Validating Freight Electric Vehicles in Urban Europe

D1.3 addendum 1: State of the art of the electric freight vehicles implementation in city logistics - Update 2015

Work package: WP1 Assessment and ICT Framework

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## Glossary

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<th>Description</th>
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<tr>
<td>CDC</td>
<td>City distribution centre</td>
</tr>
<tr>
<td>CEV</td>
<td>Commercial electric vehicle</td>
</tr>
<tr>
<td>CO₂</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>EFV</td>
<td>Electric freight vehicle</td>
</tr>
<tr>
<td>EU</td>
<td>European Union</td>
</tr>
<tr>
<td>EV</td>
<td>Electric vehicle</td>
</tr>
<tr>
<td>FTL</td>
<td>Full truckload</td>
</tr>
<tr>
<td>ICE</td>
<td>Internal combustion engine</td>
</tr>
<tr>
<td>LTL</td>
<td>Less than truckload</td>
</tr>
<tr>
<td>TCO</td>
<td>Total cost of ownership</td>
</tr>
<tr>
<td>ULS</td>
<td>Urban logistics space</td>
</tr>
<tr>
<td>VAT</td>
<td>Value added tax</td>
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Executive summary

This FREVUE State of the art update 2015 is based on two main sources: i) recently published results (2013 – 2015) from the projects and demonstrations that include freight electro mobility in city logistics, and ii) the first insights from FREVUE project demonstrations. In order to provide a continuity of approach, the focus in this addendum, i.e. the update of FREVUE deliverable 1.3 ‘State of the art of electric freight vehicles implementation in city logistics (2013), is also on technological performance, operational performance, economics, environmental performance, social and attitudinal impacts, supporting local and governance structures of electric freight vehicles. The final discussion section also highlights more soft skills and process elements that contribute to actually implementing electric freight vehicles (EFVs) in daily city logistics operations.

Recent years have shown an increasing number of trials and demonstrators running EFVs in daily city logistics operations. In some countries EFVs are penetrating more and more specific niche markets. Running services and new demonstrations are continuously delivering new results on the performance of the electric freight vehicles in urban logistics. Technologies and business environments are not standing still so new success factors and barriers are emerging; this is the main reason for updating the 2013 State of the Art FREVUE deliverable 1.3 in this addendum.

Today technological performance and reliability of the vehicles still vary between specific vehicle types. In general, small EFVs are no longer seen as “trial” products but reliable vehicles, whereas large vans and trucks are still not produced on a large scale. Two issues that emerged are the lack of efficient manufacturer support in case repair is needed and clear need in the improvement of the ICT to support of EFVs’ operations. As more knowledge is gained on the batteries, charging procedures and the vehicles itself, the attitude towards the issue of limited range of EFVs is changing: there are more and more companies running EFVs in daily operations which are perfectly fine with the vehicle’s range. Even if in general charging does not represent a challenge, some FREVUE demonstrators had to adapt existing power grids and invest in additional charging infrastructure. Currently on-going EU-wide standardisation of grid-to-vehicle technology is very well perceived by all of the operators.

From the operations point of view there is now a common understanding that EFVs are suited for urban logistics. The focus is now more on finding out for which kind of operations within urban logistics practices EFVs are the most suitable and beneficial. In some cases, the delicate nature of supply chains needs to be taken into account in more detail. In any case the adjustment of operational processes or routes was necessary in the majority of cases and FREVUE demonstrators have illustrated that the use of EFVs requires at least more intelligent journey planning.

The purchase price of EFVs remains significantly higher compared to the conventional vehicles. Therefore, operators keep searching new forms of ownership of the vehicles and advantages in the daily operations in order to find viable business models. The procurement process for the small vans is now easier with more transparent information on OEMs available on the market. Even though regular maintenance costs are reported to be significantly lower, if the vehicle breaks, the repair costs can become really high. Investment in training of drivers, or hiring of drivers with a specific set of skills, is advisable by demonstrators.

FREVUE Deliverable 1.3 addendum 1 State of the art of the electric freight vehicles implementation in city logistics - Update 2015.
Finding a feasible business case for use of the EFVs is still considered a challenging issue. An active role is often expected from local authorities (in the form of privileges leading to operational advantages, as well as subsidies). At the policy level there is an understanding that non-monetary incentives are also very important as these are providing EFV operators with operational advantages and as a result lower operational costs. The main focus is now on choosing the right instrument and apply it in the way that intended effects are maximized. Certification was identified as an issue where regulatory support is necessary.

The positive social attitudes towards EFVs is confirmed: EFVs are in general very well perceived by the general public and receive positive feedback from drivers. Undoubtedly, environmental performance of the EFV is one of its main strengths, though, with the appearance on the market of freight vehicles running on other alternative fuels and strengthening of EURO standards for ICEVs, this competitive advantage of EFVs might reduce in the future.

It follows from the above that the main strength of EFVs remains being of environmental and social character and long term reduction in some operational costs. The main weaknesses that makes the EFV business case still problematic is the lack of big manufacturers producing large vehicles and providing efficient after-sales support as well as high procurement costs of all types of vehicles that is partly due to the high battery prices. Nowadays, the opportunities lie in the improvement of the vehicles’ technical performance and specifically in the increase of the vehicle payload and range, in order to increase its attractiveness.

Finally, this addendum presents actions or advice to local governments and transport operators that can contribute to a further uptake of EFVs in city logistics. Cities and regions need to reinforce cooperation between all the actors in the EFVs industry and go towards an operation within a clean mobility package, leading the way to successful business cases. From the perspective of the transport operators, a strong internal company support and commitment for the EFVs project is considered as very important as well as collaboration between different partners. These and other practical recommendations are detailed in the final section of this addendum.
1. Introduction

1.1 Towards zero emission urban logistics

Urban freight transport is a significant contributor to local emissions (i.e. NOx, elemental carbon and organic carbon) affecting the urban air quality and to global emissions (i.e. CO₂) affecting global warming. Poor air quality is a pressing problem in many urban areas as it directly affects the health of people and as a result the life expectancy of citizens. The World Health Organisation states that poor air quality is a serious health risk. Furthermore, many European cities are not meeting the agreed European standards for air quality (Directive 2001/81/EC), which can result in penalties. Therefore, it is not surprising that one of the major short term concerns for local authorities is to improve local air quality. In the longer term, the European Commission formulated the ambition to make urban freight transport emission free by 2030 (EC, 2011).

Albeit urban freight transport having these effects, it is of major importance to sustain urban life by providing both the supply of all goods (including the necessities of life) and the removal of all waste from the locations where people concentrate, i.e. the cities. Therefore it is necessary to continuously examine the possibilities of how to reduce the negative impacts while maintaining an efficient urban freight transport system. The use of zero emission vehicles could be one key element. One of the most promising technical solutions existing at this moment is the electric powered vehicle: it does not produce local emissions (from the tailpipe), and – depending on the way electricity is generated – has huge potential in reducing CO₂ emissions (see for example Quak and Nesterova, 2014).

However, the transition from conventionally powered diesel vehicles towards electric vehicles in urban freight transport is not an easy one.

1.2 Background and overview of FREVUE

FREVUE demonstrates the use of electric freight vehicles (EFV) in city logistics operations in eight European cities (see figure 1). The project is co-funded by the European Commission under the Seventh Framework Programme, Theme 7 Sustainable Surface Transport. It answers the call “Demonstration of Urban freight Electric Vehicles for clean city logistics”. Within the project the demonstration of EFVs is organized, covering a variety of urban freight applications that are common across Europe. This includes:

- goods deliveries (including food, waste, pharmaceuticals, packages and construction);
- new logistics systems and associated ICT;
- organisation with a focus on consolidation centres to enable the reduction of trips in urban centers;
- vehicle types (from small car-derived vans to large 18 tonne goods vehicles);
- climates (from Northern to Southern Europe);
- diverse political and regulatory settings that exist within Europe.
1.3 Deliverable objective

The FREVUE project is broken down into five work packages, which are described in figure 2. More information on the project is available at the FREVUE website (www.frevue.eu)

This addendum (i.e. ‘Deliverable 1.3 addendum 1 State of the art of the electric freight vehicles implementation in city logistics - Update 2015’) is an update of deliverable 1.3 (i.e. ‘State of the art of the electric freight vehicles implementation in city logistics’) from 2013. The main findings from deliverable 1.3 (2013) are copied in the appendix of this addendum. This update is written so that it can also be read on its own.

The main reason to update the earlier deliverable follows from the dynamic and fast changing situation around electro mobility and urban logistics. An increasing number of city logistics operations are performed in practice by electric freight vehicles (EFVs). And although this still often happens in the form of small scale demonstrations, the field of electro mobility and urban freight transport operations is rapidly changing due to the increasing
supply of electric freight vehicles (in area of small vans at least) and the local authorities’ and logistics service providers’ increasing interest in experimenting with zero emission urban logistics. These relatively fast changes in the field were the main reason to require updates by the EC of FREVUE’s state-of-the-art review that was published in 2013. This addendum contains the first update of the state-of-the-art review. A second update will follow at the end of 2016. The first results of this current update were presented at the ninth International Conference on City Logistics and published in the paper Quak et al. 2015.

1.4 Scope of the deliverable

Due to the current urbanization process which generates more freight volumes in cities, transport is being increasingly fragmented due to the success of light commercial vehicles and distances being stretched out due to the delocalisation of logistics platforms to the periphery - vehicle-kilometres of freight vehicles are expected to further increase in the future (Lebeau et al., 2015). That is why large-scale implementations are getting more important. Specifically electric freight transport is seen as a promising option to make urban freight transport operations more environmentally friendly. This contribution examines the barriers and possibilities that arise when actually using EFVs in daily operations. This document is a continuation on the state-of-the-art study on electric freight vehicles from 2013 (see Nesterova et al., 2013). In this updated state-of-the-art study we do not aim at repeating all insights and results that were presented in the 2013 study and are focused on identifying trends and changes that occurred in the period 2013 – 2015. For this update we follow the approach as presented in the memorandum dated 13 January 2015. One disclaimer has to be made: some logistics companies using EFVs, do not report or publish on the results of EFVs in practice. As a result, two main sources are used for this update:

1. Recently published results (2013-2015) from the projects and demonstrations that include freight electro mobility in city logistics;
2. The first insights from FREVUE project are presented.
2. Methodology

2.1 Approach for the addendum

In the memorandum ‘update and revise state of the art document’ dated 13 January 2015, a set of criteria was developed in order to perform the update of the state-of-the-art study.

First, in the review projects and demonstrators were selected that have papers or reports being published between 2013 – 2015 presenting the results from EFV implementations in city logistics or other relevant research papers on electro-mobility and city logistics. We have also checked updates from the projects reviewed in the previous State of the art version in order to build up on the existing project results.

We focused on publicly available reports and articles written in English. Worldwide geographical scope is applied. Focus was given to the informative results from projects/demonstrators and not on the announcements by the carrier on the start of the EV operation.

Next, for each source reviewed, we were particularly looking at the results concerning technological performance, operational performance, economics, environmental performance, social and attitudinal impacts, supporting local and governance structures and other striking results.

Finally, we looked at projects and research that focus solely on electric freight vehicles such as trucks and vans. Therefore, for example, no electric bicycles, tricycles and trams are included in the overview.

Two main types of sources were envisaged:

- An internet based literature research based on the following main key-words: City logistics AND electric vehicle; city distribution AND electric vehicle; electric freight vehicle; e-mobility logistics / freight; electromobility logistics / freight, as well as input from conferences and other relevant meetings (such as EVS and the Stakeholder forum¹), explained in more details in section 2.2.

- Input from FREVUE demonstrations and the case of TransMission’s Cargohoppers in Amsterdam. The FREVUE demonstration results come mostly from the information reported by the project partners in bi-yearly FREVUE process evaluation forms (up till now the forms from two reporting periods were available). This implies we include first insights from the FREVUE demonstrations in this update. Section 2.3 explains the cases.

2.2 Literature review update

The search performed within the criteria described above has resulted in a review of the projects and corresponding deliverables, papers and reports presented in Table 1.

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¹ EVS – Electro Vehicle Symposium and Stakeholder forum refers to e-mobility stakeholder forum.
## Table 1. Overview of the reviewed EU projects

<table>
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<th>Project Acronym/Duration</th>
<th>Project full title</th>
<th>Demonstration case</th>
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<tbody>
<tr>
<td>ENCLOSE (2012-2015)</td>
<td>Energy efficiency in City Logistics Services for small and mid-sized European Historic Towns</td>
<td>LuccaPort: up to date 6 EV’s and purchase of 3 more during the project duration (Italy) Trondheim city logistics: 15EV in Norway Post and planned to increase till 37 by 2015 (Norway)</td>
</tr>
<tr>
<td>SMARTFUSION (2012 – 2015)</td>
<td>Smart Urban Freight Solutions</td>
<td>Testing of EV and HV for distribution of perishable goods; testing of EV equipped with metering devices (Italy)</td>
</tr>
<tr>
<td>STRAIGHTST OL (2011 – 2014)</td>
<td>Strategies and measures for smarter urban freight solutions</td>
<td>Usage of 2 EV’s in DHL demonstration (Spain)</td>
</tr>
<tr>
<td>SELECT (2012-2015)</td>
<td>Suitable electromobility for commercial transport</td>
<td>The project’s central objective is to understand the technical and practical user requirements for using electric vehicles in commercial transport and to develop a set of methods for the fleet management of electric and mixed fleets.</td>
</tr>
<tr>
<td>NSR (2011 – 2014)</td>
<td>North Sea Electric Mobility network</td>
<td>WP7 focusing on promoting efficient and effective urban freight solutions in enhancing regional accessibility; investigating a lot of cases using different electric freight vehicles in Denmark.</td>
</tr>
<tr>
<td>Molecules (2011-2014)</td>
<td>Mobility based on eLectric Connected vehicles in Urban and interurban smart, cLean, EnvironmentS</td>
<td>Demonstrators in Berlin, Grand Paris area and Barcelona, including electric vehicles for municipality needs</td>
</tr>
<tr>
<td>C-Liege (2011-2013)</td>
<td>Clean Last mile transport and logistics management for smart and efficient local Governments in Europe</td>
<td>Demonstration in Stuttgart region</td>
</tr>
<tr>
<td>Tide (2012- 2015)</td>
<td>Transport Innovation Deployment for Europe</td>
<td>Electromobility cluster, studying, between other, clean urban logistics</td>
</tr>
</tbody>
</table>

Next, we also include the following reports and papers in this update (following from the literature research):

- Lebeau et al. (2015), Conventional, Hybrid, or Electric Vehicles: Which Technology for an Urban Distribution Centre?, The Scientific World Journal, Article ID 302867
2.3 Cases: FREVUE demonstrations and TransMission’s Cargohopper

Next to presenting only results that were reported in other projects, reports or papers, we also present experiences from the case of TransMission’s four Cargohoppers in Amsterdam which was already reported in the 2013 report, as well as from the FREVUE demonstrations actually running EFVs in daily operations.

2.3.1 TransMission’s Cargohoppers in Amsterdam

We provide more details on the case of TransMission’s Cargohoppers in Amsterdam, in comparison to deliverable 1.3 (2013) as the Cargohoppers started operations in Amsterdam in 2014. The transport company TransMission operates four electric freight vehicles in Amsterdam, the so-called Cargohoppers (as well as in Utrecht and Enschede). In order to perform logistics operations in Amsterdam with EFVs, TransMission developed a small truck-trailer combination, the Cargohopper 2 (see Figure 3). This vehicle is developed by order of TransMission and follows from the development of the early Cargohopper 1 that looked like a small road train (that was used in Utrecht). The first version of Carohopper 2 was deployed in Enschede. Lessons from these vehicles were taken into account, and as a result the Cargohopper 2 that runs in Amsterdam is, among other things, about 750 kilogram lighter than the comparable version in Enschede.

Prior to the implementation of the electric Cargohoppers, TransMission served Amsterdam from its depot in Almere (about 28 kilometers from the city center of Amsterdam) by six conventional vehicles, that either delivered pallets or parcels. In the new situation TransMission uses one large truck to transport all goods for the environmental zone in the Amsterdam city center to a micro-hub that is owned by removal firm Van Deudekomclose. As is discussed later in this contribution the search for this micro-hub turned out to be very challenging. After the depot was adapted to the requirements of the Cargohopper, TransMission performed its city logistics operations as follows: one big conventional truck brings pallets and parcels from Almere to the micro-hub. In the hub all goods are cross-docked to four Cargohoppers that combine parcel and pallet deliveries. The Cargohoppers make deliveries and pickups in Amsterdam and return to the micro-hub. From there a large truck brings the goods to the depot in Almere.

Figure 3 Cargohopper in Amsterdam and micro-hub (source: TransMission)

2.3.2 Current status of FREVUE demonstrators

We briefly present the current status of the different demonstrations in the eight cities that take place in FREVUE in the following sections. The main reason to discuss the current
affairs here is that we refer to the different demonstrations later in this addendum in the section on challenges and factors of success (see section 3). More detailed results of the FREVUE demonstrations will be presented in the future FREVUE WP3 deliverables (expected 2016 and 2017). The results that we use in this addendum follow from the process evaluation forms that all FREVUE demonstration partners regularly fill in. Twice a year each FREVUE project participant that is involved in demonstration reports on the activities performed in the reporting period, if there are any delays occurred, what are the barriers and facilitators of success encountered and lessons learned. Currently process evaluation forms for two reporting periods are available:

- reporting period 1 (April 2014 - September 2014)
- reporting period 2 (October 2014 – March 2015).

Table 2 illustrates for which FREVUE demonstrators process evaluation forms were received for two reporting periods. Reporting distinction is made between two main stages in the demonstrator process:

- preparation means that operator is in the stage of procurement and making all necessary arrangements to perform operation of the EFV;
- operation means that EFVs are physically running.

### Table 2. FREVUE process evaluation forms received in two reporting periods

<table>
<thead>
<tr>
<th>Project partner</th>
<th>Reporting period 1</th>
<th>Reporting period 2</th>
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<td>X (preparation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Lisbon, CTT</td>
<td></td>
<td>X (operation)</td>
</tr>
<tr>
<td>Lisbon, Municipality</td>
<td></td>
<td>X (operation)</td>
</tr>
<tr>
<td>London, UPS</td>
<td>X (preparation)</td>
<td>X (preparation)</td>
</tr>
<tr>
<td>London, Arup</td>
<td></td>
<td>X (preparation)</td>
</tr>
<tr>
<td>London, Westminster</td>
<td></td>
<td>X (operation)</td>
</tr>
<tr>
<td>Madrid, Calidad Pascual</td>
<td>X (operation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Madrid, ITEENE</td>
<td>X (operation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Madrid, CITY COUNCIL + EMT</td>
<td>X (operation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Madrid, SEUR</td>
<td>X (operation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Madrid, TNT</td>
<td>X (operation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Milan, Municipality</td>
<td>X preparation</td>
<td>X preparation</td>
</tr>
<tr>
<td>Rotterdam, UPS</td>
<td>X (operation)</td>
<td></td>
</tr>
<tr>
<td>Rotterdam, Municipality</td>
<td></td>
<td>X (operation)</td>
</tr>
<tr>
<td>Amsterdam/Rotterdam, TNT</td>
<td></td>
<td>X (preparation)</td>
</tr>
<tr>
<td>Amsterdam/Rotterdam, Heineken</td>
<td></td>
<td>X (preparation)</td>
</tr>
<tr>
<td>Amsterdam, Municipality</td>
<td></td>
<td>X (preparation)</td>
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<tr>
<td>Stockholm, Fortum</td>
<td>X (preparation)</td>
<td></td>
</tr>
<tr>
<td>Stockholm, Swedish Transport Administration</td>
<td>X (operation)</td>
<td>X (operation)</td>
</tr>
<tr>
<td>Stockholm, City of Stockholm</td>
<td>X (operation)</td>
<td>X (preparation)</td>
</tr>
<tr>
<td>Oslo, Bring</td>
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Below we present the current status of demonstrations within eight FREVUE cities.

**Amsterdam:** In Amsterdam three companies and the municipality are involved in the FREVUE demonstration: i) Heineken’s logistics service provider is using a 12 tons electric truck (Ginaf) to supply hotel, cafes and restaurant establishments in the city center, ii) UPS uses six retrofitted large electric vans (which looks like the typical UPS van form the
outside), and iii) TNT recently started operating 5 large retrofitted electric vans (based on Fiat Ducato chassis) for their express deliveries. In addition to subsidies the municipality of Amsterdam has taken complementary policy measures to make EFVs use more attractive. Those privileges are exemptions on traffic codes / regulations / rules, such as parking on sidewalks to load / unload, driving into roads that are only for pedestrians, etc.

**Figure 4. One Amsterdam demonstrator: TNT** (source: FREVUE)

**Lisbon**: The Portuguese postal company CTT uses 10 small electric vans (type Renault Kangoo ZOE) for post and parcel operations in Lisbon. Next, EMEL uses five small electric vans for maintenance of the on street parking and charging point infrastructure. The Lisbon local authorities are the third FREVUE partner in this local demonstration. The municipality looks at supporting policies for EFVs and already uses some EFVs for waste collection and gardening and city maintenance.

**Figure 5. One Lisbon demonstrator: CTT** (source: FREVUE)

**London**: For FREVUE UPS has 16 EFVs running in London. These are all retrofitted vehicles, this implies: a changed powertrain and refurbished old vehicle. These EFVs replaced existing round trips of diesel vehicles. The replaced round trips are less than 75 kilometers, so these do not exceed the daily range of the EFVs. In the other London demonstration Clipper uses two EFVs of ten tonnes for the operation of the consolidation centers in London. These EFVs make two round trips per day between the large consolidation center in Enfield 10 miles north of the London city centre and the smaller one at Regent Street in central London.
Madrid: The Madrid demonstration includes three operators and an UCC (Urban Consolidation Center). The operators active in the Madrid demonstration are: TNT Spain, SEUR (both parcel deliveries) and Pascual (dairy products). Currently four electric vehicles are running: two Renault Kangos (TNT and SEUR) and two larger vans for Pascual (Iveco Daily and Mercedes Vito). The local authorities decided to use an UCC in the FREVUE demo. After a search for an available suitable location, they found an old market for fruit and vegetables in the southern part of Madrid that was empty. Part of this old market is reconditioned to make it suitable for UCC, including charging infrastructure for the EFVs. The use of the UCC is offered for free to the operators in the FREVUE project, except for some really minor costs, e.g. the costs for cleaning, some maintenance issues, etc.

Milan: the Milan demonstration is slightly delayed due to several technical and legal barriers when trying to get a French-authorized electric freight vehicle with temperature controlled box vehicle to operate in Italy. A specialized logistics operator, i.e. Eurodifarm, specialist in the temperature controlled distribution of pharmaceutical, diagnostic and biomedical products to pharmacies, hospitals, third party distributors, nursing homes and patients, will operate two EVs in the demonstration.
Oslo: In Oslo Bring is the logistics company running the FREVUE demonstration. Bring uses subcontractors to deliver and pick up parcels. The company plans to operate 6 vehicles in the FREVUE demonstration, from which 4 are already operating. These EFVs are replacing existing conventional vehicles. The EFVs deployed are Peugeot Partners. The logistics concept is as follows: in the morning deliveries are made and in the afternoon pick-ups are done. Basically, the routes start at home, to the post office, to the Bring customers, doing pick-ups, to the post office and then back to home. Four different post offices are used to start 4 different EFVs operated routes.

Figure 8. Oslo demonstrator, Bring (source: FREVUE)

Rotterdam: In Rotterdam the Binnenstadservice’s local franchisee RoadRunner uses a Nissan eNV200 for its deliveries. TNT just started operating 4 large electric vans and UPS operates 4 large electric vans. Next, Heineken operates one large 19 ton electric truck (Hytruck). The city of Rotterdam is also active in FREVUE preparing a study in cooperation with the local grid operating company. The objective is to determine the spatial distribution of business vehicles (trucks and vans); derive the overnight charging requirement if all vehicles were electric; combine this spatial distribution of demand with the grid capacity; explore the possibilities of local energy production and storage in a pilot.

Figure 9. Two Rotterdam demonstrators, UPS and Heineken (source: FREVUE)

Stockholm: Originally one demonstration was planned with a construction consolidation centre (CCC) and EFVs carrying construction materials from the CCC to the construction sites. After one year as the capacity of the electric vehicle was too limited for all construction
deliveries, the electric van (Mercedes Vito) that was used to move materials from the CCC to the construction sites accompanied by two conventional trucks with hybrid cranes. Now Stockholm is examining the possibility for an UCC to deliver goods in the city centre using electric freight vehicles.

Figure 10. Stockholm demonstrator (source: FREVUE)

Nesterova et al. (2013) have indicated that the first massive trials / demonstrators of electric freight vehicles were undertaken more than 20 years ago. The main challenges faced then by operators in implementation of EFVs in city logistics were: high procurement costs, limited range of vehicle models, little or no after sale support and long waiting time for spare parts, low performance of the lead-acid, nickel – cadmium and ZEBRA battery technologies, limited mileage range, low vehicle speed and limited payload. In short, these early EFVs were far from perfect and were not a serious alternative for internal combustion engine vehicles (ICEV) in city logistics operations. The development of more reliable and better performing batteries was considered crucial for all types of electric vehicles to become (more) competitive to conventional vehicles.

FREVUE’s state of the art review defined a list of challenges and success factors for EFVs uptake relevant to demonstrators, trials and initiatives implemented before 2013. Now, two years later (i.e. 2015), there is more knowledge available on technical and operational performance of the EFVs as well as their economics. There is a shift in the attention focus in the discussions of what are the most critical success factors and barriers for wider deployment. We show how the field evolved over the last two years. Therefore the following sections present a follow-up (and are therefore complementary) to the state of the art review performed within FREVUE in 2013, showing the changes and trends structured according to the elements that were introduced in Nesterova et al. (2013): technical performance, operational performance, economics, environmental performance, and policy and governance.

3.1 Technical performance: from focus on range to the importance of aftersales

Back in 2013, it was reported that the range of EFVs is usually not larger than 100 – 150 kilometres. The range promised by the manufacturer was often not reached, although new(er) vehicles have a higher real range. Whether the range is a limiting factor depends on the logistics operations. Technical issues observed included: failing batteries (and limited or late) support, equipment availability issues, relatively long charging time and the necessity to adapt charging infrastructure for fleet needs. The rapid improvement in the technology was mentioned as a reason for waiting to acquire EFVs. The limited availability of standard vehicles and vehicle types (especially for larger vans and trucks) was also mentioned as a factor that is seen as a barrier for EFV implementation.

Today, technological performance and reliability of the vehicles still depends a lot on the specific vehicle type or model. Some companies are very happy with the vehicles deployed and based on this experience decide to increase the share of the EFVs in their fleet. These companies report that EFVs have an exclusive advantage of excellent acceleration and high torque, are comfortable to drive, and fast and flexible in urban traffic. The opposite cases also exist, where operators got really disappointed in the technological performance of a particular EFV type which further unmotivated them to continue using EFVs. The latter part is closely related to another problem that gains a larger focus today: lack of efficient manufacturer support in case repair is needed (in comparison to the quick support by existing dealer-networks for conventional vehicles).
In general, the increased insights in the EFV maintenance show that, when operating well, the regular maintenance of the EFVs requires fewer efforts compared to ICEVs. That is because EFVs have fewer moving parts than ICEVs, do not need regular oil changes, as regenerative breaking allows for less break wear. At the same time, almost in all cases where problems occurred, there was a lack of available resources for quickly solving technical issues with the vehicles (Pelletier et al, 2014). As Ninh et al. (2014) report, there are “only some garages where they know technical specifications of EFVs in order to fix them”. As EFVs are still relatively new products and only a limited number of EFVs are used per city (certainly in comparison to ICEVs) the availability of technical parts, as well as the availability of skilled servicemen to perform the repair quickly is not always guaranteed. In majority of broken-down cases the reported repair time is very long – sometimes up to several months (Ninh et al., 2014; TU Delft, 2013). As a result, companies experience limited flexibility as there are not always schemes providing a back-up service available yet. Few available cases have shown that retrofitted vehicles experience more technical problems than new mass produced electric vehicles (Baster et al., 2014). Next, a comparable EFV replacement vehicle is often not available, so as a result in case of problems the operators have to make use of ICEV-replacements.

Next, we noticed that the attitude towards the issue of the limited range of EFVs has changed. There are still remarks on insufficient range of EFVs. Of course, from the improvement of the EFVs range everyone will gain, but, currently, the latter concern also comes from the fact that companies through trial and demonstration processes are trying out to see to which kind of businesses and operations EFVs fit best. At the same time, there are more and more companies running EFVs in daily operations which are perfectly fine with the EFVs’ range. First, those who do not require high range in their operations and secondly those who have adapted their daily routines to the available range. Range-anxiety is reduced due to better knowledge on the actual range in daily operations and corresponding route planning. As Taefi et al. (2014) summarize, “whether or not an application is successful is largely case-specific and depends on whether the performance of the EV complies with the intended transport use for this vehicle”. In any case, it is now confirmed that factors temporary reducing available range are: extreme temperatures, driving style (e.g. rapid acceleration and high driving speed) and hauling heavy loads (see e.g. Pelletier et al, 2014; Vaicaityte et al., 2014; ENCLOSE, 2014). Taefi et al. (2014) also state that “the range listed by EV manufactures is based on measurements according to the New European Drive Cycle, which compared to real life energy consumption in urban last mile delivery do not give a reliable indication of the expected range”. This disparity of declared and real range is confusing for transport operators in the beginning of the operation of EFVs. This disparity is also noticed for ICEVs, as real life usage is different from testing on a roller test bench. However, logistics operators have more experiences using ICEVs and as a result in reading the ICEVs’ results.

In comparison to the 2013 state of the art study more knowledge on the batteries is available now: lithium-ion batteries used typically in current EFVs should last around six years (Pelletier et al, 2014). At the same time, typical battery warranty lengths for electric trucks have been reported as being in the three to five years range (Pelletier et al, 2014). Battery health can be influenced by the way they are charged and discharged, where frequent overcharging or frequent discharging to very deep levels can affect battery lifespan, just as keeping the battery at high states of charge for lengthy periods (Pelletier et al, 2014). Therefore, with time, the stability of the battery range becomes problematic (Taefi et al.,
2014). Multiple experiences show that only 80% of the marketed battery capacity is actually usable. There are also considerations to take the battery recycling policy of manufacturer into consideration (Vaicaityte et al., 2014).

Basically, four charging methods can be distinguished: in-house charging, public charging points, inductive charging and battery changing. In-house charging is the most common for the companies operating EFVs and public charging is usually seen as a positive supportive factor that provides operator with ability to charge when necessary in between tours. TU Delft (2013, German cases) comes even to conclusion that expensive public infrastructure is not necessary for charging as commercial EV’s are charged mainly overnight on company grounds. Charging time varies largely depending on the type of electric vehicle supply equipment and type of battery. Some cases were reported (Taeﬁ et al., 2014; FREVUE demonstrator: UPS) where in-house charging infrastructure was over-loaded by (or not sufficient for) the high capacity needs during simultaneous charging of several EFVs. Taeﬁ et al. (2014) report that other charging related issues appear, such as: “solutions to ensure charging in case of power outage are necessary; implementation of a smart grid and load management for large electrical fleets; charging plugs being too damageable and only specially trained staff being able to handle a plug”. In some cases improvement of the cable bound charging process was described as of a high importance: currently the cable can be unplugged by anyone, even while the vehicle is still charging (TU Delft, 2013, German cases). On the EU level, EU-wide standardisation of grid-to-vehicle technology is currently on-going and is very well perceived by the operators.

![Figure 11. Charging system in Rotterdam (at Heineken’s local depot, source: FREVUE)](image)

Improvement and sometimes standardisation of the software inside the EFVs as well as connecting EFV with a grid is an emerging issue gaining attention. There is a clear need in the improvement of the ICT support of EFVs operations in different application areas. As noted by Taeﬁ et al. (2014), “the introduction of an electric vehicle has resulted in some less optimal information processes due to the fact that the long distance transport (by regular truck) and short distance transport (by electric truck) were no longer in one pair of hands”. Conducted demonstrations have illustrated that, for example, dispatching software available
today is not yet ready to manage electric vehicles when it is necessary to take into account the remaining and predictable battery level (Taefi et al., 2014; TU Delft, 2013).

*Technical insights from FREVUE.* So far the majority of vehicles used in FREVUE do perform excellent from a technical point of view. Calidad Pascual (Madrid demonstrator) has reported frequent failures of the batteries because of which the vehicle had to be stopped for about 6 days. TNT in Amsterdam / Rotterdam demonstrator also experienced technical problems with the vehicle. Otherwise no problems or issues were reported and all vehicles performed as was promised by the manufacturers. Obviously, the vehicles have only been running for short periods so far (between a few months to about two years), but based on these observations we can say that the **small and medium EFVs are no longer 'trial' products** (as these were in the early 2000s), but **reliable vehicles.** As availability of the heavy EFVs is still extremely limited, they are still falling in the “trial” category.

The running FREVUE demonstrations showed that in some cases the existing power grid is not sufficient to actually charge the EFV fleet during the off hours at the depot. For example, the London demonstration showed that it was necessary to upgrade the power grid in order to charge the 16 UPS EFVs (and run the sorting machine) at the depot at the same time during the night. Grid upgrades are expensive for commercial vehicle fleets and are non-scalable. These upgrades (owned by the power-network company) have to be paid by the end user regardless of who is the owner. This is contradictory, because it requires a logistics service provider to make an investment in a network it does not own. UPS (London) stated that it was difficult to develop full technical and economic understanding of power infrastructure upgrade alternatives on a full life cycle NPV basis. Next, in this particular case the process of obtaining landlord permission for the necessary infrastructure upgrade works proved to be more complicated than anticipated. That is largely because there are multiple levels of ownership involved. Most other cases show that **some investments are necessary for charging infrastructure and sometimes in the grid** (for example in Rotterdam), but these investments are limited in comparison to grid investments that we saw in the London-demonstration.

### 3.2 Operational performance: fine-tuning urban logistics operations to EFVs

FREVUE’s 2013 review concluded that EFVs demonstrate both positive and negative operational performance characteristics compared to conventional vehicles. Because of their environmental performance and reduced noise level they are often permitted in larger geographical areas and wider time windows in cities where any of those restrictions exist. Some technological features, like an acute turning range, steering circle and improved visibility, facilitate the manoeuvring of the vehicles in dense city areas. At the same time, charging, load capacity, maintenance and the need to adapt logistic concepts for the usage of EFVs were seen by operators as the main existing operational challenges. Not all freight operations were considered suitable for using EFVs, which is particularly the case for the long-haul operations and operations requiring large loading capacity. In terms of range, payload and overnight charging, current EFV performance levels are good enough for city distribution operations.

Today the majority of these conclusions remain the same. The common understanding is that **EFVs are suited for urban logistics.** Therefore, the focus has shifted to finding out for which kind of operations within urban logistics practices EFVs are most suitable and beneficial. Electric freight vehicles have already been tested for many urban freight transport
tasks: post and courier delivery, pizza delivery, garbage collection, cash managing companies, on-line supermarkets, etc. The overall agreement is that light electric freight vehicles are best suitable for “duty cycles in (sub-)urban areas involving a low daily driving range and a relatively low load capacity” (ENCLOSE, 2014). Combined with limited payloads, this makes them best suited for last mile deliveries in compact cities involving frequent stop and go movements, limited route lengths and low travel speeds (Pelletier et al, 2014, ENCLOSE, 2014). Ninh et al. (2014) additionally refer to the size of the company: “in some companies, EFVs might fit well in their business, because they deliver small parcels and use small ICE vans anyway. Then it would not be a big problem for them to switch to EFVs with the same size. For bigger companies, which transport large amounts of goods every day to the inner city, it would be hard for them to pay more for the labour cost in order to switch to smaller vehicles”.

At the same time the delicate nature of some supply chains needs to be taken into account. For example, in case of FREVUE demonstrator in Milan, dealing with distribution of pharmaceutical, diagnostic and biomedical products, a specific technical expertise and professional knowledge of handling drugs is required. EFV equipped with temperature controlled boxes were chosen which are not yet wide-spread on the market. The temperature controlled boxes needed to be built up by manufacturers which entailed additional delays and costs.

As mentioned before, satisfaction with a range is case specific with some operations within city logistics being more suitable for the currently available range than others. From one side, as stated by Leal et al. (2014), “the low range (in average 100 km) of the electric vehicle is not an obstacle to the reliability of the urban freight transport business: the travel distance is often known in advance and the travel routes can therefore be optimized to fit the range of the electric vehicles”. From another side, as Baster et al. (2014) conclude, “when a distance travelled by ICEs in a company is higher than the range proposed by EFVs, this decreases the flexibility for the business – as in need for additional vehicles at the longer routes, they simply cannot serve them”. Currently transport operators using EFVs are finding their ways in adapting their routines to the available vehicle range.
In any case, the adjustment of operational processes or routes was necessary in the majority of cases. Taefi et al. (2014) state that “direct substitution of conventional commercial vehicles with EVs does not fully exploit the strengths of EVs, hence often leading to operation that is simply not profitable”. Therefore, adaptation of logistics concepts is necessary in order to achieve the profitability of the EFV business case. On the level of the urban planning, two main combinations of measures are currently being implemented: consolidation of supply (deployment of EFVs in combination with urban logistics centres) and consolidation of demand (combining deliveries to one area from multiple suppliers).

Loss of payload due to heavy batteries remains a valid issue. EFVs are, due to the weight of the batteries, heavier than comparable ICEs. As a result, EFVs become heavier than 3.5 tonnes, whereas the comparable ICE is lighter. Therefore a professional driver is required for the EFV (i.e. C license versus B). The costs for a driver with a C license are higher. As TU Delft (2013, German) reports “the loss in payload of 200 – 250 kg is critical. Maximizing the gross vehicle weight is not a solution. When operating a truck over 3.5t, the driver needs a truck license and a profession driver’s qualification. Exemptions for EVs due to additional battery weight are needed, to be able to operate the EV with a similar payload in the same vehicle class as conventional cars”. In some countries, for example the Netherlands\(^2\), this exemption exists, which makes it possible for drivers with a B license to drive an electric freight vehicle that is heavier than 3.5 tonnes, so that a company does not need to find a new driver if it replaces a large conventional van or small conventional truck with a EFV. If such an exemption does not exist, an extra barrier rises for transporters to use EFVs in their operations.

Operational insights from FREVUE. FREVUE demonstrations (e.g. UPS, Rotterdam demonstrator, TNT, Amsterdam/Rotterdam demonstrator) provide good examples of logistics (re)organisation via direct replacement of internal combustion engine vehicles by EFVs. Simply replacing a conventional vehicle with an electric vehicle seems to be the easiest way to use electric freight vehicles in urban freight transport operations. However, most of the time this is not an optimal solution, as the logistics organisation was designed for ICEVs. Still, some routes have the characteristics that perfectly fit EFVs, i.e. parcel or post deliveries. Usually, these trips cover short distances, have a high drop density and start from depots close to cities. FREVUE examples of CTT (Lisbon), UPS (London) and Bring (Oslo) show that this is indeed the case. Replacing an ICEV can be done by operators if the round trips that were performed fit the limitations of EFVs, especially the limited range of an EFV compared to an ICEV.

From the demonstrations we learned that in many cases replacement does not mean that there are no additional efforts. For example, the use of an EFV requires more intelligent planning. In the case of RoadRunner (Rotterdam) the EFV replaces a conventional vehicle on a route. However, during or after this fixed round trip planners used to plan pickups for the conventional vehicle, whereas for the replacing EFV this results in issues with the vehicle range. So in planning extra variable pickups after the fixed round trip to this vehicle, the EFV had an extra constraint. Another FREVUE example where the EFVs also replaced existing ICEV round trips is London demonstrator (UPS). There, the challenge with EFVs is the following: at UPS the vehicles follow a very tight routine at the depot, such as washing and fuelling, loading and unloading. With the ICEVs this routine is easy and fast. With an EFV

\(^2\)https://zoek.officielebekendmakingen.nl/stb-2010-33.html (in Dutch)
there is less flexibility as these have to be planned at a charging location (where it should be for about eight hours). All vehicles are running from e.g. 8am to 6pm, so then these are away from the depot. Between 6-10 pm the vehicles are washed and fuelled / charged. Next, the conventional vehicles are four hours idle and from 2am these are off for inbound logistics operations again. These four hours are too short to charge the EFVs fully. So operations at the depot have to be planned around the charging of the vehicle. As a result the vehicles are charged at the time that most electricity is used (e.g. the sorting machines, as this process also takes place in the late evening / early night).

**Adaption the logistics concept: introduction of a hub**

Another way to use EFVs in city logistics operations, in cases where replacement of the vehicles is not possible due to e.g. range issues, is to make use of a hub. Most parcel and postal companies already make use of a dense hub network, which makes these types of operations very suitable for the use of EFVs in the last mile. Several examples exist where hubs are introduced as a starting point for city logistics operations with EFVs.

**TransMission:** in order to make deliveries in Amsterdam, TransMission needed a location where it could cross-dock deliveries from the conventional vehicles to the Cargohoppers. The search for a hub at the right location (i.e. south east of Amsterdam, at the route from Transmission’s depot in Almere to the city centre of Amsterdam) took over two years, even though the local authorities were very helpful in and during this search. Many warehouses and locations were examined, but very often issues like opening hours, available space, etc. did not match TransMission’s requirements to operate its four Cargohoppers. After a search of over two years, and being close to abandoning the entire plan of making zero emission deliveries to Amsterdam, the hub was found. The removal firm Van Deudekom allowed for the necessary changes in one of their warehouses (e.g. charging infrastructure, adapting docks to the Cargohopper) and in 2014 the Cargohoppers started operating in Amsterdam. Cross-docking at this microhub enables TransMission to have operational advantages (combined parcel and pallet networks) in Amsterdam and a consolidated flow between the microhub and TransMission’s existing warehouse in Almere that can be performed by a big truck.

**Madrid’s Urban Consolidation Center (UCC) in FREVUE:** the local authorities redeveloped an unused market place to an UCC with facilities for charging and cross-docking for the FREVUE demonstrators in Madrid. This facility enables the carriers to operate in Madrid with EFVs at low costs, as the use of this UCC is, except for some services, free for them. This UCC is used for cross-docking deliveries and pickups from EFVs to conventional vehicles (and the other way around) and charging the EFVs. There is no bundling of loads between the users of this facility.

**Stockholm’s Construction Consolidation Centre (CCC) in FREVUE:** the CCC has a temporary structure as it will be moved during the 15 years of construction development. The city of Stockholm owns the CCC and an operator, who won the tender, runs the operations. Since the city owns the land on which construction takes place, local authorities could require the use of the CCC in the building regulations. The city is also a developer itself, and from that role it can also require the use of the CCC by builders. All vehicles carrying limited volume (i.e. less than about 5 euro pallet places) that deliver to the building sites have to unload at the CCC. When construction started, most deliveries from the CCC to the actual construction sites were transported by the EFV. However, in early 2014 the volume of goods
The purchase price for EFVs is significantly higher than for conventional vehicles. That is explained by the high battery cost and limited production volumes of these vehicles. Nesterova et al. (2013) state of the art report states that in the longer term it is expected that EFVs will become more competitive (especially from a TCO perspective), incorporating savings from the improved operational performance, reduction in purchase prices due to the massive production and associated environmental benefits. Currently, as operators are usually more focused on short term benefits, the wider uptake of electric vehicles is difficult. The fact that the second-hand market and residual value of EFVs are not yet clearly known holds back some of the operators in their purchase decision. Leasing and financing companies are also reluctant to invest due to these uncertainties. Battery leasing or swapping options are regarded as potential options to reduce vehicle purchase and operational costs. These main conclusions remain the same two years later: on the one hand the purchase price is higher and on the other side energy and maintenance costs are (or could be) lower than for conventional vehicles. On top of the high purchase price, transport operators working in the extreme weather conditions or within supply chains with specific requirements often have to invest into additional heating or cooling systems of the vehicle.

Procurement for the small vans is seen easier now with more transparent information on OEMs providing EFVs as well as different models of EFVs available on the market. The literature review as well as FREVUE experiences have demonstrated that for the large EFV a very small supplier base exists which is a very big problem. Transport operators declare “not to have a serious offer from the OEMs in this segment” (TNT, Amsterdam/Rotterdam demonstrator).

Energy saving has been up to now considered as one of the main competitive advantages of the EFVs. At the same time, TU Delft (2013, German cases) reports that energy demand is...
higher in last mile operation than average values listed by operators. Also, some counter-arguments to this benefit start to appear. TU Delft (2013, German cases) reports that “the price of electric energy is influenced by the shutdown of nuclear reactors, additional renewable power plants and further construction of the power grid. Therefore these factors need to be closely monitored as profitability of EVs is influenced by the price of electric energy” (TU Delft, 2013). Pelletier et al (2014) indicate that commercial EFVs will also have to compete with other fuel alternatives such as compressed natural gas, in which case the business case can be harder to make. Further significant improvement in ICEs efficiencies is expected in upcoming years which could also reduce “the environmental” advantage of EFVs.

Even though regular maintenance costs reported so far for EFVs seem to be significantly less (20-30% lower) than for ICEVs (Pelletier et al, 2014; TU Delft, 2013, German cases ), the main problem is that if the vehicle breaks, the repair cost becomes extremely high. That is the case because of the high price of small repairs as well as because “EV technology is not as well developed as its ICE counterpart and still only very few people are trained and educated to repair EVs” (Ninh et al., 2014).

**Hiring of additional drivers is reported as a potential additional cost of EFVs** compared to ICEVs. This happens, because an EFVs driver has to have a different set of skills, e.g. identification with technology, understanding the need for an economic driving style and an ability to communicate advantages of EVs to customers (TU Delft, 2013, German and Danish cases). In any case, there is an agreement that there should be a certain investment in training of drivers: both on operation of EVs and related to its eco-driving.

Another point of discussion is how the business case of EFVs can be improved. Taefi et al. (2014) make an overview of options available to reduce the TCO of EFVs: i.e. reduction of capital investment (e.g. purchase price subsidy), increase in vehicle range (e.g. implementing slow and quick charging, implementing battery changing system or installing solar panels on the roof of the vehicle), increase of the EFV turnover (by communicating the green image, benefiting from additional privileges provided by local authorities), further decreasing the operational expenses (charging off peak hours allowing for reduced electricity rates). Also, some companies, for example, Greenway in Slovakia, start offering EFVs leasing services.

**Economical insights from FREVUE and TransMission.** The FREVUE demonstrators have confirmed that the availability of EFVs varies: in general the market for smaller vans is reasonably well developing (EFVs smaller than 3.5 tonnes), whereas larger vans or trucks are often tailor-made or produced in smaller batches. As reported in FREVUE periodic reports, EFVs larger than 3.5 tones are not yet a proven technology and big OEMS are not providing them to the wider market (e.g. TNT and Heineken, Rotterdam and Amsterdam demonstrators). Small companies see this as an opportunity to take a leadership role but have problems in assembling EFVs because of a lack of financial resources as well as experience. Therefore, most of the vehicles used in the category of larger vans are retrofitted vehicles, for example UPS (Rotterdam demonstrator) changes the powertrain and refurbishes the old vehicle, whereas TNT (Amsterdam/Rotterdam demonstrator) makes use of retrofitted vehicles on a new Ducato chassis.
Another difficulty reported regarding the procurement of large vans is that production of the batteries takes place when the producers have enough orders to produce them all together which can cause delivery delays (Heineken, Amsterdam demonstrator). In FREVUE two of Heineken’s logistics service providers are using an electric truck at this moment (one 19 tonnes truck and one 12 tonnes truck), which will be increased to seven trucks in total. Suppliers of equipment reported that they were not licenced to import some engine parts necessary for battery production. These procurement difficulties translate into increased procurement costs.

Smaller vans (less than 3.5 tonnes) are more expensive than conventional vans with an order of magnitude about twice the procurement price. Larger vans (between about 3.5 and 7.5 tonnes) that are often retrofitted show an order of magnitude about twice to four time the procurement price of a comparable conventional vehicle. Trucks (more than 7.5 tonnes, up to the 19 tonnes truck that Heineken uses in the Rotterdam demonstration in FREVUE) can be about four / five times or more as much in procurement. Demonstrators also confirm cost advantages of EFVs, such as the use of electricity instead of diesel, tax reductions, and subsidies.

Finding a feasible business case for use of EFVs in city logistics operations is still a challenging issue. Following the line of reasoning as described in Quak et al. (2014), we see that using an EFV in city logistics mainly affects the cost-side. On the one hand, investment costs increase due to higher vehicle prices, reorganisation of planning, use of extra locations, etc. Costs advantages also occur due to the use of electricity instead of diesel, which can be considerable (sometimes up to 80%) and some other advantages that are discussed in the following sections. On the other hand, the use of EFVs does not usually result in extra revenues as most customers do not want to pay more for zero emission deliveries, although some FREVUE demonstrations (e.g. city of Amsterdam) do examine possibilities to include zero emission deliveries as favourable in the procurement of products or services. However, if there are no extra revenues, it is important to find ways to make the business case.

One of these examples where operational advantages were found is the case of the Cargohoppers in Amsterdam. In the baseline scenario when all deliveries were made by conventional vehicles TransMission ran two networks in Amsterdam: one for parcels delivered by vans and one for pallet-loads (or bigger) delivered by trucks. These networks overlapped geographically. In the new situation all deliveries are brought to the micro hub where further sorting is done for the four Cargohoppers. The networks that were separated are combined in this new situation and as a result TransMission requires fewer kilometres (both in Amsterdam and in the trips from the depot in Almere to Amsterdam and back), which is an operational advantage.

3.4 Environmental, social and attitudinal impacts: confirmation of positive trends

Undoubtedly the main strength of EFVs currently continues to be its environmental performance, manifested in reduced CO₂ emissions (depending on how the electricity was generated) and almost absent tailpipe and noise emissions compared to ICEs. This implies that EFVs’ engines do not contribute to deteriorating of cities’ air quality, as no NOx or PM is emitted by their engines. The good environmental performance (local and global emissions)
was also mentioned in the 2013 deliverable 1.3 as the most important advantage of EFVs in comparison to other types of vehicles. For the full picture well-to-wheel emissions need to be considered and therefore certification of the electricity supply is important. Being less noisy and more environmentally friendly than conventional vehicles, EVs continue to be very well perceived by the general public and receive positive feedback from drivers in most of the initiatives. However, as mentioned before, with the appearance on the market of freight vehicles running on alternative fuels and with the strengthening of EURO standards for ICEVs this competitive advantage of EFVs might reduce in the future.

Some companies look at their experiences with EFVs as a clear opportunity, e.g. “the early implementation of electric mobility in courier and express services gave as a head start over the competition to learn about the new electric vehicle technology and the processes that need to be tailored in the daily workflow” (TU Delft, 2013, German cases). Baster et al. (2014) report that “the green image is perceived as a future investment and not as an investment which can provide profit today”. Companies report that utilisation of eco-friendly vehicles helped them to strengthen the relationship with existing customers and gain new ones. The majority, however, remain reluctant based on the financial case of EFVs. As was summarised by one transport operator: “about 98% of customers are looking at the price and delivery service. So if price is a bit higher, because the company is driving EFVs, very few customers would be interested in it” (Ninh et al., 2014).

Training is necessary in order to familiarize drivers and general transport operators with the technical and operational particularities of the vehicles in order to achieve better results from the vehicle performance. After utilizing the EVs for some time, the drivers report to be very positive about the EVs performance and comfort. Some are saying to be proud in driving a vehicle that does not pollute. From TransMission we learned that not all drivers are suitable for driving EFVs, as they do not succeed in conscious driving.

3.5 Local policy and governance structure: to a more integrated city management approach

Supportive government policy is still of high importance for the wider uptake of EFVs. Initially financial subsidies were largely used. Nowadays there is an understanding that non-monetary incentives are also very important, as financial ones are not sustainable on a longer term. A better way to support the mass adoption of the alternatively fuelled technology is to give them a long-term competitive advantage.

A variety of instruments are available for local policy makers: financial incentives that aim to reduce upfront costs of electric vehicles and charging equipment (e.g. purchase subsidies and all forms of tax exemptions) and prioritized access initiatives (e.g. access to high occupancy lanes; exemption from road tolls; extended delivery time window; exemption from maximum weight restriction; preferential parking, etc.). However, the main question for the local policy makers today is not only which instrument to choose, but also how to apply it in the way that intended effects are maximized and that reduces unanticipated effects (Van der Steen et al., 2014). Moreover, in case of financial support through the preferential taxation of the EFVs, it is recommended that the value tax being put on a vehicle should not aim to encourage a specific vehicles “technology”, such as electric vehicles, but should be depended on the level of pollution produced by specific fuels (Baster et al., 2014). This way vehicles reducing pollution in the most cost effective way are chosen.
Policy insights from FREVUE and Transmission. Since EFVs in all categories are more expensive to purchase, an active role of local authorities is often expected to make their business case. Arup (FREVUE partner for the London demonstrator) reports “public sector levers such as policy (e.g. Ultra Low emission zone) are strong allies in building the case for EVs and CCs”. In FREVUE demonstrators three instruments are used in cities to promote the uptake of EFVs:

- Subsidies – most of the FREVUE vehicles are partly (i.e. a part of the marginal costs compared to a conventional vehicle) funded through the project. Some local authorities also have subsidies in place for the procurement of EVs, e.g. Amsterdam.
- Some of the FREVUE demonstrations use favorable taxation schemes like no congestion charge for EFVs, no parking fee, or no road tax to make the business case more attractive for EFVs. Some of these instruments focus on electric vehicles more generally rather than just EFVs. For example, carriers do often not pay parking fees when making their deliveries, so there is no actual operational advantage for EFVs if these vehicles do not have to pay a parking fee.
- Supportive policies such as entering (low) emission zones, use of bus lanes, parking at non loading areas, wider time access restrictions, and possibilities to enter pedestrian zones can result in operational advantages (as is demonstrated in the Amsterdam demonstrator). One main outcome of this demonstration is that drivers experience less pressure, as EFVs are allowed to load and unload at more areas, resulting in fewer fines and discussions with enforcement officers, fewer aggressive traffic participants that have to wait for blocking vans that are unloading and faster round trips in the city centre. At the same time, some environmental zones do not apply to vans and as a result in these cities there is no operational advantage for electric vans at this moment (see for example Rotterdam, Madrid demonstrators).

Certification is another issue where regulatory support is necessary. This is the case both for EFVs that are developed in small batches, for example the Cargohoppers, but also the larger trucks as for Heineken. The requirements are strict: all vehicles, as these are often tailor made or specifications slightly differ in batches, have to be tested to get a certificate. These extra certification costs add to the already high prices. No certifications based on standard components are yet allowed.

Another issue, following from the FREVUE demonstration in Milan, is that a vehicle that is approved for one country is not automatically allowed on the road in another European country. The partner who provided the vehicles for Milan is French and the vehicle has a special certification to circulate in France which is not recognised in Italy. As a result, the already limited supply of electric refrigerated vehicles in Italy is further reduced.

3.6 Summary

Today, the technological performance and reliability of the electric freight vehicles still depends on the specific vehicle type. In general, small and medium EFVs are no longer seen as "trial" products but reliable vehicles. Lack of efficient manufacturer support in case repair is needed and clear need in the improvement of the ICT support of EFVs’ operations, are, however, two emerging issues.
As more knowledge is gained on the batteries, charging procedures and the vehicles themselves, the attitude towards the issue of limited range of EFVs is changing: there are more and more companies running EFVs in daily operations which are perfectly fine with the vehicle’s range. Even if charging does not generally represent a challenge, some FREVUE demonstrators had to adapt the existing power grid and invest in additional charging infrastructure. On-going EU-wide standardisation of grid-to-vehicle technology is very well perceived by all of the operators.

From the operations point of view there is now a common understanding that EFVs are suited for urban logistics. The focus is now more on finding out for which kind of operations within urban logistics practices EFVs are most suitable and beneficial. In some cases, the delicate nature of supply chains needs to be taken into account. The adjustment of operational processes or routes was necessary in the majority of cases and as FREVUE demonstrators have illustrated the use of EFVs requires at least more intelligent journey planning.

The purchase price of EVs remains significantly higher compared to that of conventional vehicles. Therefore, operators keep searching for new forms of ownership of the vehicles and successful business models. The procurement process for small vans has become easier with more transparent information on OEMs available on the market. Even though regular maintenance costs are reported to be significantly lower, if the vehicle breaks down, the repair costs can become very high. Investment in training of drivers, or hiring of drivers with a specific set of skills, is advisable by demonstrators.

As making a successful business case for use of the EFVs is still considered a challenging issue, an active role is often expected from local authorities. At the same time, at the policy level there is now an understanding that non-monetary incentives are also very important as they give operators of EFVs long-term competitive advantages. The main focus is now to see how to choose the right instrument and apply it in the way that maximises intended effects. Certification was identified as an issue where regulatory support is necessary.

Finally, there is a confirmation of positive social attitudes towards EFVs: they are in general very well perceived by the general public and receive positive feedback from drivers. Undoubtedly, environmental performance of EFVs is one of their main strengths, though, with the appearance on the market of freight vehicles running on other alternative fuels and strengthening of EURO standards for ICEVs, this competitive advantage of EFVS might reduce in the future.
4. Main strengths and weaknesses determining EFV uptake

Despite of the increased availability of vehicles and information about the EFVs on the market as well as technological progress that is made, the main strengths of EFVs continue to be of an environmental and social nature. In most of the reviewed papers, no distinction is made by vehicle size. In general, we see that the supply of small vans (less than 3.5 tonnes) is increasing and getting more competitive in comparison to conventional vehicles. For the larger vans (between 3.5 and 7.5 tonnes) and trucks (more than 7.5 tonnes) the market is still relatively small and many vehicles are tailor-made or specifically retrofitted. Most of the reviewed studies concern small vans and some large vans. Electric trucks are hardly used or reported on. The next FREVUE state of the art update (i.e. end of 2016) will specify conclusions based on different vehicle sizes, if possible, as economic issues as well as operational performance and development is different for the different vehicle categories.

The main weakness that makes the EFV business case still problematic is the lack of manufacturers producing large vehicles and providing support via dealer-networks as well as the high procurement costs that are partially due to high battery prices. Operational specifics are increasingly integrated into the daily routine of the companies neither representing a big challenge nor an operational advantage. The opportunities lie in the improvement of the vehicles’ technical performance and specifically in the increase of the vehicle payload, in order to increase its attractiveness. Finally, main threats are related to the improved environmental performance of vehicles running on alternative fuels.

Based on the review performed in previous sections and FREVUE demonstration experiences we can define the following SWOT (strengths, weaknesses, opportunities and threats) analysis for the implementation of EFVs in city logistics:
Strengths:
- Low fuel costs
- Efficiency of operation in case of government support
- Good environmental performance
- No noise from vehicle
- Positive acceptance by public and drivers
- High driving comfort and less pressure for drivers
- Lower operational costs
- Available charging infrastructure

Weaknesses:
- High procurement costs
- Limited loading capacity
- Limited, unreliable and/or expensive after-sales support
- No better revenues (limited no. customers paying more) for EV deliveries
- Grid issues with large fleets
- Limited market supply of large vans and trucks
- Imprecise range and energy saving estimation
- Incompatibility of purchased EVs’ plugs with public charging infrastructure
- Insufficient ICT support

Opportunities:
- New(er) vehicles have higher range
- Adaptation of logistics concepts to EFVs
- Well-fitting to the specific niches
- Increasing availability of public charging points
- Innovative vehicle/battery leasing schemes and sustainable investment schemes
- Decrease in battery price

Threats:
- Unclear regulation regarding certification
- Better environmental performance of vehicles running on alternative fuels
- Low oil prices and increasing electricity prices
5. Conclusion

In this updated state of the art document we discuss the current tendencies in the implementation of the electric freight vehicles in urban logistics. Results from FREVUE and the case of Cargohopper in Amsterdam are combined with reviewed trials and running activities.

Where EFVs in the early years received mainly criticism about the limited range, now transport operators are shifting their attention to how to better adapt their operations to deal with the smaller range. EFVs are perfectly fitting the requirements of urban logistics, especially within small and medium sized cites. Currently, the focus is on defining which kind of activities in city logistics can benefit most from the EFVs case.

The business case, for operators, for using an EFV is still suffering from high purchase price of the vehicle and uncertainty about its residual value. Companies as well as local authorities are trying to find ways to improve the TCO of electric freight vehicles by acting on other cost elements.

At this moment in time, local authorities’ support is still a critical factor for the successful uptake of EFVs, which is more than only subsidizing at the procurement phase, e.g. privileges can result in operational advantages. There is a growing understanding that even though financial incentives are currently the most powerful in order to support the market uptake of the vehicles, in the long term a more integrated city management approach is necessary. The focus is shifting towards more non-monetary measures and general support of the less polluting vehicle technologies.

Lack of qualified and reasonably priced aftersales support, the necessity to develop new ICT concepts both for in-vehicle and for vehicle-grid connection, and the absence of proper certification mechanisms, are reported as important challenges at the moment.

In summary, the demonstrations show that the current generation of EFVs next to the good environmental performance, in overall terms have a good technical performance. In general, companies using EFVs are satisfied and often look at opportunities to deploy more EFVs. Obviously still some barriers have to be levelled, but the solutions to do so are far from insuperable, as also noted in this paper.

Next Steps

The next state of the art update will be performed at the end of 2016. The objective of the document will be to collect new insights in the implementation of the EFVs in city logistics from existing cases (literature study) and to further focus on the experiences from FREVUE demonstrators. That will be the last D1.3-update before the FREVUE project finalisation. Therefore, in addition to the regular review of the technological, operational and environmental performances, economics, social and attitudinal impacts, supporting local and governance structures factors, we will present an analysis of trends (evolution of strengths and weaknesses, opportunities and factors of success) in the field. Concrete recommendations based on the FREVUE experiences will be developed.
6. Other factors for success: soft skills and process

6.1 Make it fun and interesting

In addition to the categories (technology, economy, social, environment and policy) that were discussed in this addendum, FREVUE demonstration partners also provided other factors that contribute to success or could be a barrier when implementing EFVs in daily logistics operations. These factors, mostly on soft skills and internal organization, were captured in the process evaluation forms. This update of the state of the art review (section 1-5) followed the elements that are usually discussed in most project reports and papers on EFVs, where usually these soft skills and project issues are not mentioned at all.

We report these elements, as these can be either challenges or success factors, and therefore contribute to the wider uptake of EFVs in city logistics and can as such be useful for other logistics operators considering implementing EFVs. Many of the factors in this section apply more to innovations and projects in general, and maybe less to EFVs or city logistics in particular. This section only presents the (process) feedback and lessons of FREVUE demonstration partners (both cities and operators) as was experienced in practice, and no additional research on these topics was conducted.

This section’s title comes directly from one of the FREVUE partners; as there are many barriers, and making changes and finding support (also in the own organization) could sometimes be more difficult; it is important to highlight (also for external parties) that doing something new could (or should) be fun and interesting. Do this in a serious way could also increase EFV uptake in city logistics: EFVs could use a high profile champion to ‘glamourize’ the industry, supported by a high profile marketing campaign (similar to, for example, Tesla for passenger EVs).

6.2 Broad collaboration is vital

Public sector support is necessary in order to make the implementation of EFVs in city logistics successful (see also FREVUE deliverable 1.3, 2013). From the perspective of cities and regions this implies a strong and broad cooperation between cities and regions, vehicle manufacturers and energy suppliers and logistics operators (see also according Vancluysen, 2009). A large deployment of electric vehicles is unlikely to occur until the right combination of vehicles, infrastructure, services, financial incentives and environmental awareness is in place, and many different stakeholders are required to make this happen. Policy incentives still need to “lead the way” in order to provide a successful business case. Therefore political leadership and vision are not negligible factors in the process of implementation of the EFVs in the daily practices of the transport operators. One of the main achievements might be to have a high profile champion, illustrating a successful business case of EFVs implementation in city logistics.

This implies, as also follows from the factors for success mentioned by FREVUE partners: committed collaboration with different partners is very important, e.g.:
- Get all parties involved in the total chain from OEM to the end customer;
- Collaborate with city authorities, partners with complementary skillsets, any other partners for example to exchange information in terms of existing suppliers;
- Foster the personal relationships with enthusiastic individuals in related departments and organizations, both on the local and the national scale.
- In general, it is necessary to design a cooperation model among private and public bodies in order to achieve success in the development of this kind of project.

6.3 For companies operating EFVs: internal commitment is essential

There should be strong internal company support for and commitment to EFVs, as in many cases both changing existing operations is difficult and the business case for EFVs is not always evident. For this, FREVUE demonstrators recommended to:
- Have a vision and share this in the company;
- Sell it internally using business risk and opportunity language;
- Be persistent;
- Build partnerships with complementary skillsets.

Additionally, the following factors – on a project management level – strengthen the case for companies planning to start running EFVs in daily city logistics operations:
- Strong project management internally to convince decision makers;
- Having a structured, informed plan prior to implementation will help to avoid any unexpected delays;
- Include clear “go” or “no go” moments in the project management;
- Team work with regular meetings and calls;
- Business controller as a team member;
- Correct people in the project.

Next, specific process management aspects are of higher importance when dealing with EFV implementation in daily city logistics operations:
- Start with a pilot: it reduces risks and can be a good showcase to convince others;
- Good contact people and fellow-thinkers are very relevant;
- Maintain good relations with the companies / authorities that apply for privileges: phones calls, arrange a meeting when necessary;
- Monitoring is key: it can convince policy makers in the future (if you want to roll it out on a bigger scale);
- Try to organize as much as possible from one point of contact to hold all strings;
- You need patience: only small steps can be made at a time;
- Communication, monthly, bi-monthly meetings taking into account all the partners;
- When meeting with criticism, try and determine what exactly is causing the barrier;
- Include suppliers in the preparation and planning phase;
- Draw on public sector support and even financing where possible to speed up uptake.

6.4 Consider the phase you are in

Next, some specific recommendations were developed and lessons learned in relation to different project phases that partners were in e.g. the procurement stage or the operation stage.

Specifically for the procurement stage the following points were considered to be important:
- Define clearly the procurement process;
- Consider the permit issue early in a project, do not assume that previous experience of permission granting timelines will be repeated;
- Try to join forces for procurement of EFVs and use other (EU) projects’ key learning points to leverage efficiency;
- Don’t try to find the perfect vehicle (it does not exist...yet);
- Never underestimate the lead time for every step in the supply of EVs.

For the operation stage, FREVUE partners recommend the following:
- Foresee more time for testing vehicles on site before real launch (for technical adjustments); it’s better to make a good start late, than a quick start with problems (as this will result in less support internally);
- Bring suppliers together to fix issues about innovation and new technology, as this is about non-standard set up and products;
- Ensure all parties understand not only the benefits of EFVs but also discuss the concerns surrounding them such as range restrictions, or (expected) technical issues.

6.5 Change more than just the vehicles: the set-up of a UCC

Experiences observed in FREVUE with establishment of consolidation centres show that it has a significant impact on the existing organisation of last mile deliveries – these are difficult to change even when no additional cost occur for the vehicles, as it is more about organisational change. Therefore one of the demonstrators reports that development of consolidation centres and enhanced logistics procedures (whether with EFVs or not) will require a change in mind-set among the key stakeholders. While the process has yet to be applied as it is still in the development state, it is suggested that the move to a more collaborative approach is needed compared to existing business practices.

In this respect, to establish consolidation centres it is necessary to:

- Develop a strategic approach to collaborative working:
  - Achieve agreement from senior management across the partner organizations, with agreement on core objectives and activity approaches – not just with procurement or environmental teams, but also finance, corporate strategy and the executive board.
- Develop the specified implementation strategy:
  - Start with knowledge sharing, particularly in response to competency or awareness gaps in senior management;
  - Develop a comprehensive strategy and business case that also includes wider economic benefits/transport analysis guidance.
- Assess the capability and organizational maturity to engage in successful collaborative initiatives:
  - Align organizational goals with partners – this is particularly important with partner selection processes;
  - Develop a relationship management plan to strengthen overall effectiveness.
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Appendix. Background, the main findings state of the art 2013

Challenges and factors of success
A review of demonstrators, trials and initiatives with the Deliverable 1-3 (FREVUE, 2013) EFVs resulted in the following challenges and success factors for EFV implementation and uptake in daily city logistics operations:

Technical performance: the range of EFVs is usually not larger than 100 – 150 kilometres. The range promised by the manufacturer is often not reached, although new(er) vehicles have a higher real range. Whether the range is a limiting factor depends on the logistics operations. Technical issues observed include: failing batteries (and limited or late) support, equipment availability issues, relatively long charging time and the necessity to adapt charging infrastructure for fleet needs. The rapid improvement in the technology is mentioned as a reason for waiting to acquire EFVs. The limited availability of standard vehicles and vehicle types is also a factor that is seen as a barrier for EFV implementation.

Operational performance: EFVs demonstrate both positive and negative operational performance characteristics compared to conventional vehicles. Because of their environmental performance and reduced noise level they are often permitted in larger geographical areas and time windows in cases where any of those restrictions exist. Some technological features, like an acute turning range, steering circle and improved visibility facilitate the manoeuvring of the vehicles in dense city areas. At the same time, charging, load capacity, maintenance and the need to adapt logistic concepts for the usage of EFVs are seen by operators as the main existing operational challenges. Not all freight operations are currently suitable for using EFVs, which is particularly the case for the long-haul operations and vehicles with a large loading capacity. In terms of the range, the payload and overnight charging, current EFVs performance levels are good enough for the distribution operations.

Economics: currently the purchase price and total cost of ownership (TCO) for EFVs are significantly higher than for conventional vehicles. That is explained by the high battery cost and limited production volumes of these vehicles. In the longer term it is expected that EFVs will become more competitive, incorporating savings from the improved operational performance, reduction in purchase prices due to the massive production and associated environmental benefits. Currently, as operators are usually more focused on short term benefits, the wider uptake of electric vehicles (EVs) is difficult. The fact that the second-hand market and residual value of EFVs are not yet clearly known holds back some of the operators in their purchase decision. Leasing and financing companies are also reluctant to invest due to these uncertainties. Battery leasing or swapping options are regarded as potential options to reduce vehicle purchase and operational costs.

Environmental performance: undoubtedly EFVs have improved environmental performance, manifested in reduced CO2 emissions and reduced local emissions, compared to the ICE. For the full picture well-to-wheel emissions need to be considered and therefore certification of the electricity supply becomes important. No consensus has yet been reached on the wider systemic impacts of the EFVs which are mainly related to congestion.
Social and attitudinal impact: being less noisy and more environmentally friendly than conventional vehicles, EVs are very well perceived by the general public and are receiving positive feedback from drivers in most of the initiatives. Training is necessary in order to familiarize drivers and general transport operators with the technical and operational particularities of the vehicles in order to achieve better results from the vehicle performance. The low noise generated was sometimes reported as a concern for the EFVs operations in the agglomeration areas.

Impact of local policy and governance structure: at the current stage of the EFVs market development appropriate government policy is necessary in order to achieve the wider uptake of the EVs. Measures both supporting the usage of EFVs and discouraging the usage of ICEs are required and are already being successfully implemented by several European municipalities. Another way to stimulate the wider uptake of EFVs is by using them in the authorities’ fleets.

Overall, the overview of EFV initiatives in city logistics identified three key issues:

- The need for an adapted logistics concept that enables the use of EFVs in city logistics operations to overcome range and load concerns.
- The need (or desirability) of authorities support to increase EFV uptake in city logistics activities.
- The opportunities that EFVs offer for private logistics companies to demonstrate their commitment to improving their environmental performance i.e. green image, visibility in cities.

A literature review together with the results from the case studies provided some operational lessons to be learnt from previous and on-going trials and initiatives:

- Detailed planning of a demonstration process is very important;
- For municipalities it is important to be coherent and consistent in their policy approach following a step by step method: building infrastructure, promotion, supporting EFVs and restricting conventional vehicles;
- Private-public cooperation is important especially during the initial trials that involve EFVs;
- From an operational point of view, driver training is important alongside the establishment of the correct vehicle charging routine;
- Sharing the results with others outside the project is important, in order to encourage far wider uptake of EVs, since this might reduce uncertainties for companies not familiar with EVs.

SWOT analysis of the EFVs implementation in city logistics

Although only a limited number of sources (from those identified in section 2.1) presented real evaluation results of EFVs, we can identify strength, weaknesses, opportunities and threats in relation to current and future implementation (i.e. the barriers and success factors) of EFVs in city logistics compared in comparison to ICE vehicles.

Strengths of EFVs compared to ICE vehicles

- Economics/operational performance:
  - Lower maintenance and fuel cost
  - In case of government support (e.g. larger time windows, environmental zones, free parking, etc) allow more efficiency in operation
- Social and Environmental impacts:
- Good environmental performance and improved air quality
- No noise from vehicles, but only from (un)loading equipment and drivers behavior
- Drivers are happy with vehicles and acute turning range, which is helpful on city’s streets
- Positive general acceptance from public
- Contributed to the positive image of transport operator and shipper

**Weaknesses of EFVs compared to ICE vehicles**

Technical performance:
- The range promised by the manufacturer is not reached and is limited in comparison to ICE vehicles
- Failing batteries
- Limited or late technical support
- Relatively long charging times
- Necessity to adapt charging infrastructure for large fleet needs
- Limited availability and types of vehicles on the market

Economics/operational performance:
- High procurement costs
- High cost of battery
- Long downtimes (due to malfunction) and limited availability of spare parts
- Limited loading capacity
- Slow maintenance services and vehicles
- Extra transshipment costs might occur (transshipment from ICE vehicles to EFVs)

**Opportunities**

Technical performance:
- New(er) vehicles have higher real range
- The availability of public charging points is seen as a confidence boosting measure
- New vehicles and batteries are available in near future (from one side its positive, from another – reason to wait (at the moment) to buy)

Economics/operational performance:
- If regulative environment supports the introduction of EVs the benefits from EVs implementation are higher
- Innovative vehicle / battery leasing schemes
- For vehicles on the fixed routes, in company charging may be sufficient; for vehicles on variable distance routes it is necessary to consider complimentary charging methods.
- Political support, procurement demands, public opinion and awareness also amount private companies and surrounding municipalities are factors of success of demonstrators.

**Threats**

Different uncertainties and risks:
- Logistics concepts might require to be adapted for the usage of EFVs (i.e. an extra transshipment point is necessary to transship goods from ICE vehicles to EFVs)
- Equipment availability issues
• Uncertain safety level
• Other uncertainties and risks

This SWOT analysis makes it clear that currently main strength of the EFVs are of environmental and social value. The main weaknesses have economic and operational character, and basically come down to the negative business case of EFVs (i.e. higher TCO) compared to ICE vehicles. Opportunities lie in the improvement of the vehicles technical performance, supporting governmental regulations (which makes the business case for EFVs more positive, compared to ICE vehicles), and increasing scale advantages in production of for example batteries (which might reduce costs). Finally, main threats are related to the fact that there is a high uncertainty level about availability of the equipment in the future, safety level and other risks.