizes (and therefore high number of stops that can be made with the relative limited vehicle volume), these type of city logistics operations fits bests. For other segments, we expect possibilities for battery electric freight vehicles as well (although financial feasibility is more challenging for larger e-trucks), such as HoReCa deliveries and even retail store deliveries. These vehicle roundtrips have in common that the often many (relatively small) drops are combined in a vehicle, and that the trips starts from a depot relatively nearby the city. As a result, the trip is relatively short in kilometers and relatively long in time (as the sum of the fixed times per stop adds up, in comparison to full-truckload deliveries in for example supermarket deliveries.

- Opportunity charging during operations: many of the EFVs we examined in FREVUE were over-dimensioned (in batteries); due to range-anxiety (during procurement) many vehicles are equipped with battery packs that can do more kilometers than follow from the worst-case scenarios. Battery costs, that form a considerable part of the procurement costs, can be reduced by using a smaller battery. However to maintain the required daily mileage, fast charging then needs to be applied (sometimes only for worst-case events). Fast charging costs more than slow charging, which means that although the investment in the battery will decrease, the speed with which this smaller investment can be earned back will also be reduced. Where the battery price is the main price differentiator between the
EFV and the CFV (as is expected with in-series produced EFVs), then reducing the battery size and (also) applying fast charging will decrease the earn back mileage. However if the price difference between the EFV and CFV is high and the battery price has less significance in this price difference (as is the case with CFVs that were converted into EFVs), then the reduction of the battery size in combination with applying fast charging might increase the earn back time (see also FREVUE, 2017 for more in-depth analyses).

- OEM availability: next to reducing the barrier for an operator to learn and examine how to procure a converted EFV (for all e-vehicles heavier than 3.5tons), it is also expected to make maintenance easier if OEM produce EFVs on larger scale (no initial issues, and higher product quality). It is expected to reduce the costs as well, as conversion is no longer required and scale advantages in production as well as battery procurement could be gained. Note that although this would provide a positive incentive for EFVs (especially if combined with policy towards zero emission city logistics), the transition will take time as OEMs are just starting to offer large vans (e.g. e-Crafter) and small rigids (e.g. e-Fuso), but have to build up production capacity. Ultimately, a short-term market stagnation where transport companies are waiting for robust OEM products can be anticipated, given that they are faced with uncertainties on the purchase of higher priced products from conversion companies. Here national or more localized legislation, and/or incentive programs, can play a significant role in encouraging the uptake of electric commercial vehicles in the next few years.

6. Concluding discussion

City logistics faces serious challenges in the near future, but at the same time the world is changing. Battery electric vehicles can deliver or pick up goods in urban areas without tailpipe emissions. However, there is no one-size-fits-all solution to transform the city logistics system, but following the specific logistics segments’ characteristics, opportunities arise to change towards a sustainable system.

The current developments also provide local authorities with ways to better steer city logistics and to provide tailored policies to incite the specific actors to change. The future solutions require suchlike tailored approach per logistics segment, which requires an in-depth decomposition of the city logistics in order to match trends, developments, opportunities and solutions. This contribution shows how the six main city logistics segments, i.e. general cargo, temperature controlled logistics, parcel and express mail, facility logistics, construction logistics and waste collection, could develop based on the identified (external) trends and developments. This contribution shows the segments with most chances for battery electric freight vehicles on the short term, both from financial as well as operational perspective.

At this moment the financial feasibility of EFVs in daily city logistics operations is still quite challenging, as follows from the various TCO comparisons. Only for small EFVs a short term feasible business case is possible, but these vans lighter than 3.5 tons have the disadvantage that the loading capacity hardly allows for any volume to be transported. For the larger vans and rigid trucks, a feasible business case is not yet possible from an operator’s perspective, often not even with subsidies. Once the vehicles are produced more by OEMs, barriers for logistics operators to use EFVs are expected to be lower, as the price is expected to drop (i.e. no more conversion costs, and scale advantages) and it becomes easier for operators to purchase EFVs, as these will be offered in their existing networks (i.e. they don’t have to get familiar with converting companies, invest time in setting up maintenance networks, and
collect information for setting up charging systems at their depots). Also, once operators become more familiar, and range anxiety is reduced during the procurement process, the operators might procure EFVs with lighter battery packs and so reduce the procurement costs even more. This will require new operating strategies, in which fast charging (opportunity charging), during the day is considered. The break-down in different segments shows that EFVs do not easily replace conventional diesel trucks for all city logistics operations. The operations that start from depots closely to the cities seem, from operational point of view, most favorable. From financial point of view, the more kilometers an EFV makes, the better the TCO comparison is for an EFV, so this contradicts operationally feasibility where short roundtrips are ideal.

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8. References

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