Validating Freight Electric Vehicles in Urban Europe

D3.5: Policies, Procurement Mechanisms and Governance

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Author(s):	N. Nesterova
Co- author(s):	Koffrie R., Quak H., Sunnerstedt E.
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Author(s)	Nina Nesterova, Koffrie R., Quak H., Sunnerstedt E.
Responsible organisation	TNO
WP Leader	Imperial College London
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Glossary

AC	Alternating Current
BEV	Battery Electric Vehicles
CFV	Conventional Freight Vehicle
CO_2	Carbondioxide
DC	Direct Current
EC	European Commission
EFV	Electric Freight Vehicle
EU	European Union
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GPP	Green Public Procurement
GW	GigaWatt
ICE	Internal Combustion Engine
ICEV	Internal Combustion Engine Vehicle
IT	Information Technology
JRC	Joint Research Centre
kW	KiloWatt
kWh	KiloWatt hour
NO_x	Nitrogen Oxides
OEM	Original Equipment Manufacturer
PHEV	c
SME	Small and Medium-sized Enterprises
TCO	Total Cost of Ownership
V2G	Vehicle To Grid
ZE	Zero Emission

Executive summary

The objective of this deliverable is to discuss what can be done to implement different categories of electric freight vehicles in city logistics and to reach EU targets on zero emission cities in 2030. Experiences indicate that along with opportunities associated with the utilization of electric freight vehicles, the wider uptake of this technology is still facing serious infrastructure, vehicle technology, policy and market related barriers. If 2030 zero emission city logistics target is to be met, the most critical barriers that are currently hampering the further development of the market need to be addressed now. This deliverable describes the key steps on EU and national/local policy levels as well as from the perspective of other freight electromobility stakeholders, such as transport operators, grid operators, shippers and others. It indicates actions different actors can take to accelerate the uptake of electric freight vehicles. Specifically, it investigates:

- Facilitation of the internal and external governance processes within urban freight electromobility;
- Experiences and challenges of new stakeholders in urban logistics supply chains;
- Alternative forms of EFV ownership;
- Discussion of a proper policy mix, efficiently supporting freight electromobility at the local level;
- Public procurement as a means to increase EFV market share.

The main focus of this deliverable is to define potential ways to mitigate challenges and to define policies, internal and external governance factors, as well as specific actions that can facilitate the wider uptake of electric freight vehicles.

Several critical factors are recognised as barriers to the uptake of the EFVs. The most critical ones are: limited offer from Original Equipment Manufacturers (OEMs), specifically for medium and heavy duty vehicles; high purchase price of the vehicles; long vehicle depreciation time than ; required technological improvements of the vehicle (range, payload, and performance of auxiliaries in extremely hot and cold conditions); availability of charging infrastructure network and potentials for its technological improvement. A large deployment of electric vehicles is unlikely to occur until the optimal mix of vehicles, infrastructure, services, financial incentives and environmental awareness is in place, and many different stakeholders are required to make this happen.

The introduction of the EFV brings an internal change to the organization which needs to adapt and integrate an innovative process: new skills within the organization; the potential reorganization of some established logistics models/practices; the establishment and development of new relations; and dealing with uncertainty and new types of risks need to be developed.

This deliverable also looks into the new relationship that transport operators need to establish within the EFVs market: electricity supply, power networks, publicly available charging infrastructure networks suppliers and operators. The wider EVs uptake largely depends on the availability of charging infrastructure and the capability of electricity network operators and suppliers of electricity to answer for the growing demand of electricity in a time and cost effective way. The responsibility for optimal charging infrastructure and electricity network provision lies both with private operators and public authorities. EU and national

public authorities need to further support and encourage the development of the public fast charging and private charging infrastructure networks, making sure that infrastructure is available on-time to support the growing number of EVs.

Addressing the barrier of the high purchase price of the vehicles, Deliverable 3.5 investigates opportunities for establishment of leasing schemes. For the leasing option to increase, first, there needs to be a larger offering of EFVs from manufacturers: leasing companies are waiting until the big OEMs will pick up the challenge. As more OEMs have announced to introduce large electric vehicles to the market, it is expected that the price of the vehicle will fall which will also positively influence the uptake of leasing schemes. Further developments in battery technology and clear opportunities of second-hand usage of the electric vehicles and electric batteries, as well as diversification of the second-hand market options are also pre-requisites for the improvement of the leasing case.

The overall conclusion is that policy incentives still need to “lead the way” in order to provide a successful uptake of EFVs. Political leadership and vision are not negligible factors in the process of implementation of the EFVs. Nowadays governments are still looking at the best ways to provide market certainty. Different types of incentives are used to support both big companies and small entrepreneurs. There are a set of concrete policy actions that are available for municipalities, which can influence electric freight vehicles uptake. These can be grouped into four main types of measures: economic/fiscal; legal/regulatory; communication and raising awareness; and planning measures. But what is key for efficient policy support is a good mix between all these measures.

Public procurement is another useful tool for public authorities that have a strong potential in assisting the uptake of clean vehicles in city logistics. By promoting and using GPP, public authorities can provide industry with real incentives for developing green technologies and products. While implementing EVs in their own fleets, municipalities directly contribute to the reduction of emissions and are an example for private operators. Public authorities have a significant influence on public transport fleets. Supporting the introduction of the electric buses is specifically important for the development of the EFVs, as further development and practical implementation of this segment is beneficial for further upscaling of the medium and heavy duty EFVs.

To summarise this deliverable a roadmap is provided for local authorities in order to overcome barriers and accelerate EFVs vehicle uptake, these include:

- Facilitate series production of the EFVs in the near future;
- Ensure that charging infrastructure is available in a timely manner;
- Ensure that this charging infrastructure is interoperable in all aspects;
- Ensure a steady increase of the EFV market, encouraging more fleets to acquire plug-in vehicles;
- Facilitate the aftermarket of electric vehicles in terms of residual value by supporting the use of vehicles after their economic lifetime for other purposes (such as low range distribution in cities) and reuse of the batteries of the vehicles;
- Create an efficient policy mix, providing a good balance between the financial and operational incentives for the use of EFVs.

The combination of these factors can initiate the steady increase of EFVs.

1. Introduction

1.1 Background and overview of FREVUE

As part of the FREVUE project, eight of Europe's largest cities, including six capitals, demonstrate that electric vehicles operating "last mile" freight movements in urban centres can offer significant and achievable decarbonisation of the European transport system.

The public-private partnership of FREVUE, which brings together 17 industry partners, nine public sector bodies and six research and networking organisations, jointly deploys demonstrators in Amsterdam, Lisbon, London, Madrid, Milan, Oslo, Rotterdam and Stockholm. The demonstrators have been designed to ensure FREVUE covers the breadth of urban freight applications that are common across Europe, including a wide range of:

- Goods deliveries (including food, waste, pharmaceuticals, packages and construction goods)
- Novel logistics systems and associated ICT (with a focus on consolidation centres which minimise trips in urban centres)
- 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

By exposing over 80 electric vehicles to the day to day rigours of the urban logistics environment, the project aims to prove that the current generation of electric vans and trucks can offer a viable alternative to diesel vehicles - particularly when combined with state of the art urban logistics applications, innovative logistics management software, and with well-designed local policy.

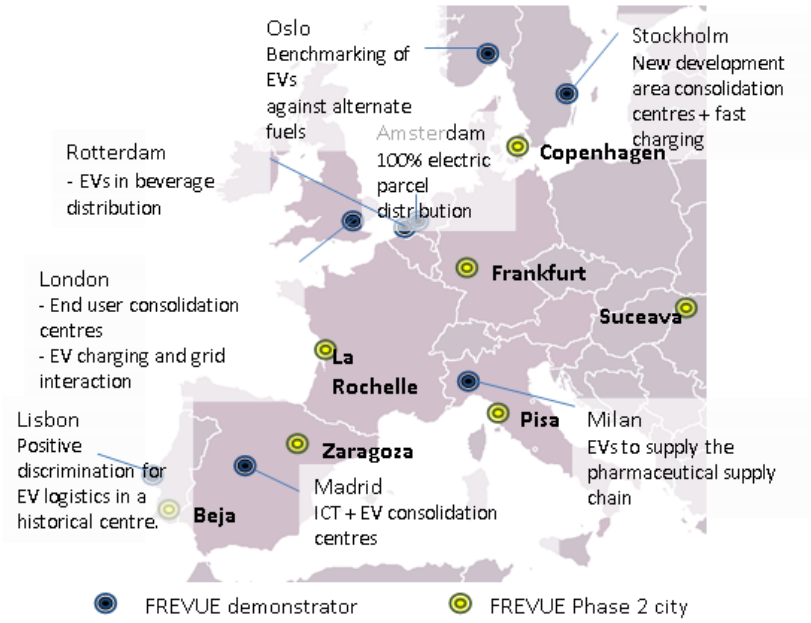

Figure 1: FREVUE demonstrator activities

The project demonstrates solutions to the barriers currently inhibiting uptake of EVs in the sector. Novel leasing and procurement models are explored to help mitigate the high capital

cost penalty for EV purchase. The impact of a wide range of local policies on the overall ownership case for EVs in logistics applications is also tested.

The project includes leading European research institutions with expertise in transport policy, logistics and electric vehicle technologies. These institutions have designed and implemented a data capture protocol and subsequent assessment framework for the project. This ensures that the project creates a valuable European evidence base on the role of EVs in urban logistics. Partners will produce clear guidelines and recommendations targeted towards the key focus groups of this project: Freight operators and fleet managers, public authorities at the local and regional level, energy network operators, ICT and service providers, and vehicle manufacturers.

These guidelines and recommendations feed into a targeted dissemination campaign to ensure that the results of the study reach an audience that will be able to act on the findings of the study and hence increase take-up of EVs in urban logistics. To complement this, FREVUE also created a network of “Phase 2” cities to directly share the lessons learned from the demonstrators. These cities are expected to be the first to expand the successful concepts developed by FREVUE.

1.2 Work package overview

The FREVUE project is broken down into five work packages, which are described below:

Figure 2: FREVUE work packages

WP1 – Assessment and ICT Framework: This work package defined the data protocols, data handling procedures and assessment framework for the demonstrators. This ensures that all required data is gathered and correctly communicated during the demonstrator operations. In addition, a review of state-of-the art logistics ensured that lessons from previous projects were taken into consideration during the planning phase for the demonstrators. Due to the dynamic and fast-changing situation around electro-mobility and urban logistics, it was agreed to update this state-of-the-art report in mid-2015 and in February 2017.

WP2 – Demonstrator trials: This package contains all aspects of the delivery of the demonstrators. Each trial has a local project manager responsible for day to day delivery of the project and the implementation of the data collection frameworks agreed in WP1. The trials follow a common structure across the eight trans-national demonstrators.

WP3 – Analysis: Data from the demonstrators is analysed and relevant conclusions for the logistics industry and policymakers are drawn including:

- Technical and economic performance of the demonstrators in FREVUE
- Environmental performance of the demonstrators (with respect to CO_2), and analysis of impacts for wider scale deployment (for air quality, congestion and the electricity grid)
- Social impact of the EV logistics applications and policies (e.g. curfew extension)
- Impact of the range of policies on the economic case for the logistics operators to deploy EVs
- Any safety issues arising during the demonstrators

WP4 – Dissemination: The dissemination activity is the key to the project and will target professionals in the logistics and ICT industries, energy network operators, vehicle manufacturers as well as policy makers with the potential to unlock further EV deployment in logistics. The task also includes direct "officer to officer" dissemination to the Phase 2 cities who have expressed interest in deploying similar programmes in the near future.

WP5 – Project coordination and management: This WP oversees the project overall and ensures efficient reporting to DG Move, that partners in the project are communicating effectively, that the project is progressing on schedule and that issues are identified at an early stage and dealt with promptly.

1.3 FREVUE Deliverable 3.5 – Policies, Procurement Mechanisms and Governance

Aim

Experience from FREVUE indicates that along with opportunities associated with the utilization of electric freight vehicles, the wider uptake of this technology is still facing serious infrastructure, vehicle technology, policy and market related barriers. The objective of this deliverable is to discuss what can be done in order to move forward in the implementation of different categories of electric freight vehicles in city logistics and to reach EU targets on zero emission cities in 2020.

The specific parts/levels of the EFV market discussed are:

- Facilitation of the internal and external governance processes within urban freight electromobility;
- Experiences and challenges of new stakeholders in the urban logistics supply chains;
- New forms of EFV ownership;
- Discussion of a proper policy mix, efficiently supporting freight electromobility at the local level;
- Public procurement as a means to increase EFV market share.

Target audience

This deliverable describes next steps on EU and national/local policy levels as well as from the perspective of other freight electromobility players, such as transport operators, grid operators, shippers and others. It describes actions different actors can take to speed up the uptake of electric freight vehicles. Therefore, the target audience for this deliverable encompasses a variety of electromobility stakeholders, such as:

- EU authorities, as this deliverable gives an insight into the potential to achieve the zero emission city logistics target by 2020. It also indicates crucial barriers making the realization of this target difficult as well as potential ways to mitigate these barriers;
- Local authorities, as these are one of the most involved and concerned stakeholder group, influencing the local policy mix and directly benefiting from the implementation of concrete measures (e.g. freight electromobility) on the local level;
- Logistics operators (both transport companies and shippers), as these are responsible for the actual transport operations in cities. The uptake of the electric freight vehicles in daily operations directly depends on them and on the benefits/obstacles they perceive;
- OEMs, as the availability of electric freight vehicles depends on them and the incentives they receive to start mass-production of EFVs;
- Grid operators, as larger uptake of electric vehicles will directly impact their everyday activity and business models.

Added value

Challenges and barriers in the way of the wider uptake of EFVs are widely discussed in current literature. This deliverable adds value in several ways:

First, it provides a deeper analysis of barriers, moving on from the simple overview of challenges to the analysis of actors involved, long-term prospects of barrier development, their impacts on EFV uptake and the possibility of mitigation.

Second, this deliverable discusses the likelihood of the 2030 zero emission city logistics target to be met by developing a roadmap illustrating how fast existing barriers could be overcome.

Third, it looks in more detail into several specific areas where the biggest changes need to be made in order to accelerate the uptake of electric freight vehicles. Examples from FREVUE partner cities are largely used to illustrate different statements and to generate recommendations for other cities. Like, for example, London and Amsterdam, two FREVUE partners, that provided their input for this deliverable on what can be an example of efficient policy mix.

Summarizing, the main focus of this deliverable is to define potential ways to mitigate identified challenges and to define the policies, internal and external governance factors, stakeholder cooperation forms, etc. that can facilitate the wider uptake of electric freight vehicles.

1.4 Outline of this deliverable

Deliverable 3.5 consists of three chapters. Based on the FREVUE deliverables 1.3, 3.1, 3.2, and 3.3, in Chapter 2 we first summarize the main barriers and challenges which currently (and potentially in the future) hindering an uptake of electric freight vehicles in city logistics. We further analyse these barriers/challenges, looking at the actors involved, severity of the impact and identify possible actions to be taken now in order to address and resolve existing barriers faster. Next in paragraph 2.2, we propose an indicative roadmap of EFV market uptake in city logistics.

Chapter 3 looks in more detail into some specific areas where major change was observed or where the main opportunities for the acceleration of EFV uptake are currently identified. Finally, Chapter 4 provides conclusions and a debate on the further developments.

2. A way forward to the wider uptake of the electric freight vehicles

Overall, the worldwide electric car stock reached 1.26 million in 2015 (OECD/IEA 2016), being mainly composed of passenger cars, two-wheelers and light vans, including both battery electric vehicles (BEV) and plug-in hybrid electric vehicles (PHEV). China and the USA are the leading markets in the uptake of electric fleets. In Europe leading markets are the Netherlands, France, Germany, Norway and the UK. In 2015, overall market share of the EVs in the EU remained really low: PHEV and BEV together made up about 1.1% of vehicle registrations, with notable differences among Member States (ICCT, 2017). For example, in 2015 in the Netherlands, 8.8% of all new sales were PHEVs and another 0.9% BEVs.

Statistics about the share of the electric fleets are not easily available in the segment of freight vehicles. Most medium and heavy-duty trucks are still in demonstration phases and their offer remains marginal. Light-duty EFVs are beyond research and development, demonstration or pilot phases, even though there is a continuous process of battery and other electronics improvement. Production volumes remain low but are growing, as are the number of manufactures offering these vehicles. Larger amounts of light-duty EFVs are being implemented in city logistics (FREVUE, 2017a). According to ICCT (2017), the average share of the non-diesel vehicles in new light duty vehicle registration in 2015 was 3% for EU-28, varying between 0% (e.g. Ireland) to 8% (e.g. Italy) and including natural gas vehicles, hybrid vehicles, and flex fuel vehicles. That illustrates that the share of the electric fleets in freight transport is still minimal.

Deciding on the purchase of an EFV is a complex decision for transport companies. This is due to several external and internal factors. Key factors currently limiting an uptake of EFVs are presented and described in paragraph 2.1. In paragraph 2.2, in the form of the roadmap we highlight what can to be done in order to support with the implementation of different categories of electric freight vehicles in city logistics and to contribute to the EU target on zero emission city logistics by 2030.

2.1 Main groups of barriers on the way of the wider EFV uptake

Experiences from FREVUE demonstrations (FREVUE Deliverable 2.2) and analysis performed (FREVUE Deliverables 3.1 and 3.2), as well as experiences from other EFV implementations (FREVUE Deliverables 1.3, 1.3 (I), 1.3 (II)) show that there is a set of key barriers that currently limit the wider uptake of EFVs.

First, the economics of many EFVs are not yet offering a stable and positive business case. The main reason for this is that EFVs, especially those over 3.5 tonnes, are typically built on demand in very small quantities, thereby typically starting with a conventional freight vehicle (CFV) and converting this vehicle into an EFV. This implies that the costs for the conventional power train and auxiliary devices still need to be covered (and little of these costs can be recovered) and the costs for electrification (battery, motor, inverter, on-board charger, and electrified auxiliaries) will need to be added. Building in small quantities implies less automation and high engineering and production costs, typically resulting in an EFV price that is between 2 and 3 times higher than its conventional equivalent. Overall, for the light duty vehicle market the is already stable offer of the vehicles on the market. For the

medium duty vehicles several OEMs have announced in-series production for the end of 2018. For the heavy duty market, the vehicles are still in testing and pilot phase.

Another reason for the lack of a positive business case is that the time to earn back the extra investment required for operating an EFV fleet is typically too long. Energy costs also play an important role in achieving a positive TCO delta (compared with a CFV fleet) within the envisioned depreciation period. For an in-series produced EFV it is expected that the difference in purchase price is predominantly dictated by the price of the battery[1]. This means that the depreciation of the battery pack needs to be earned back with lower energy costs. As the differences in electricity prices are significant among European countries (ranging from 0.06 €/kWh in Sweden up to 0.24 €/kWh in Germany) the business case for operating EFVs will heavily depend on this. Please see FREVUE, 2017 b for more details.

In addition, the urban freight logistics market is mainly composed of small and medium self-employed transport operators. These navigate a highly competitive, low margin profit market and cannot risk the quality/reliability of the service without risking the viability of their business models. High purchase prices of EFVs, a fast developing technology and the absence of hard diesel vehicle restrictions in cities can lead to SMEs waiting with the electrification of their fleets. Existing successful business models for electric freight in city logistics either include adjustment of the logistics model (through intermediate consolidation points) or are based on the direct (subsides) or indirect (taxes and other incentives) financial support from public authorities. Currently, postal service companies and local public authorities are two main groups of shippers that are actively replacing their conventional vehicle fleets with EFVs.

Second, the limited offer of the vehicles, specifically in the segment of the medium and large vehicles, and limited information on vehicle availability on the market is another important barrier. ICCT (2017) reports that “only five manufacturer groups dominate EU truck sales. Together they account for nearly 100% of all new vehicle registrations (0.4 million vehicles in 2015). In contrast to some other heavy-duty vehicle markets, the same manufacturer usually makes both the vehicle and its engine in Europe. Therefore, the heavy-duty engine market in Europe is also dominated by the same five manufacturers. In 2016 the European Commission provided evidence for cartel behaviour among heavy-duty truck manufacturers in Europe, finding them guilty of price fixing as well as delaying the introduction of emission-reduction technologies and issuing a record penalty of €2.93 billion”. With the exception of a few manufactures that have already introduced electric light-duty vehicle models (e.g. Renault, Nissan), the majority of the electric vehicles in operation are produced on demand and retrofitted vehicles. As explained above, the price of the on-demand produced vehicles will always remain high, as no economy of scale benefits, reducing vehicle price, can be achieved. Mass production of EFVs and their components (batteries, auxiliaries, etc.) is necessary to significantly reduce prices.

Third, EFVs are produced in small series that can lead to relatively high vehicle repair costs and an often limited physical maintenance support network. This is an important barrier for vehicle uptake in the eyes of transport operators. The survey of Belgian transport operators (Lebeau, 2016) illustrated that “the lack of BEV maintenance expertise in garages is identified by the respondents to be a disadvantage that is nearly as important as the high purchase cost of the vehicle”. Repairs for EFVs tend to take much longer than with diesel

[1] The costs for inverter, on-board charger, electromotor and electrified auxiliaries are expected to cost approximately as much as the combustion engine, after treatment system and mechanical auxiliaries.

trucks: this is due to the fact that only specified mechanics have the knowledge to repair an EFV, that spare parts are not in stock and that, at times, repaired vehicles need to be tested again before they can return to operation (FREVUE, 2017 a). Worth mentioning is that this barrier is expected to disappear when EFVs are produced in series. However, experience shows that the regular maintenance costs of the EFVs are lower than the maintenance costs for the conventional equivalents. For light-duty vehicles, it is already reported by leasing companies that maintenance costs for EVs are 20% lower than for their conventional equivalents.

Fourth, EU countries supporting the uptake of electric fleets are actively developing the charging infrastructure, both slow and fast charging. Still, the network currently available is not yet optimal to support the wider uptake. Figure 3 illustrates the current availability of the slow and fast charging infrastructure in the countries that are leading the EV uptake in relation to the total number of the electric cars. As illustrated, the number of electric cars per publicly available EVSE outlet falls in the range of 5 to 15 vehicles for slow chargers, with a global average of 7.8 in 2015 (OECD/IEA, 2016). As reported by OECD/IEA (2016) this differs a lot per EU country:

- The ratio of (Plug-In) electric cars per fast-charging outlet is close to 40 in Sweden and the United Kingdom (14 in Sweden and 19 in the United Kingdom for BEVs/fast EVSE outlets), and 60 in Germany (39 for BEVs/fast EVSE outlets);
- The same indicator ranges between 100 and 130 (60 and 90 for BEVs/fast EVSE outlets) in Canada, France, Norway and the United States;
- In the Netherlands there were 188 (Plug-In) electric cars (and 20 BEVs) per every fast charger outlet.

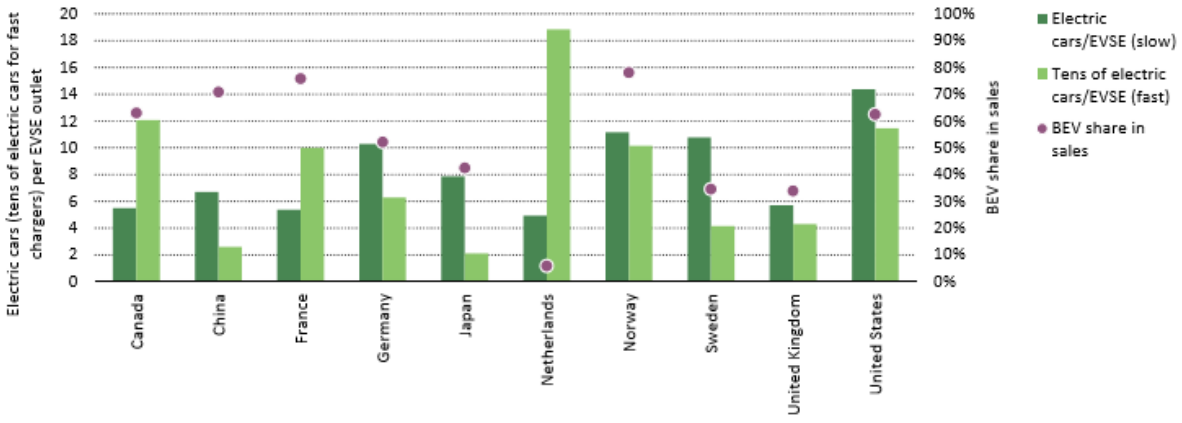

Figure 3: Electric cars/EVSE stock ratio for slow and fast publicly available chargers and share of BEVs in total electric car stock, 2015. Source: OECD/IEA (2016)

The figure shows that in the countries that a leading in the uptake of the EVs, the number of cars per every charger outlet is fast growing and it is necessary to make sure that charging infrastructure is also available for the further uptake.

Passenger cars are the main target of the publicly installed infrastructure. Currently normal power charging from 3.7 to 22 kW in the private and public domain is the backbone for the daily recharging of passenger EVs as well as light electric vehicles (AVERE, 2017). This is not enough for medium and heavy-duty vehicles that require high power charging points (charging mode 3 or 4, as defined in FREVUE, 2017a) for fast charging. The deployment of

high power charging points is needed to enable the full potential from the electric driving of medium and heavy-duty vehicles. On the economics side, most commercial vehicles are charged overnight at the depot, which means that operators have to invest in charging infrastructure, creating additional financial burdens at the outset of the vehicle operation.

Finally, on the level of the vehicle, range and payload of the vehicle are still factors of consideration for the transport operators. Decrease of the payload or limited vehicle range requires changes in daily operations or even require entire new logistics models for the transport operator. Though it is proven that for specific types of operations, especially inner city freight operations, the daily range that EFVs currently offer is sufficient, transport operators are still expressing the wish for an increase in range, which will permit longer and more flexible usage of the EFV.

Table 1 discusses these barriers in more detail, and also describes which concrete impact these barriers have on the wider uptake of EFVs. The strength of the impact indicates how much influence this barrier has on the wider uptake of EFVs, thus, indicating the urgency to address it.

Table 1. Barriers affecting the wider uptake of the EFVs

Barriers	Description	Impact on vehicle uptake	Strength
Economic			
High vehicle purchase cost	EFV purchase prices depend on the costs for the battery pack and electric motor. Most batteries are being developed "on demand", considering the intended use of the battery pack, which makes them very expensive. The overall cost of the battery continues to fall (from 2010 to 2016), but is still at a level that it will represent a profitability barrier for the next two to three product cycles.	The price difference between most EFVs and ICEs is too high, making it challenging for transport operators to replace conventional vehicles with electric.	High
Long depreciation time	The EFV purchase price discussed above paired with the difficulty to earn the extra investment back through lower operational/energy costs is a major barrier. For on-demand produced EFVs the mileage to earn back the investment is typically above 500,000 km. With this mileage a battery replacement will also be required.	The benefit in operational costs can be too low to earn back the investment. For an in-series produced EFV the price difference may be earned back between 60,000 and 200,000 km, which is more realistic to achieve.	High
High vehicle repair cost	Aftersales support represents a high uncertainty for operators. This barrier is not technology driven but due to the small scale individual production of the vehicles. The number of existing maintenance facilities is limited, spare parts are often not directly available and there is little certainty as to how fast the vehicle will be repaired. Smaller garage services are often not yet qualified to provide EFV maintenance service, and for larger manufacturers after sale support is not the priority either.	Uncertainty around maintenance costs impacts costs of leasing and insurance contracts and therefore makes EFV TCOs less attractive.	Medium
Cost of additional infrastructure	Light- and medium-duty EFVs are usually charged at operator depots overnight. For this slow charging facilities can be used. Where larger EFV fleets are introduced, investment in necessary charging infrastructure increase the capital costs (not vehicle specific, as infrastructure is being depreciated over a longer time period). Investment in smart grid solutions as well as grid upgrade (if necessary) are further increasing the initial costs but will result in lower costs per kWh.	Makes EFV TCOs less attractive	Medium
Technological			

Limited range	The currently available range of approximately 100 km for electric vans is perfectly in line with distances run by most operators within city boundaries. The operational profile of EFVs also corresponds to the profile of city logistics operations: numerous starts / stops, significant idle time, and relatively low average speeds. The length and topography of the route and the weather have a direct impact on the energy consumption of the vehicle, reducing available range. Nevertheless, operators continuously express the wish for extended range, in order to be able to use the vehicles in more ad-hoc planning situations as well as to extend the scope of activities. Some of the new generation larger trucks already have a range of up to 200 km.	Range limits operation of EFVs to inner city logistics. It also limits the types of services for which EFVs can be used and requires planning for the vehicle daily trip.	Medium
Limited payload	The heavy weight and volume of the batteries, within the same gross weight and shape of the vehicle result in a reduced payload compared to the ICE equivalent.	Less efficiency in transport: may result in larger EFV fleets than the CFV fleet that is being replaced.	Medium
Difference in standards	There is single standard yet for fast charging EFVs. However, it seems standardisation is being developed by the industry, e.g. through initiatives like OppCharge	Specifically medium- and heavy-duty trucks cannot be easily charged on the public infrastructure and need to use specific charging infrastructure.	Medium
Limited availability of public charging infrastructure	The currently developed public charging infrastructure does not normally support fast charging options necessary for the uptake of the medium- and heavy-duty trucks. The network of charging points is insufficient in many countries/cities. It is however presumed that if increasing demand becomes apparent, fast charging solutions will also appear. Business cases around sharing bus fast charging infrastructure with EFVs are currently being looked at.	Influence on the range of the EFVs. Increases range anxiety of the operators.	Medium
Inefficient auxiliaries	In regions of extreme weather conditions additional air conditioning equipment (cooling or heating) is required. In some situations and climates their usage is crucial and cannot be neglected. Current systems consume high amounts of energy.	Reduce the range of the EFVs.	Low
Procurement			
Limited offer of the vehicles	Only a limited number of options are currently available on the light-duty EFV market and only a few OEMs are mass producing them. Medium and heavy duty trucks are currently produced on demand.	The limited offer of vehicles is closely linked to their high purchase prices. For light-duty vehicles the choice of models is. The offer of heavy- and medium-duty trucks is very limited and causes delays in procurement.	High
Limited information about available vehicles	Access to information about EFVs and their availability is limited and often difficult to access for self-employed drivers.	Additional time cost for the transport operators to find information about vehicles and to define their order requirements. It remains significantly easier to go back to the known ICE supplier.	Medium
Limited offer of financial mechanisms supporting EFVs	Limited and very expensive leasing schemes, high loan rates due to the uncertainty about residual value and high associated risks related to the lack of a second hand market	Less options to finance EFVs	Meidum

Source: FREVUE, EC (2017)

Looking forward to when uptake of EFVs will have increased, additional challenges will appear that already now should be taken into consideration: e.g. electric grid upgrade;

development of smart grid technologies; second hand market for the batteries and recycling of the used batteries. Some of these barriers are further discussed in Chapter 3.

The barriers mentioned in Table 1, combined with the fact that in-series produced and therefore less expensive solutions are expected to become available on the market within the next few years result in transport operators waiting for more efficient vehicles and can cause short-term market stagnation in the uptake of the EFVs. Specifically for the medium- and heavy-duty vehicles market, high investments in EFVs can be difficult to get approved by a board: from the perspective of many transport operators they are being asked to invest in an uncertain product with uncertain partners with no clear advantages.

In order to prevent this and to accelerate the wider uptake of the EFVs in city logistics a set of actions is required from the key stakeholders of the EFV market.

2.2 Addressing the barriers: Roadmap

The EU has developed an explicit strategy to de-carbonize the transport sector as one of the biggest polluters: specific targets are established to progressively implement zero-emission transport in cities. This is only possible with a full transition to more sustainable and efficient fuels.

Even if sustainable transport is recognized as crucial to reach city targets, the major burden of the uptake of cleaner vehicles is put on transport and logistics operators as the primary users of freight vehicles. Public authorities develop targeted support actions, helping to procure the vehicles or providing charging infrastructure. This support helps to increase the confidence in the electric freight transport but is not currently sufficient to speed up the wider uptake of EFVs and make the business model of EFVs self-sustainable.

Transport activity is initiated by the demand from producers, receivers or shippers. The greener image that comes with the deployment of EFVs is recognized to be of added value, but does not yet allow for a price premium to be paid. Thus, all increase of costs or negative impact on performance associated with the use of EFVs will be covered solely by businesses and business models of transport and logistics operators. The latter are often SMEs and cannot support this transition on their own. Therefore, combined efforts from multiple actors are necessary, addressing current and new barriers. Table 2 presents a roadmap that looks towards the development of EFVs as from where the market stands now. The roadmap identifies key stakeholders that are involved in the actions necessary to address key barriers. It also identifies concrete actions to be undertaken, as well as a realistic time horizon.

Table 2 Addressing the barriers: Roadmap for the wider uptake of the EFVs

Barriers	**Description of current and expected trends**	**Stakeholders involved and required actions**		
		Stakeholders	**Actions**	**Time horizon**
High vehicle purchase costs	A price breakthrough is expected due to the transition to mass production of all EFV components: batteries, auxiliaries, battery packs, etc. Further cost optimisation in the production of battery packs, electric motors, inverters, electric auxiliaries is necessary. The trend towards cheaper electronics systems will decrease the price of the inverters. Improvements of the battery efficiency (e.g. development of the active battery conditioning that permits for a longer battery lifetime and higher currents) focusing on the battery lifetime will increase residual value of the battery and decrease its price.	OEMs	Mass production of the EFVs in medium and heavy duty segment Diversification of the vehicle choice for all vehicle segments	LDV: ongoing MDV: announced as from 2018 HDV: test and pilots are ongoing
		Research	Improvement of vehicle components, specifically battery	Ongoing
		EU and local authorities	Targeted financial help for procurement	Until the business case looks more favourable

	Overall, there is al		Operational incentives Infrastructure installation	especially for the medium and heavy duty trucks Until infrastructure needs are met
		Leasing companies and financial institutions	Provide feasible leasing options for EFVS	LDV: on-going MDV: 2-3 years
Long depreciation time	The EFV purchase price discussed above paired with the difficulty to earn the extra investment back through lower operational/energy costs is a major barrier. For on-demand produced EFVs the mileage to earn back the investment is typically above 500,000 km. With this mileage a battery replacement will also be required.	OEMs	Mass production of EFVs	LDV: ongoing MDV: announced as from 2018 HDV: test and pilots are ongoing
		EU and local authorities	Targeted financial help for procurement Operational incentives	On-going
		Transport and logistics companies	New logistics models	From now
High vehicle repair cost	Mass production of EFVs will increase availability of spare parts, reduce the time required to repair vehicles and increase general knowledge about vehicle repair and its efficiency. Financial help and restricting policies announced by various local authorities will also boost leasing schemes and OEMs producing EFV and have a positive impact on the reduction of repair costs and improvement of maintenance networks?	OEMs	Develop vehicle maintenance network Mass production of EFV spare parts	LDV: ongoing MDV: announced as from 2018 HDV: test and pilots are ongoing
		Independent maintenance service operators	Develop vehicle maintenance network	In 2 - 10 years
		Leasing companies	Support the development of the vehicles maintenance network	In 3 - 10 years
		Infrastructure operators	Develop infrastructure and infrastructure maintenance services	In 3 - 10 years
		Transport and logistics companies	Develop internal knowledge on the EFV maintenance	Continuous
Additional infrastructure cost	Mass production of charging infrastructure necessary for the wider uptake of EFVs will decrease the cost per unit as well as operator costs when infrastructure is to be installed in-house. Expansion of an efficient public fast charging infrastructure network can reduce in-house infrastructure needs. It is expected that fast chargers with lower usage patterns will be dropping in TCO by allowing second-life stationary batteries to be used for peak-shaving the power demand from the grid connection.	Charging infrastructure providers	Mass production of charging infrastructure	Ongoing
		Research	Improvement of charging infrastructure efficiency	Ongoing
		EU and local authorities	Provide public infrastructure network, including fast charging Targeted financial support for installation of infrastructure	From now to 10 years
Limited vehicle range	Further improvement of technologies is necessary, specifically battery efficiency. The trend towards super-fast charging systems of more than 300 kWh, allows for, e.g. heavy-duty vehicles to charge for another 50 km of	OEMs	Technology improvement	Ongoing
		Research	Technology improvement	Ongoing

	range within 10 minutes.	Transport and logistics operators	Look into logistics concepts extending vehicle range	Ongoing
		EU and local authorities	Assistance with installation of fast charging network	Ongoing
		Infrastructure operators	Installation of fast charging network	Until infrastructure needs are met
Limited payload	Further research in vehicle technology is necessary in order to decrease the size of the battery and increase its efficiency. As a medium term solution fast charging network can be used as it permits to have decreased battery size (and, therefore, improved payload of the vehicle) by keeping up with the necessary range requirements. Regulative support from the public authorities is necessary, addressing questions around the limited EFV payload s (in some countries EFVs are discriminated due to the lower payload as current legislations are weight related to the conventional vehicles).	OEMs	Improvement of technologies	Ongoing
		Research	Improvement of technologies	Ongoing
		EU and local authorities	Regulation adjusted for the weight and payload of the EFVs (e.g. Extension of the B driving license)	Until the needs are met As soon as possible – ongoing in some countries
		Infrastructure operators	Installation of fast charging network	Until infrastructure needs are met
Difference in standards	In future charging infrastructure suppliers have to be able to provide equipment compatible with vehicle test labels of the majority of OEMs. Currently existing differences in vehicle and charging standards make the development of interoperable charging stations difficult. On-going standardisation for automatic fast charging solutions of above 40 kW/hour will specifically benefit the market of medium- and heavy-duty vehicles. The lack of standardization, interoperability and regulatory frameworks for chargers and/or on-board information technology (IT) systems to enable this flexibility, will lock out smart charging opportunities.	OEMs	Establish strong cooperation links with infrastructure providers	Ongoing
		Infrastructure operators	Establish strong links with OEMs	Ongoing
		EU	Implement and ensure legal process for standardisation	Ongoing
Limited availability of public charging infrastructure	Experience with alternative charging infrastructure options (fast conductive charging, inductive charging, in-motion charging with overhead wires for e.g. trucks (“electric highway”) or buses). Identify the dominant design for the future charging infrastructure that can support the large-scale adoption of electric vehicles. Fast charging can be a feasible solution of range extension only if standardisation of charging protocols will be finalised and extensive charging infrastructure networks will be made available, specifically for the medium- and large-sized electric trucks. Development of smart grid solutions, like slow charging in residential garages and office parking has the potential to offer flexibility, primarily due to variable charging, i.e. the possibility to modulate charging time and power; using batteries to balance the power.	Infrastructure operators	Provide widespread network of charging infrastructure (both slow and fast charging)	From now to 10 years
		EU and local authorities	Support installation of public charging infrastructure	From now to 10 years
		Research	Develop new charging options; Develop smart grid solutions	Ongoing
		Transport and logistics companies	Trying out alternative charging options Apply smart grid solutions	Ongoing Ongoing
		Grid operators	Work together with other local market stakeholders to make sure electricity grid will have enough capacity	From now on
Inefficient	Improvement of energy consumption rates of	OEMs	Technology	Ongoing

auxiliaries	the auxiliaries		improvement	
		Research	Technology improvement	Ongoing
Limited vehicle offer	Several large OEMs have announced plans to build medium- and heavy-duty electric trucks in the near future, which will further change the structure of the market. Shippers (e.g. DHL) are developing their own EFVs fit to their needs. Transport operators and shippers initiate joint demand statements (e.g. FREVUE Declaration of Intent) to communicate demand to the market. National EV procurement initiatives aim to generate a common demand for EFVs, thus creating more stimuli for OEMs to start mass production.	OEMs	Mass production of EFVs	LDV: ongoing MDV: announced as from 2018HDV: test and pilots are ongoing
		Research	Technology improvement	Ongoing
		Transport and logistics operators	Joint demand statement	From now on
		EU and local authorities	Joint demand statement Green public procurement initiatives	From now on
Limited information about vehicle availability	Mass production of vehicles and advertising of available vehicle models will improve availability of information. Further awareness raising is needed, highlighting the importance of zero emission transition to shippers, the wider public and other sector stakeholders.	OEMs	Publish catalogues with an available vehicle offer	From now on
		EU and local authorities	Organize information campaigns informing public about EFV availability Continuously raise awareness about importance of the zero emission transition Provide vehicle catalogues	Ongoing Ongoing Continuous
		Associations	Organise information campaigns informing the public about EFVs market Publish catalogues with available vehicle offers	From now on From now on
		Transport operators	Communicate experiences with EFVs	From now on

Table 2 addresses only the barriers that are hampering the wider uptake of the EFVs right now as well as in the coming years. With a growing number of electric vehicles (both passenger and freight) new problems will arise about which it is necessary to think already now. These are, for example, issues such as:

- Grid upgrade: Getting larger electric vehicle fleets in cities requires thinking about the integration with electricity supply and power networks – the new elements in the transport operator value chain. Two critical issues in relation to the grid are: possible necessity of a grid upgrade and deployment of smart grid technologies. In both cases, responsibility for optimal infrastructure provision and grid upgrade lies both with private operators (for stationary charging of their own fleets) and with public authorities/infrastructure and grid operators (for the provision of urban and regional stationary and fast charging infrastructure and grid upgrade). Research and transport and logistics operators further develop and test smart grid technology.

- Battery and EFV recycling: Few possibilities currently exist for a battery at the end of its technical life (which is defined as a 20% degradation of its original capacity). One possibility is to use such vehicles for less demanding operations: it may even be a strategy to specify/purchase EFVs based on the most demanding operations and later move these EFVs on towards less demanding operations or sell the EFV to an operator with less demanding operations. Another possibility is to invest in the use of public (extra) fast charger solutions while time passes. Replacing the vehicle battery and using the aged battery in a stationary application is also possible. Within the same domain, such a battery may be used for peak-shaving purposes in a fast-charging station. The last step is to consider options for mechanical battery recycling after its useful life period. If not properly recycled, hazardous materials from batteries would enter the waste stream, both at the end of a battery's useful life, as well as during its production. At the moment only small quantities of batteries are available and the battery recycling and refurbishment market is not yet mature.
- The necessity to use clean energy will become more urgent with more EFVs entering the market. If we want to speak truly about “zero” emission, than there should be strict consideration of the electricity sources used in the vehicles.

The 2030 CO_2 free city logistics target is approaching fast but it is clear that the market is not yet fully mobilized to achieve this target. However, a solid foundation for this is has been laid now. Even though it is the common responsibility of all the EFV market players to “make it happen”, EU, national and local authorities play a critical role in the process. Policy objectives for zero emission cities are outlined on the EU and national levels, but no firm policy targets, backed up with clear and effective measures are defined. Therefore, the critical message is not passed on to OEMs, transport operators and other market players. Combined with the existing barriers, transport operators are not sufficiently encouraged to invest in new technology and OEMs are not urged to significantly increase their market offer.

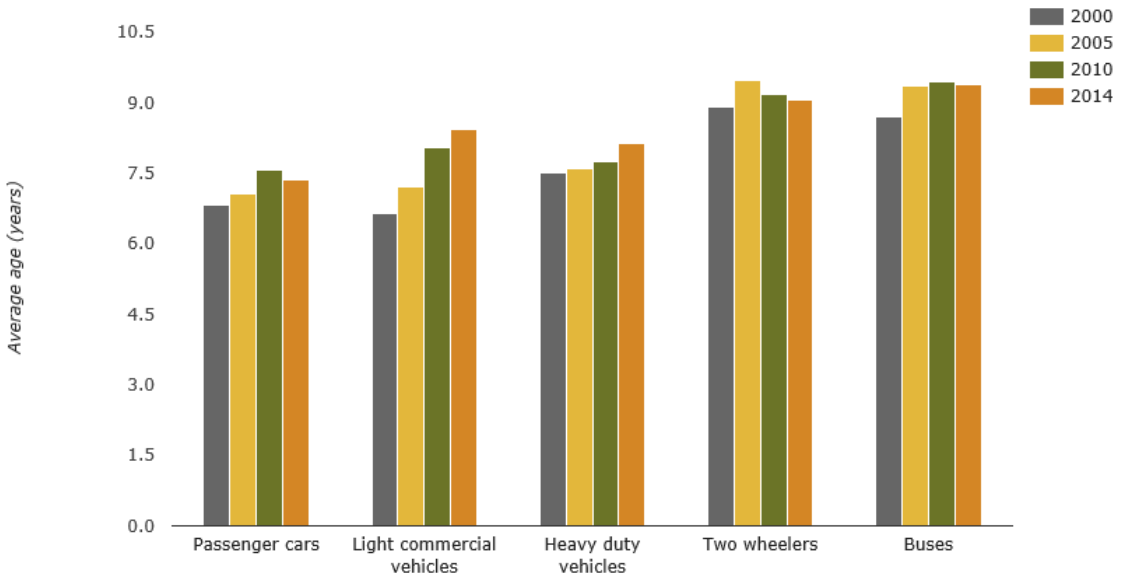

Figure 4 Average age of road vehicles in Europe[2]

Figure 4 illustrates the average age of the European vehicle fleet. When electric vehicles are available on the market it will take on average eight years to "clean" large fleets and, as experience shows, up to 12 years to replace 80% of the entire fleet (for large companies). Once clear policy targets with timelines are presented to OEMs, they also need some years to adjust their production processes and start manufacturing EFVs in large-scale series.

Realistically, for zero emission city logistics to happen, this means that once there is a clear and sound message from the public authorities, it still take over 15 years to realise the transition, without putting logistics operators at risk.

In order to speed up the uptake of the EFVs, it is necessary to facilitate the series production of EFVs, supported by various actions on the charging infrastructure, standardisation, and the development of solid business cases for transport operators. The ensure the latter, a combination of fiscal and operational benefits has to be developed, taking into consideration the development of energy prices, addressing the current situation with decreased payload of the vehicle, and extension of the B drivers license category from 3.5 tonnes to 4.250 tonnes. Overall, a clear message from public authorities is necessary, indicating a firm decision on when the cities (or specific zones in the cities) will become zero emission.

3. Speeding up the EFV uptake: what can be done

Several factors influence the wider uptake of EFVs as described in Chapter 2. In Chapter 3 we look in more detail at some specific areas where key changes need to occur. First, dealing with new technologies and new value networks brings challenges in daily practices of transport operators: critical decisions are to be made and motivation and enthusiasm to integrate EFVs into fleets have to be maintained. Paragraph 3.1, based on the experience of the FREVUE demonstrators, discusses what can be done internally within transport operators to start and support the transition to EFVs. Paragraph 3.2 focuses on the challenges the new players of the EFV market (charging infrastructure operators and grid operators) are facing today and what can be done to decrease the impact of these challenges on the upscaling of EFVs. Paragraph 3.3 investigates what should be done that other forms of EFV ownership, more precisely leasing of the vehicles, become feasible, thereby increasing the options for EFV operators to introduce these vehicles into their fleets. Paragraph 3.4 looks at what could potentially be an efficient policy mix, efficiently supporting the uptake of the EFVs. Finally in paragraph 3.5 we are highlighting how public procurement can play the role in the uptake process.

3.1 Going electric: Facilitation of the internal and external governance processes for transport operators

Currently reported experiences with electric freight vehicles are focused on the driver experiences, procurement experiences, impact on the operations or socio–economic environment. At the same time, as discussed in FREVUE Deliverable 3.2 and Deliverable 1.3 (II), the whole value chain of the transport operators is being changed and relationships

[2]Source:https://www.eea.europa.eu/data-and-maps/indicators/average-age-of-the-vehicle-fleet/average-age-of-the-vehicle-8

with new external parties have to be established. This, of course, influences the company's internal governance processes and its management of the relations with external parties.

These factors, mostly on soft skills and internal organisation, were captured in the FREVUE process evaluation forms that partners filled in on a six-monthly basis during the project lifetime. These forms have focused on the experiences during two main periods: the preparation and the operation phase. The preparation phase includes the vehicle procurement process, installation of charging infrastructure, and changing the logistics models, where necessary. The operation phase is the period in which the electric freight vehicles were running (and continue to run) as part of the organisations' normal operations. The process evaluation identified several internal and external bottlenecks concerning the integration of electric freight vehicles into the company's governance process. It also provided concrete practical suggestions on how to make it a successful internal experience. This section only presents the process feedback and lessons learnt by FREVUE demonstration partners (both cities and operators) as was experienced in practice.

The introduction of electric freight vehicles brings an internal change to the organization. It is an innovation project which comprises: the requirement of new skills within the organization; the potential reorganization of some established logistics models/practices; the establishment and development of new relations; and dealing with uncertainty and new types of risks. Introducing new practices in an organization can be a time-consuming process: relationships with new partners need to be developed; trust-worthy and reliable partners have to be found; unpredictable risks have to be addressed; etc. As the use of EFVs is a new and unknown area, companies were faced with long internal decision-making and validation processes. Transport operators were not only dependent on internal processes, but also on the long decision-making processes with external partners and on time-consuming operations on the side of external parties (e.g. production or retrofitting of the vehicle; maintenance of the vehicle). These issues were difficult to address as they were outside the circle of influence of transport operators.

One of the major problems reported by FREVUE demonstrators is finding a successful and sustainable business model for the operation of EFVs that is valid over time. The standard assessment of costs and benefits still contains a lot of uncertainties that have to be fine-tuned over time.

FREVUE demonstrators have experienced that even though sustainability concerns are largely discussed in the media and priority to them is highlighted at city level, there is still a lack of awareness and engagement among key stakeholders in addressing sustainability topics in practice. Absence of the clear and firm message from the political/policy makers for the subject makes longer term planning of actions more difficult, which makes it harder to generate commitment from other partners and stakeholders.

Another barrier for the implementation of EFVs is the difficulty of engaging new actors (e.g. grid companies, OEMs, leasing companies, parts of the cities) in the process. But also with the traditional market players there is a great complexity in bringing involved actors together to address this new topic. Sharing of information and using a business model that suits many actors is a challenge. Designing a public-private partnership business and management model which allows developing this kind of project is not a straightforward process.

Going through the procurement, preparation and operation of EFVs, FREVUE demonstrators shared their experiences on how the above-mentioned barriers can be addressed. It is important that doing something new could (or should) be engaging and interesting. Overall,

strong internal project management and motivation of the team to make it work is essential. This commitment is important especially in the framework of a fluctuating job market, where organizational restructuring can influence the teams involved. As summarized by one of the FREVUE demonstrators, “pushing through decisions on electrification within an organization requires vision, persistence and partnerships”. Other recommendations from FREVUE demonstrators include (FREVUE, Deliverable 1.3 (I)):

- 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.

On a project management level it is necessary to:

- Have a structured, informed plan prior to implementation to avoid any unexpected delays;
- Include clear “go” or “no go” moments in the project management;
- Work in a team with regular meetings and calls;
- Have a business controller as a team member;
- Have people with necessary skills in the project;
- Monitor the implementation process: it can convince policy makers in the future (if you want to roll it out on a bigger scale).

Next, committed collaboration with different partners is of a high importance. 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. From the beginning, it is necessary to design a cooperation model among private and public bodies in order to achieve a successful operation and profitable business case. Overall, the following communication aspects are important when dealing with EFV implementation as was mentioned by the FREVUE demonstrators:

- Good contact with people and fellow-thinkers is very relevant;
- If possible, get all the parties involved in the total chain from OEM to end customer. At least, collaborate with city authorities, partners with complementary skillsets, and any other partners to exchange information, for example 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.
- Maintain good relations with the companies / authorities that apply for privileges: by phone calls, and arrange a meeting when necessary;
- Try to organize as much as possible from one point of contact to hold all strings;
- Communication in monthly or bi-monthly meetings taking into account all partners;
- When meeting criticism, try and determine what exactly is causing the barrier.

In the process evaluation forms FREVUE demonstrators have reported specific recommendations in relation to different phases of setting up and operating the electric freight transport service.

While setting electric freight transport service, it is advised to start with a pilot: it reduces risks and can be a good showcase to convince other involved parties. In the current situation

of limited vehicle offer and limited information about EFVs, it is important to establish direct contact with OEMs, trying to build specific projects and partnerships.

Specifically for the preparation phase of a demonstration (including the procurement of a vehicle as well as preparation of the infrastructure and of the operational service) the following points were considered to be important:

- Clearly define the procurement process;
- Exchange information in terms of existing suppliers with your network;
- Conduct a market research in order to evaluate the main characteristics of the electric vehicles currently available in the market;
- Try to join forces for procurement of EFVs and use other (EU) projects' key learning points to leverage efficiency;
- Include suppliers in the preparation and planning phase;
- 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;
- Establish partnerships with key stakeholders (e.g. grid operators).

For the operation phase, FREVUE partners recommend the following:

- Foresee more time for testing vehicles on site before real launch (for technical adjustments); it is 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 that all parties understand not only the benefits of EFVs but also discuss the concerns surrounding them such as range restrictions, or (expected) technical issues.

It is useful to support the deployment of EFVs by a marketing campaign attracting attention to the topic of green logistics. This is to inform drivers and customers about the advantages of using EFVs as well as about real life experiences with them. Strong cooperation between city authorities and partners has in some cases been decisive in overcoming technical and legal problems.

In FREVUE several demonstrations have used electric freight vehicles in combination with consolidation centres. As reported in FREVUE Deliverable 1.3 (I), the establishment of consolidation centres has a significant impact on the existing organisation of last mile deliveries – these are difficult to change even when no additional cost occurs 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 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 organisations, 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 organisational maturity to engage in successful collaborative initiatives: Align organisational goals with partners – this is particularly important with partner selection processes; develop a relationship management plan to strengthen overall effectiveness.

3.2 New forms of the stakeholder relationships: charging infrastructure and electricity grid

Electricity is the sole energy carrier for EFVs: the vehicles are powered by batteries that must be recharged, usually from the grid. Operators need to think about charging infrastructure and strategy for their vehicles. Larger vehicle fleets require thinking about how the electric fleet is best integrated with the rest of the system: electricity supply, power networks, and publicly available charging infrastructure networks. This brings new components and new relations in the transport operator value chain: energy companies, grid operators, other electricity consumers, energy regulators, charging infrastructure providers, charging infrastructure operators, etc. In addition to the additional costs for charging infrastructure, this again is often a new knowledge domain for the operator, which requires the investment of time (FREVUE Deliverable 3.2). This paragraph outlines the main challenges that are slowing or will slow down the wider uptake of EFVs from the perspective of the charging infrastructure and electricity grid.

Before getting to the vehicle, electricity has to be produced and transported to the vehicle: from the power plant/alternative energy source to the vehicle charging location, delivered through power grids, via the charging infrastructure electricity gets to the vehicle. Therefore, the wider uptake of EFVs depends on / impacts both the process of electricity production and infrastructure (power grids) that are being used.

Installation of charging infrastructure is currently actively facilitated by many European cities. The main focus area is slow charging for passenger cars (3.7 to 22kW). These charging facilities are not corresponding to the requirements of EFVs, especially for medium- and large-sized trucks. And even though it is argued that the majority of transport operators will have charging infrastructure in-house, publicly available fast charging infrastructure is seen as a booster for opportunity charging, extending the daily range of the vehicle, decreasing drivers' range anxiety and increasing daily operations of the vehicle. As discussed in FREVUE Deliverable 1.3 (II), the general future trend is to increase charging speed in all AC and DC charging modes. Currently, public fast chargers are, even if available, not often used by logistics operators as it requires extra planning. Next, there is the risk that the commercial vehicle has to wait for another vehicle at the charger, which results in potential issues for the rest of its roundtrip (i.e. late deliveries and / or missed time slots).

Even though fast charging is regularly referred to as a future infrastructure supporting electric freight, nowadays there are still a lot of uncertainty about massive deployment of fast charging infrastructure. For example, as reported by OECD/IEA (2016), at 43 kW to 200 kW, fast chargers are likely to require substantial reinforcements of the electricity grid: their usage profile, focused on the need to minimize charging time, is typically not in line with the possibility to provide demand side response. Fast chargers are also likely to be underutilized at night, since they cannot be integrated into low voltage household networks. This transition may result in the change of battery chemistries, as the batteries should be able to cope with

the higher currents and higher temperatures. It is also possible that a dedicated supply line to the grid will be necessary, that is able of delivering the very high currents.

Further improvement of fast charging options themselves is foreseen. Already nowadays 300 kWh charging systems are being trialled in Germany, for example. More research is needed to assess alternative ways of charging, specifically inductive charging schemes, when there is no conductive/galvanic connection between the vehicle and the grid. Instead, the receiver coils within the vehicle are moved into close proximity to the transmitter coils and the charging occurs automatically by magnetic resonance coupling. New charging strategies should be tested: e.g. fast charging while (un)loading at intermediary stops; usage of solar panels on the roofs of the vehicles; top-down pantograph fast-charging systems, etc.

If electric freight is scaled up significantly, what would the impact be on the European energy and electricity system and, specifically, would local municipal electricity grids handle such loads? Due to high power requirements during charging phases, the deployment of electric cars and EFVs can have sizeable impacts on the load profile of the power generation system and load distribution across the electricity network (OECD/IEA, 2016). Specifically, due to the consumption patterns of the vehicles, the load on the power grid will be increasing in the early evening hours coinciding with the highest peaks of household demands.

The electrical grid includes transmission and distribution lines. Back in 2011, CE Delft (2011) stated that “the transmission and distribution network in most EU countries are already operating close to or beyond their rated capacity and some even frequently fail to meet supply due to demand which exceeds their design specifications”. Based on estimations of EEA (2016), the growth in electric vehicle use will result in extra energy demand in the European Union (EU-28): Europe's total electricity consumption by electric vehicles will increase from approximately 0.03 % in 2014 to 9.5 % in 2050. This, coupled with more intensive use of electricity in other sectors, will have a significant impact on electric power distribution and transmission networks in Europe.

The transmission leg involves the bulk transport of electric energy from generating site to an electrical substation. Transmission lines are for the large distances and are of more direct importance for the long distance inter urban logistics flows, therefore are no more discussed further here.

The situation with distribution lines is less straightforward. Distribution lines transport electricity locally: from substations to consumers. They are made for short distances and have lower voltage. The main problem with accommodating the growing amount of EVs is that if uncontrolled, the EV charging will affect peak load factors of distribution grids. Currently the typical situation is that EFVs are being charged once they arrive at the depot after their daily shift, which coincides with the peak electricity demand from households.

This question is of a high concern both to policy makers and grid operators and there is an understanding that as it is, in many places the existing distribution grid will not suffice if we want to have a fully electric fleet by 2025. As experience shows, already now it might develop into a big issue for transport operators that want to upscale their fleets (UPS in FREVUE[3]; German operator as reported by Taeffi (2016)). So, if cities want to go zero emission already now it is necessary to look closely at the local electricity distribution infrastructure and its capacity to support specific fleets at the local level. Cooperation between public authorities, grid operators, charging infrastructure operators and transport

[3] http://frevue.eu/wp-content/uploads/2016/05/FREVUE-UPS-case-study_infrastructure.pdf

operators is essential, in order to identify weak points in the grid and to decide on optimal dedicated locations for the charging points.

Several steps are ongoing on EU level in addressing the above issues. First, the further development of smart grid solutions is key to avoiding potential problems with electricity grids. They offer an efficient solution for network planning, addressing the balance between supply and demand of electricity. As described in FREVUE Deliverable 1.3 (II), the objective of applying smart grid technology is to match the demand to the available supply instead of traditional matching supply to demand. This is achieved by using advanced metering infrastructure systems that allow utilities to charge "time-of-use" electricity rates and to provide predictions for these rates. In smart grid solutions, the EFVs can be acting as decentralized electricity storage. The charging of the EFVs is then regulated to coincide with the availability of electricity. This ability of electric vehicles to be used in a smart, controlled way, could therefore help to minimize potential disruptions of the grid.

The vehicle can be used both for trading of the energy on the spot market, as well as balancing the market. For example, vehicle to grid systems offer an opportunity to not only manage the electricity demand of plug-in electric vehicles, but also to fully integrate EV charging infrastructure into a power network by allowing connected vehicles to sell electricity back into the grid rather than drawing from it. There are a number of V2G projects that are currently being implemented. For example, in May 2016, Nissan and Enel in the UK have started a trial implementing 100 V2G charging units to be used by Nissan Leaf and e-NV200 electric vans. These trials aim at answering many open questions around this new technology (e.g. if active wear of the battery will outweigh the economic benefit from the implementation of the V2G technology, in relation to the offered grid service (grid stability, primary reserve, secondary reserve, etc.)). Common V2G technical standards have not yet been agreed upon and the process efficiency losses have to be overcome.

Implementation of the smart grid solutions is not an easy process. Several technical measures are indispensable for enabling an integrated smart grid (CE Delft, 2011):

- Integrating renewable and conventional power sources into virtual power plants that stabilize supply;
- Increasing transmission capacities and implementing real time transmission grid monitoring;
- For V2G, updating the distribution grid for two way power transmission;
- Smart metering and dynamic pricing for customers, giving incentives to off-peak consumption patterns;
- Demand management including intelligent household appliances;
- Allow the on-board AC charger to support bi-directional power transfer.

Taefi et al (2016) adds that "other charging related issues found were that the implementation of a smart grid and load management for large electrical fleets is not yet clarified; solutions to ensure charging in case of power outage are necessary; and charging plugs were too damageable".

Second, on-going work on standardisation, is an important step for the massive uptake and roll out of the EFVs. Smart grid developments will be supported by the standards that are currently being developed. For example, the IEC 15118, that has to be adopted by the main EV OEMS and EVSE producers, will provide a standard for information exchange which will be required for smart charging within a smart grid environment and will enable reactions on

energy prices. Standardization is also on-going for automatic fast charging solutions of above 40 kW, from which medium and heavy duty vehicles will benefit.

Finally, looking at the upscaling of EFVs, the key reason for upscaling has to be kept in mind – bringing transport emissions down to zero. Electric vehicles are solely powered by electricity and cause zero local pollution, but within current EU electricity mix their overall CO_2 footprint is not yet close to zero. There is strong commitment from the European electricity industry to achieve carbon neutral electricity by 2050 and the work is well underway. The new EU 'Clean Energy For All Europeans' Package (2016) opens energy markets to demand side flexibility and introduction the right for consumers to self-consume, store and generate their energy. Both ingredients can be key to facilitate the impact of the massive EFVs implementation on the electric grid. The package supports the development of reliable energy price comparison tools and the possibility to produce and sell own electricity. The package creates favourable conditions supporting a possibility to consumers (including commercial transport operators) to control their energy consumption and respond to price signals, as well as enabling them to produce and sell their own electricity. This development is largely supporting the development of smart grid solutions.

In order to maintain the key economic benefit of the EFV it is necessary to make sure that the costs for the electricity remain lower compared to diesel. It is obviously important to move towards renewable electricity production to support the well-to-wheel ambitions from the Paris agreement, however, as this may raise the costs for electricity, it is important not disrupt the energy price relation between EFVs and CFVs in favour of the CFVs. To allow for a positive business case around electrical freight transport, the factor (fuelPrice/3.5 - kWhPrice) shall exceed the battery depreciation per kWh, which is to be expected around 0.10 Euro.

Wider EVs uptake largely depends on the availability of charging infrastructure and the capability of electricity network operators and suppliers of electric energy to answer the growing demand of electricity in a time and cost effective way. These are closely interrelated. For example, without adequate location and time signals in electricity pricing, fast charging could become a concern for distribution networks (OECD/IEA, 2016). Therefore, responsibility for optimal charging infrastructure and electricity network provision lies both with private operators and public authorities. For example:

- EU, using appropriate regulation (e.g. Alternative Fuels Infrastructure Directive) can encourage Member States to facilitate the roll- out of sufficient public fast charging points;
- The cost of fast charging options are still extremely high (e.g. DC charging of 150 kW can cost up to 150.000 euros) and individual companies can hardly invest in it; EU and local authorities may think of financial support for installation of public fast charging network;
- Fast charging is typically the responsibility of municipalities or (local) governments, as only big operators may be able to exploit their own fast chargers. In this process, public authorities have to allocate/provide public space for the fast chargers and make sure that these public spaces are close to the mid-voltage grid (close cooperation with local Distribution Grid Operators (DSOs) required);
- EU and local public authorities via appropriate regulation can make it as easy as possible for private parties to install their private charging points;

- EU need to continue with standardization of hardware and software necessary for the charging interoperability at different levels, making sure that charging infrastructure in interoperable in all the aspects, as well allowing more advanced options for the smart grid solutions;
- Local authorities can play a major role in the process of the electricity grid upgrade, bringing together all the relevant stakeholders, addressing key points to upgrade and financial options for this;
- Research partner and transport operators continue developing and trailing out smart grid, V2G and other technologies that allow the full integration of the EV into the grid.

Making sure that the charging infrastructure is available in time will require from public authorities the reinforcement of the local and national electricity grids. These reinforcements typically coincide with upgrades of sewage systems and cable infrastructures and usually happen within the intervals of 30 years. This means, that grid reinforcement and grid storage capacity, required in the transition to the renewable energy has to be consider long ahead.

3.3 Dealing with market barriers through new forms of ownership

Buying an EFV nowadays is not a straightforward process for the transport operator who wants to run a cleaner vehicle: investments in the vehicle are high and risks remain. It is also difficult to finance the purchase of a large electric truck via banks due to the maturity level of the technology. Leasing reduces all risks associated with the vehicle and electric vehicles are excellent candidates for leasing as they typically have a relatively high purchase cost and low running costs.

The number of EFVs deployed, especially in the segment of the medium- and heavy-duty vehicles is very low and the number of vehicles leased represent an even smaller proportion of it. This is because (1) in order to try a new technology a lot of companies were buying their first EFV usually with a help of the public authorities, and (2) there were no leasing options for the EFV market. Nowadays the situation is slowly changing and we see that in some countries the leasing market for the light duty electric vehicles is picking up (e.g. UK, the Netherlands, and Portugal). For example, in FREVUE both Lisbon demonstrators EMEL and CTT have leased the second set of EFVs that they have introduced into their fleets. Athlon (NL), Fleetdrive (UK), Nextgreencar (UK), Voltia (Slowakia, the NL, Germany) are examples of companies that offer leasing of the electric passenger cars but also electric light-duty vehicles. Some manufactures are also offering an option to lease a battery.

Leasing of the vehicle can be financial or operational. With financial leasing the vehicle is placed on the balance sheet of the company and the company itself has high risks of residual value, maintenance costs and is responsible to get rid of the vehicle after its useful life. The leasing company is providing a loan-type service, where at the end of the contract the vehicle belongs to the transport operator. With operational leasing, maintenance and taxes are the part of the contract. The leasing company has all the risks on residual value of the vehicle as after the lease period the vehicle returns to them. Operational leasing is well developed for ICE vehicles and offers some advantages over the ownership for EFVs too:

- Avoidance of the high up-front costs in purchase of the vehicle;
- Foreseen payment structure and facilitated cost control;
- The maintenance of the vehicle and unforeseen technical issues are taken care of;

- No risk related to the depreciation or residual value of the vehicle as there is no ownership of the vehicle.

As described in detail in FREVUE Deliverable 3.2 (2017), in the new situation with EFVs, in most cases the logistics operator is no longer able to buy or lease the vehicle from its normal dealer or leasing company as leasing options for EFVs are very limited. BeliEVe (2014), defined the three main parameters “that make or break the business case for all-electric car leasing compared to leasing of an ICE car. These parameters are: purchase price, residual value and mileage fuel cost”.

Within ICE market, leasing companies are able to offer competitive leasing prices because they buy thousands of vehicles and using their buying power can get a better offer from OEMs. Within the current EFV market leasing companies are losing this competitive advantage, as vehicles are mostly produced on demand and remain very expensive. In addition leasing companies (as well as banks) are used to work with bigger OEMs and are very reluctant to do business with small and unknown manufacturers. For example, in this case they do not have clarity who they need to turn to for maintenance or to whom to return the vehicle in case if it is broken or does not match the expectations.

Next, critical for the leasing industry element is the residual value of the vehicle. As most of the car holders (both in the case of ownership or leasing) would like to change the car before the end of the car’s life, the residual value of the car is crucial for customers. What the residual value of an EFV will be is currently one of the main market uncertainties. The unknown residual value of the vehicle increases leasing fees that transport operators have to pay. The variance between what operators estimate the residual value will be is high. CIRRELT (2014) estimates EFV residual value as 30% of the retail price for the planning horizon of 8 year and 20% for the planning horizon of 10 years (CIRRELT, 2014). According to Lebeau (2016), “residual values might also be captured from used batteries thanks to the development of second hand applications of BEVs batteries. These residual values should be able to recover between 25% to 75% of the initial price in order to reduce the TCO of battery electric vehicles below the TCO of their diesel versions”. FREVUE, Deliverable 3.2 (2017b) uses no residual value in its TCO calculation (as well as some transport operators are doing), but estimates a residual value of the battery of 20%. From the experience of a leasing company, the average residual value of an ICE (leased for 4 years with 30,000 km/year) is 55%, when for EFV this amount is put at 40% for the same conditions.

Closely related to the residual value of the vehicle and the next important for leasing element is the second–hand market of the vehicles. In the case of the passenger cars (including electric) there is quite high differentiation of preferences over the second-hand car, which ensures that there is a customer base large enough to have a second hand vehicle market for each of the steps in the leasing chain. That is not a case with the freight vehicles, where traditionally for ICEs the main vehicle second hand market customers are wholesalers.

As far as concerns the mileage fuel cost of the EFVs, they are relatively low compared to the ICE vehicles. Preservation of the price gap between diesel/petrol and electricity (in a situation when conventional vehicles are becoming cleaner) is critical to maintain a competitive advantage of the EFVs car. Currently, even though mileage fuel cost of the EFVs are low, they are not low enough to get a break even annual mileage of relevance for many large customer segment (BeliEVe, 2014). The leasing service remains too expensive.

Finally, operational leasing of the vehicles includes in the package the maintenance of the vehicle. Even though experiences of already running EFVs shows that in average the

maintenance cost of the EFVs are lower compared to those of the ICEs, there is currently no well-developed infrastructure network for the maintenance of the EFVs. Transport operators are referring back to the OEM in case of technical issues with the vehicle.

The high cost of the battery and a lot of associated to the EFV risks are related to the battery. To reduce these risks and uncertainties for the operators of the battery electric vehicles, manufactures have already developed solutions by providing a warranty on the battery or by offering the possibility of leasing the battery (Lebeau, 2016). Within the “battery leasing model” the battery remains in a property of the manufacturer, who also bares all necessary repair costs. The costs of the battery are spread to the transport operator via monthly payments within a renting scheme. Within this scheme, the risk of the battery is transferred to manufactures, but the uncertainty related to the batteries affects estimated residual value of the vehicle and its depreciation period. Still, comparing the ownership of the battery and its leasing, Lebeau (2016) comes to the conclusion that the battery leasing model reduces the TCO of the vehicle compared to the battery ownership model. This scheme can be potentially a good way for the future, when more is known about the overall residual value of the vehicle.

For these reasons, specifically for the market segment of medium and heavy duty vehicles, where there is no large scale production of the vehicles, the leasing companies are currently not setting up the leasing service. The situation with an offer or the light duty vehicles is a bit better and only couple of companies are offering the leasing service. The companies that are leasing the EFVs additionally to providing a vehicle are offering a range of accompanying services. These services, for example, include: analysis of vehicle fleet, ensuring companies are using the most suitable vehicles for their businesses; analysis of driving routes and their suitability for incorporation electric vehicles; offer information about charge point locations and charging options; provide guidance on electric driving styles and organize driver trainings.

Looking into the future of the EFVs leasing, some experience can be learnt from the electric passenger car market, where the leasing service market is more advanced compared to the electric freight vehicles. Specifically, currently available knowledge (for hybrid cars) shows that there is not much devaluation of the electric battery. After 5 years of vehicle operations batteries are still on 95% compared to their full capacity. Lebeau (2016) confirms this, saying that “there is indeed a potential for a second hand market of BEV batteries since 80% of the battery capacity remains when it reaches its end life for transport operations”. Devaluation of the battery is much better that was initially expected. The leasing companies are still including the risks in, but that is already clear that the risk is not as high as it was initially expected. Additionally, as concerns the utilization of the battery after a certain lifetime, it is also possible to replace some modules of the system and not the whole battery, which also reduce additional investment costs. Vehicle maintenance remains a critical problem for the electric passenger cars. There are 5 – 6 dedicated dealers each having a dedicated workshop for the electric vehicles. When technical issues occur, companies can only appeal to the dedicated dealer network. If an efficient maintenance to be achieved, it is necessary to have repair workshops where service can be performed for any car brands. Also it is observed that customers are still having range anxiety and prefer to wait for more mature technology

Overall, for the EFVs leasing to pick up, there should be a solid offer of the EFVs from the large manufacturers: leasing companies are waiting until the big OEMs will pick up the

challenge. As more OEMs have announced to introduce large electric vehicles to the market, it is expected that the price of the vehicle will fall which will positively influence the wider uptake of the EFVs and facilitate the setting up of the leasing schemes. Battery technology improvement will also lead to decreasing prices of EFVs and positively impact the leasing of EFVs. More developed and clear opportunities of using electric batteries and vehicles after their first or even second life will also improve residual value of the vehicle and increase second hand market options for the vehicles and the batteries. BeliEVe (2014) suggests that leasing companies can even look for an additional value from collecting battery-, use- and charging statistics for key partner as the value of that information is currently unknown and might be of use for key partners.

Policy support for the EFVs market can also play a role in further development of leasing options. When the purchase of the vehicle is subsidized, that helps the first buyer of the vehicle to improve his TCO, but does not bring additional value to the second or third users. In this sense, operational incentives, more related to the usage of the vehicle, can help the development of the second hand market, thus decreasing the risks for the leasing companies.

3.4 Finding a proper policy mix, efficiently supporting freight electromobility on the local level

Development and uptake of the EFV market is a responsibility shared by all market players involved. Still, in its current stage appropriate government policy is crucial in order to achieve the wider uptake of the EVs. Today, public authorities support is taking place in different areas: support for the development of charging infrastructure, standardisation processes, direct subsidies for the purchase of the vehicle/infrastructure, raising public awareness about the operational and environmental performance of the EFVs, showing an example by implementing EFVs in its own fleets or introducing environmental requirements in the tendering process.

Through the years of the FREVUE project, we have observed how governments were looking at the best way to provide market certainty, given current technological capabilities of the vehicles, its market supply and availability of infrastructure. Nowadays there is an understanding that, first, an efficient policy mix is needed, combining both direct support for the vehicles and infrastructure as well as the creation of long-term operational advantages for EFVs. Measures both supporting the usage of EFVs and discouraging the usage of ICEs are required. Second, transport operators acquiring EFVs include both, big companies and SMEs, there are different types of incentives to develop. Today, the main question for local policy makers is not only which instrument to choose, but also how to apply it in the way that its intended effects are maximized and unanticipated effects are reduced.

A more integrated approach to EFV management, as reported in 2015, means that nowadays targeted financial support schemes or infrastructure research and support projects are becoming integrated programmes supporting local electromobility in all of its aspects and mobilising the variety of stakeholders together (FREVUE, 2017a).

It is possible to group different interventions in four type of measures:

- Economic/fiscal measures
- Regulatory/legal measures
- Planning measures

- Communicating and raising awareness measures.

Economic and fiscal measures aim to improve the total cost of ownership of the electric freight vehicles. These are political instruments that aim at guiding the behaviour of individuals and companies in a desired direction by means of economic incentives. Concrete examples of fiscal/economic measures are: local tax incentives, tolls, congestion charges, road user chargers, but also vehicle taxes and fuel duties. In a survey of transport operators conducted by Lebeau (2016), respondents were asked about the most important policy measures that the authorities should implement. The results showed that transport operators primarily support measures that reduce the costs of BEVs: “In particular, an exemption for BEVs from a kilometre tax is seen as a priority. Subsidies for the purchase of BEVs, fiscal deductions for BEVs and exemption from an urban toll at the city entrance for BEVs are other measures that are strongly supported by respondents”.

Legal/regulatory measures are, so-called, “command and control” measures in which a specific restriction is introduced and must then be controlled. These measure require existence of the enforcement mechanism. A municipality can introduce local traffic regulations on public roads relating to speed of travel, stopping or parking, or any other operational characteristic of the traffic. Overall, 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. While providing operational incentives from which EFVs will benefit, is it also necessary to implement stricter enforcement of fines for conventional vehicles. That would, for example, prevent conventional vehicles to park at the exempted locations, as well as prevent passenger cars to stop at (un)loading bays, making the exemptions more valuable. Other examples of the possible exceptions are:

- Access regulations: pedestrian zones, low emission zones, zero emission zones;
- Parking and loading/unloading permissions: granting permissions for EFVs to park and (un)load for free/use privileged loading areas;
- Use bus/tram or cycle lanes: allow circulation of the EFVs in the lanes dedicated for other transport modes;
- Wider time-windows of deliveries for the EFVs.

Communication and awareness measures aim to address the barrier of a lack of information about EFVs as well as target new potential users. They aim at disseminating experiences about the performance of the EFVs and to explain the costs and benefits of EFVs to transport operators. Communication and awareness measures include: creation of logistics measures, targeted dissemination of information and research and development. Logistics networks are groupings of a number of different stakeholders in the urban logistics sector, meeting regularly and discussing current challenges in the urban transport as well as possibilities to mitigate those. Lack of awareness about real costs and benefits of the EFVs was identified as one of the barriers currently experienced by small transport operators. That is why, even though, dissemination of information is a “soft” measure that is not requiring any regulation or so, it can have a very large impact. Information has the potential to influence behaviour of market players and provide increased knowledge on the subject. Finally, research and development is still needed in the area of the EFVs, specifically in relation to the battery efficiency and clean energy sources.

Planning measures refer to the policy direction that introduce the changes in the city. Those are large variety of them. For the EFVs so far the most relevant were: installation of charging infrastructure, development of the urban consolidation centers, development and support of the maintenance network, etc. In some cities, for example, like London, facilitating the access to the real estate in the city centre (converting it to UCCs) is key to create a favourable business case for EFVs in city logistics. Overall, the provision of the public charging infrastructure network largely depends on the participation of the public authorities. Procurement and own fleet replacement are also powerful tools municipalities can use and is developed more in detail in other sections of this proposal.

All these measures have a potential to increase the uptake of the EFVs in city logistics. Thought, they need to be used within an intelligent mix, taking in account counter-effects of each other.

For example, in January 2016 Transport for London (TfL) has launched the LoCITY programme with the aim to encourage the uptake of low emission commercial vehicles. LoCITY is a five-year industry-led collaborative programme that has brought together fleet operators, central and local government and other public sector organisations, vehicle manufacturers, and refuelling and recharging suppliers to improve air quality. In line with the discussion above, LoCITY research has identified that the following barriers were slowing down the uptake of the electric commercial fleets in London:

- Lack of clarity around what constitutes ‘low emission’ and ‘ultra low emission’ commercial vehicles
- The absence of a clear policy drive for alternatively fuelled vehicles
- Vehicle manufacturers said that there was a lack of demand and insufficient policy support or clarity on new policy timescales
- Fleet operators reported that the lack of suitable alternative vehicles was the main issue deterring them from upgrading their fleets
- Infrastructure providers have experienced difficulties establishing sufficient demand for infrastructure and accessing affordable land
- Concerns over vehicle operational capability and whole life costs. Upfront costs are the most significant barrier to take-up of ultra low emission vehicles, with a lack of independent information also a concern

Addressing these barriers, the objectives of the programme are to: Support freight and fleet operators, vehicle manufacturers and infrastructure suppliers to increase the availability and uptake of ultra low and zero emission commercial vehicles; Support boroughs in upgrading fleets to cleaner vehicles and alternative fuels; Prepare the freight industry for the introduction of the Ultra Low Emission Zone (ULEZ); Aid the reduction in air pollution in London, delivering health benefits for Londoners, and help meet targets on climate change. LoCITY is structured into three work streams:

- Vehicles: increase the availability and affordability of viable low emission commercial vehicles.
- Infrastructure: establish alternative fuel and supply chain infrastructure to support the uptake of cleaner commercial vehicles.
- Communication: improve understanding through jargon-free communications. Highlight the bold steps organisations are already taking. Inform future fleet buying decisions.

Stakeholder engagement and interaction is considered critical to the success of the programme: Nearly 1,000 individuals from over 600 organisations are involved in the LoCITY programme. Four working groups have been set up to provide expert advice and guidance on LoCITY and its outputs, each covering a particular part of the commercial vehicle market: Vans; Waste & Construction, HGVs; and Policy, Planning & Procurement. The groups are comprised of stakeholders including vehicle manufacturers, fleet operators, central and local government, recharging and refuelling infrastructure providers and trade associations. Delegates work together to identify and overcome the barriers to uptake of alternatively fuelled vans and HGVs.

Concrete achievements of the programme so far include major engagement of stakeholders in key electromobility events (e.g. LoCITY first annual conference); raising awareness through video case studies (e.g. operators sharing experiences with electric vans or which type of fuel to use in the fleets); development of tools for fleet managers (e.g. an interactive online tool providing details about the availability of alternatively fuelled commercial vehicles; a one-stop-shop interactive online map showing the locations of recharging and refuelling infrastructure in London and the Home Counties); an industry-leading training course and supporting e-learning modules; as well as the LoCITY Fleet Manager Toolkit.

LoCITY programme is in its second year of functioning, but evaluation of the measures undertaken has shown that the following strategies are highly effective:

- Providing trusted information to fleets, with a focus on whole life cost data and real-world case studies
- Giving fleets hand-on experience with vehicles, and the opportunity to hear from other fleets that are already using or trialling this technology
- Facilitating the provision of infrastructure to support vehicles, covering drivers' homes, depots, and on-street locations
- Leveraging the influence of procurement and contracts to incentivise accelerated uptake of cleaner vehicles

Another example is City of Amsterdam that is a FREVUE project partner and is supporting freight electric mobility through a combination of measures:

- Stimulating:
    - Subsidy schemes for electric vehicles: Delivery vans can receive 5000 euro subsidy per vehicle. Trucks and Vans can receive 20% of the purchase value, with a maximum of 40.000 euro.
    - Traffic regulations exemptions for operators using electric freight vehicles
    - Practice what you preach: encouraging zero emission deliveries in the procurement of our own office supplies: Coffee and paper is already being delivered by electric vehicles.
- Facilitating:
    - Build a platform: Front runners "Amsterdam Electric": different network meetings are organized in which different companies (companies with electric freight vehicles, companies who sell electric freight vehicles, research institutions, companies with an interest in electric freight vehicles) are brought together and discuss the obstacles these companies run into when wanting to take the next step in driving with electric freight vehicles.
- Regulating:

- Low emission zones for trucks and vans: since 2009 it is prohibited to drive in Amsterdam for trucks (N2, N3) with an diesel engine lower than euroclass IV. Since 2017 this is also prohibited for Vans (N1) with a diesel engine form 1999 and older.
- Emission free in 2025: There is an agreement with the business that al vans that drive in the city will be electric vehicles by 2025. Trucks should be as clean as possible.

Furthermore, from March 2015 to April 2017 there was a pilot with traffic regulations exemptions for operators using electric freight vehicles, for both vans and trucks: approximately 20 vehicles from 7 companies were exempted from parking prohibitions in tailored designated areas. These exemptions allow electric freight vehicles to (un)load directly to the pavement, to operate outside the time access windows and to enter certain pedestrian zones. The areas were defined based on participant's preference and traffic situation, and the logistics operators could ask for exemptions specific to their business. As a result, the number of exemptions provided varied by participating operators, ranging from three to 28. This pilot was evaluated and the evaluation results show that operators give a positive feedback on the privileges, due to the operational benefits perceived. Also the enthusiasm reported by the drivers plays a role: less stress, fewer confrontations with the general public and enforcement officers, fewer fines, and less time pressure resulted in a more pleasant working environment. Due to positive results the Municipal Executive decided to transform the pilot to the policy. From the first of April it is already possible for companies to get exemptions throughout the entire city (instead of just the city center). At the end of 2017 the traffic regulations exemptions for electric vehicles will be included in the broader exemptions policy.

Looking on the more aggregate level on what public authorities can do in order to accelerate the market take up of the EFVs, there several policy options that can help municipalities to assist with an uptake of the EFVs.

Communication and awareness measures are necessary to inform and educate stakeholders. These measures address the barrier of lack of information about the EFVs as well as target new potential users of the EFVs. They aim at disseminating experiences with the performance of the EFVs and explain costs and benefits of riding electric to the transport operators.

Fiscal measures change the fiscal burden on the EFV, improving TCO of the vehicle. In a survey of transport operators, Lebeau et al (2016) asked their respondents about the most important policy measures that the authorities should implement. The results showed that transport operators primarily support measures that reduce the costs of BEVs: "In particular, an exemption for BEVs from a kilometre tax is seen as a priority. Subsidies for the purchase of BEVs, fiscal deductions for BEVs and exemption from an urban toll at the city entrance for BEVs are other measures that are strongly supported by respondents". Concrete examples of fiscal measures are: local tax incentives, tolls, congestion charges.

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. Legal and regulatory measures influence the behaviour of stakeholders by enabling favourable conditions for the EFVs or prohibiting specific spectrum of activities in

specific conditions for the conventional vehicles. These measures aim at providing operational incentives for the EFVs users. Operational incentives include:

- Access regulations: pedestrian zones, low emission zones, zero emission zones;
- Parking and loading/unloading permissions: granting permissions for the EFVs to park and unload for free/use privileged loading areas;
- Use bus or cycle lanes: allow circulation of the EFVs in the lanes dedicated for other transport modes;
- Wider time-windows Often delivery time windows based on regulations and shop opening hours, are rather short, reducing the operating time to as little as one hour. As a result, operators employ several vehicles to carry out all the deliveries, with more than one man per vehicle. A wider time window would reduce the vehicles on the streets as well as staff costs;
- Similar to bus lanes, the tram-lanes can be used. The operators agree that the use of tram lanes would save time, due to usual traffic jams on car lanes.

Providing operational incentives from which EFVs will benefit ICEs, is it also necessary to implement stricter enforcement of fines for conventional vehicles. That would, for example, prevent conventional vehicles to park at the exempted locations, as well as prevent passenger cars to stop at (un)loading bays, making the exemptions more valuable. Therefore the use of electric vehicles for freight would be further encouraged.

Finally, planning measures refer to changes in the city: infrastructure, built environment, business activities. Here, the role of public authorities is crucial as well. In some cities, for example, like London, facilitating the access to the real estate in the city centre (converting it to the UCCs) is a key to create a favourable business case for the EFVs in city logistics. Overall, provision of the public charging infrastructure network largely depends on the participation of the public authorities.

To effectively obtain benefits from synergies measures should be coherently packed together with a clear stated objective (EC, 2017). FREVUE, Deliverable 3.4 (2016), provides with a detailed analysis of the state and municipal measures, looking into how using various incentives and policy instruments, public authorities can positively influence goods transportation in cities. A single measure seldom produces an optimal impact by itself. Instead, a combination of several different policy instruments and incentives is required to achieve the desired effect. Urban measures have to be chosen carefully, deepening on the context and unique features within specific municipalities. As defined in FREVUE, Deliverable 3.4, each category of policy measure impacts differently urban logistics activity and have different impact on other ongoing initiatives, which needs to be taken in consideration while developing appropriate policy mix.

While thinking about developing an efficient policy mix that is also necessary to take into consideration that any specific measure brings along conflicting interests with which politicians will have to deal. For example, when giving privileges to EV's you have to deal with limited public space, spacial design, safety issues etc. Another example is that each extra public charging point for electric vehicle provides less parking space for other non-electric vehicles (FREVUE, Amsterdam process evaluation form).

At this current moment, the financial barrier for purchasing and exploiting EFV is the most critical to address, especially for the heavier vehicle types. For this, series production of the EFVs should be facilitated. Cities can contribute in the improvement of the TCO for the EFVs

by providing operational privileges. Still, with this way they cannot provide the required means for this financial instrument on their own and need to team up and mobilize their national transport departments, which in turn should aim for an EU effort (FREVUE process evaluation forms). Based on the experiences from the FREVUE the following listed actions from public authorities at different levels are seen as highly favourable to further support freight electromobility.

EU policy needs to further address positive discrimination of the EFVs. Funding programs financing fleets electrification (vehicles and infrastructure) and continuation of demonstration projects that will allow both transport operators to get acquainted with new technology and will allow manufactures to fine-tune the vehicles are important. Networks bringing different electromobility stakeholders for exchange of ideas and experiences are of a high value. A platform / market place where all types of suppliers, incl. small and new ones can present their offer can improve the lack of information about available EFVs models and facilitate the choice of the EVs for the operators. Continuation of standardization processes is a key for the implementation of a universal EU EFV system. Another question to address on the level of EU an national regulation is the driver license exception for 3.5 tonne vehicles upgraded to 4.25 tonne vehicles (as currently discussed in NL) to compensate for higher vehicle weight due to batteries without compromising on payload.

National and local governments also play an important role in contribution to the EFV uptake. Enforcement of regulation on charging infrastructure; investments and funding programs supporting the fast charging; reduction on national taxes for electric vehicles; removing of legal barriers; creation of concrete operational incentives; development of tender procedures for service awards with priority for companies delivering with electric vehicles. City authorities will play an important role in the process of the local electricity grid upgrade.

But first, and the least, in order to achieve a definitive commitment for the further development of the EFVs from all other stakeholders, public authorities (at all levels) have to pass a firm and clear (joint) message of the date when only emission less vehicles will be allowed into the city(ies).

3.5 Using public procurement to stimulate EFVs uptake

Public procurement has a strong potential in assisting the uptake of the clean vehicles in city logistics. Public authorities purchasing goods and services generate a lot of transport flows in a city. It is estimated that the expenditures of public authorities constitute approximately 14% of the overall gross domestic product in Europe (JRC, 2017). Additionally public authorities operate their own fleets for which they can set up concrete renewal targets. Thus, public authorities, additional to their regulation power are also a powerful purchaser on the market. Table 3 illustrates the role of the public sector in different EU vehicle markets and its potential influence on decarbonisation of urban transport. Reflecting on this table, JRC (2017) estimates that “the public sector is responsible for procuring around 575 000 vehicles a year and relevant services that might have a value in the order of billions of Euros, particularly when considering that no information was available for bus or waste collection services. Where information was available, it was clear that the vehicle markets are still dominated by vehicles using diesel and petrol, rather than those using alternative fuels, while the fleets are dominated by vehicles that meet Euro emissions standards of Euro 4/IV or earlier”.

Table 3 The size of the respective markets and the role of the public sector in these

Vehicle/service	Size of the EU market	Proportion of which is operated/purchased by the public sector (estimates)
Passenger cars	14.6 million vehicles (new registrations 2016)	3.4% (496 000 vehicles)
Light commercial vehicles	1.9 million vehicles (new registrations 2016)	2.8% (53 000 vehicles)
Buses and coaches (> 3.5t)	36 000 (new registrations 2016)	75% (27 000 vehicles)
Waste collection trucks	4 500 (estimated new registrations, 2013)	Nearly 100% (4 500 vehicles)
Post and courier services	€91 billion (2011)	No more than 5% (postal) No more than 1% (courier)
Moving services	No data	No more than 2%

Source: JRC, 2017

In the EU, public procurement is regulated by the Clean Vehicles Directive (The Directive on the Promotion of Clean and Energy Efficient Road Transport Vehicles (2009/33/EC)). The Directive aims at a broad market introduction of the environmentally-friendly vehicles. It requires that energy and environmental impacts linked to the operation of vehicles over their whole lifetime are taken into account in all purchases of road transport vehicles (as covered by the public procurement Directives and the public service Regulation)[4]. In other words, it obliges public authorities and public transport operators to consider energy efficiency, CO_2 emissions and local pollutants such as particulates and NO_x in their procurement decision. Currently the Clean vehicle directive is under review, aiming to address the gaps in the existing Regulation.

Another relevant on-going development is the Revision of the EU Green Public Procurement Criteria for Transport. Green Public Procurement (GPP) is defined in the Commission's Communication "COM (2008) 400 - Public procurement for a better environment" as "a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured"[5]. The EU GPP criteria are developed to facilitate the inclusion of green requirements in public tender documents, looking for the balance between environmental performance, cost considerations, market availability and ease of verification. GPP criteria are not mandatory and procuring authorities may choose, according to their needs and ambition level, to include all or only certain requirements in their tender documents.

Supported by these and recognising the importance of the zero – emission cities target, more and more public authorities identify internal targets to decarbonize their own fleet and/or to decrease the environmental impact from their activities. For this, first, it is necessary to have a clear understanding what kind of purchase decisions and overall activities performed by public authorities generate transport activity. BuyZET (2017) identifies three main transport service categories:

[4] https://ec.europa.eu/transport/themes/urban/vehicles/directive_en
[5] http://ec.europa.eu/environment/gpp/faq_en.htm

- The services performed by municipality with its own fleet: the vehicles are owned and operated by the city itself. The city has a direct influence through procurement on the kind of vehicles used to carry out specific services.
- Procurement of services for which the transportation of people or goods is the central component but which are performed for municipality by a third party provider using the third party provider's transport fleet. The level of influence the municipality have on the type of vehicle used is different depending on the contract.
- Procurement of goods, works and services which involve an element of transportation of people or goods which are performed for municipalities, by a third party provider using the third party provider's transport fleet. It includes vehicles of the city's suppliers of goods and services or their transport service providers. The municipality has only indirect influence on the procurement of the vehicles used.

Having a clear understanding of the types and amount of services falling under each category is critical as it reflects the degree of influence the municipality has in making its procurement activities emission free. Depending on this degree of influence, different strategies to reach an impact are developed, e.g.: setting a target to make the municipality's own fleet zero emission and acting as an example to other organizations; setting regulatory standards; investing in necessary infrastructure; introducing zero emission fleet criteria in the procurement contracts and this way influencing vehicle fleets of third party providers.

Some European cities have already established targets on bringing their own fleets to zero-emission and are successfully introducing EVs in their fleets. For example,

- The City of Rotterdam has more than 100 electric vehicles driving about in its own fleet. This includes segways, electric scooters, private cars, delivery vans and hybrid trucks. The short term target is to have 50% of its own fleet electric by 2018 (Rotterdam Electric program, City of Rotterdam; Rotterdam Climate Initiative (2015));
- Municipality of Copenhagen target is by 2025 have all city administration vehicles run on electricity, hydrogen or biofuels. By the end of 2016 already 85% of the vehicles were emission free;
- Since more than a decade, Stockholm municipality only introduced clean vehicles in its fleet. Today, 100% of the fleet is running on electricity, ethanol or biogas.
- 13% of Lisbon municipality fleet are EVs or 108 vehicles[6].

For services provided by municipality own fleet electric (freight) vehicles can be used for collecting waste, cleaning streets, providing food to schools or hospitals. "Transport" profile of these operations fits perfectly to the operational profile of the electric drive systems: pre-defined routes; limited range; a lot of stops; etc. Own fleet vehicles are "the easiest" to target for public authorities, as they have a full impact on the decisions about the fleet renewal.

Next, public authorities have a big influence on the public transport fleets. Public authorities are not owing the vehicles, but still have a direct and strong influence on the procurement of this transport service. Support for the introduction of the electric buses is specifically important for the development of the EFVs, as further development and practical

[6] http://www.ebridge-project.eu/it/news-events/340-electric-vehicles-in-the-municipal-fleet-the-pioneering-experience-of-camara-municipal-de-lisboa

implementation of this segment is beneficial for the further upscaling of the medium and heavy duty EFVs. The benefits are not straightforward, but more on the level of possible developments with batteries, fast charging infrastructure developments and other experiences with the segment of medium and heavy duty vehicles. Results of ZeEUS project show that "19 public transport operators and authorities, covering around 25 European cities, have a published e-bus strategy for 2020. By this date, there should be more than 2,500 electric buses operating in these cities, representing 6% of their total fleet of 40,000. Meanwhile, more than 13 public transport operators and authorities in a further 18 European cities have a strategy up to 2025; by then, they are expected to have more than 6,100 electric buses in service, representing 43% of their total fleet of 14,000. The greatest number of electric buses of the above types can be seen in the United Kingdom, with over 18% of the total European fleet, followed by the Netherlands, Switzerland, Poland and Germany, with around 10% each"[7].

Finally, public authorities can introduce green public procurement criteria in the tendering process for purchasing contracts of goods, services and works. Usually, transport activity generated by implementation of these contracts is very hard to influence, as amount of contractors and number of trips they generate is very high. City of Stockholm is one of the good examples of introduction of stronger environmental requirements for transport within the public tendering process for transport (please, see FREVUE Factsheet Stockholm for more information). Recognizing that each sector is unique, the city has taken into consideration each sector's specific characteristics: industry composition, types of vehicles used, maturity of the industry in regards to environmental requirements, vehicle lifetime, etc. that prices were not affected by the environmental requirements and green procurement has not limited competition. Environmental criteria were introduced for three types of contracts: passenger transport, relocation and furniture, delivery of groceries.

As reported by Stockholm (Stockholm City, 2016) the evaluation of experiences have shown that: the city's green procurement has not led to price rises. "Furthermore, they have not led to a reduction in market competitiveness in the short term. Results from analysis show that the requirements are set in such a way to allow companies with reasonable economic performance to fulfil the requirements over time. At the same time, research has shown that environmental requirements can lead to a modernisation that can in turn lead to a decreased number of transport companies in the long term. If old companies are replaced by new companies whose business better meets the market demands for clean and low carbon transport, this development can be seen as positive. (…) The city's green procurement speeds up the transition to a fossil free vehicle fleet in an area that has few policy measures that can be applied. Statistics show that the share of environmentally friendly trucks is higher in Stockholm than in the rest of the country, which partly can be explained by the city's work. Several of the companies that are tendered by the city are moving towards a vehicle fleet that can completely operate on renewable fuels. The environmental benefit of the city's requirements is thus greater than the direct impact of reduced emissions of transport directly related to the City of Stockholm's work".

Summarizing, public procurement is a powerful tool in fostering the uptake of the EFVs. First, by promoting and using GPP, public authorities can provide industry with real incentives for developing green technologies and products. In some sectors, public purchasers have a large share of the market and their decisions will have a considerable

[7] http://www.uitp.org/news/zeeus-report

impact on the fleet composition for these services. Second, while implementing EVs in their fleets municipalities directly contribute in reduction of the emissions and are setting up an example for private operators. Going through all the steps of procuring, preparing and implementing the electric (freight) vehicle, public authorities face all the challenges and barriers alongside the process themselves, thus gaining a valuable experience and critical knowledge on what should be addressed in order to facilitate the E(F)Vs uptake. It is then also more acceptable to transport operators to accept the message of going electric if the municipality shows a clear example.

4. Conclusion: towards zero emission city logistics

In the Transport White Paper (COM (2011) 144 final), the European Union provides a very clear message: emissions of air pollutants from transport that harm our health need to be drastically reduced. The EC is presently supporting three main alternative types of fuels and propulsion technologies: battery electric and hybrid plug-in electric vehicles; hydrogen and fuel cells and; biofuels, liquid or gaseous. Electric vehicles are consensually regarded as the most promising alternative to replace ICEs in the context of urban logistics.

Demonstrations conducted within FREVUE project have illustrated that electric freight vehicles have a set of clear advantages:

- In the correct setting, EFVs are felt to be better than equivalent conventional vehicles;
- They have lower operating costs for transport operators;
- They improve the working environment for drivers. EVs are silent from which both the drivers and pedestrians will benefit. The drivers also noted reduced smell of exhaust fumes as an advantage.
- Support (in form of subsidies and long term benefits) exist aimed to facilitate the introduction of electric vehicles in companies fleets.

Despite the advantages listed, wider uptake of the vehicles has been slow. This is due to a number of reasons, which are discussed in FREVUE deliverables 3.1 – 3.4 as well as FREVUE deliverables 1.3 and are summarized in Chapter 2 of this document. The most critical barriers are: limited offer from the OEMs, specifically for the segment of the medium and heavy duty vehicles; high purchase price of the vehicles, even though the total cost of running a vehicle includes low fuel and maintenance costs advantages; long vehicle depreciation time; required technological improvements of the vehicles (range, payload, performance of auxiliaries in extremely hot and cold conditions); availability of charging infrastructure and potential for its technological improvement. In this deliverable we discussed what type of developments have to take place to support the further uptake of the EFVs market.

Facilitation of the internal and external governance processes

The introduction of electric freight vehicles brings an internal change to the organization. It is an innovative project which comprises: the requirement of new skills within the organization; the potential reorganization of some established logistics models/practices; the establishment and development of new relations; and dealing with uncertainty and new types of risks. Overall, strong internal project management and motivation of the team to make it work is essential. It is necessary to have a team that shares the same vision, and would like and are able to move forward despite the problems encountered. Strong internal leadership is crucial, as with the introduction of an electric freight vehicle service you need to have the ability to adapt to new situations along the way. From the beginning, it is necessary to design a cooperation model among private and public bodies in order to achieve a successful operation and positive business case. Committed collaboration with different stakeholders in the EFVs market is of a high importance. A large deployment of electric vehicles is unlikely to occur until the optimal combination of vehicles, infrastructure, services, financial incentives and environmental awareness is in place.

New forms of the stakeholder relationships: charging infrastructure and electricity grid

Switching to electric vehicles, transport operators can no longer use the easily accessible fuel station network. They need to think about charging infrastructure and strategy for its vehicles. Getting larger vehicle fleets requires thinking about how the electric fleet is best integrated with the rest of the system: electricity supply, power networks and publicly available charging infrastructure networks. This brings new components and new relations in the transport operator value chain: energy companies, other electricity consumers, energy regulators, charging infrastructure producers, charging infra operators, grid operators, etc. The wider EVs uptake largely depends on the availability of charging infrastructure and the capability of electricity network operators and suppliers of electricity to assist with the growing demand of electricity in a time and cost effective way. The responsibility for optimal charging infrastructure and electricity network provision lies both with private operators and public authorities. EU and national public authorities need to further support and encourage the development of public fast charging and private charging infrastructure networks, making sure that infrastructure is available on-time to support the growing number of EVs. It is necessary to make sure that this charging infrastructure is interoperable in all aspects: from technological (e.g. connectors/wireless energy transduces) to communication protocols and payment options. Local and national authorities together with grid operators have to work on the electricity grid upgrade. Research institutes and transport operators continue developing and trialling smart grid, V2G and other technologies that allow the full integration of the EV into the grid.

Dealing with market barriers through new forms of ownership

Buying an EFV is not a straightforward process: investments in the vehicles are high. It is also more difficult to finance a purchase of a large electric truck as banks are not willingly developing loans for this market as technology is considered to be innovative and associated risks are too high. Considering the risks associated to the EFV, the leasing option would be an interesting one for the transport operator as it reduces all the risks associated with the vehicle. Nowadays only a few companies are offering the leasing option for electric light duty vehicles. For the leasing option to increase, first, there needs to be a larger offering of EFVs from manufacturers: leasing companies are waiting until the big OEMs will pick up the challenge. As more OEMs announce to introduce large electric vehicles to the market, it is expected that the price of the vehicle will fall which will positively influence the wider uptake of the EFVs and facilitate the setting up of the leasing schemes. Further developments in battery technology will also lead to decreasing prices of EFVs and positively impact the leasing of the electric vehicles. Next, with clear opportunities of second-hand usage of the electric vehicles and electric batteries, the residual value of the vehicles will improve, as well as the second-hand market options, which will also improve the leasing case. In this sense, operational incentives, more related to the usage of the vehicle, will support the development of the second hand market, thus decreasing the risks for the leasing companies. The low fuel cost of EFVs remains one of the main factors supporting their business case compared to that of ICE vehicles. Preservation of the price advantage between diesel/petrol and electricity (in a situation when conventional vehicles are becoming cleaner) is critical to maintain a competitive advantage of the EFVs and making leasing option possible.

Finding a proper policy mix

Policy incentives still need to "lead the way" in order to provide a successful uptake of the EFVs market. Political leadership and vision are not negligible factors in the process of implementation of the EFVs for the daily practices of the transport operators. Back in 2013 (FREVUE, 2017a), programmes supporting electromobility were mainly started on a national level whereas nowadays, almost all major European cities claim to have electromobility on their political agenda. National programmes are being further developed, from targeted financial support scheme or infrastructure research and support projects becoming integrated programmes supporting electromobility in all of its aspects. Governments are looking at the best way to provide market certainty, given current technological capabilities of the vehicles, its market supply and availability of infrastructure. Different types of incentives are used to support both big companies and small entrepreneurs. A good mix between fiscal and regulatory (operational) incentives is necessary, supported by the planning, communication and awareness raising efforts. The package of measures available for policy makers consist of economic/fiscal, legal/regulatory, communication, raising awareness, and planning measures. However, a single measure seldom produces an optimal impact by itself and a combination of several different policy instruments and incentives are usually required to achieve the desired effect. Urban measures have to be chosen carefully, taking into account the context and unique features within specific municipalities and considering the fact that any specific measure bring along conflicting interests. Each category of policy measure will impact urban logistics activity differently and will have different impact on other ongoing initiatives. This needs to be taken in consideration while developing appropriate policy mix.

Using public procurement to stimulate EFVs uptake

Public procurement has a strong potential in assisting the uptake of the clean vehicles in city logistics: in addition to their regulation power they are also a powerful purchaser on the market. First, by promoting and using GPP, public authorities can provide industry with real incentives for developing green technologies and products. In some sectors, public purchasers have a large share of the market and their decisions will have a considerable impact on the fleet composition for these services. Second, while implementing EVs in their own fleets, municipalities directly contribute to the reduction of emissions and are setting an example for private operators. Going through all the steps of procuring, preparing and implementing the electric (freight) vehicle, public authorities face all the challenges and barriers alongside the process themselves, thus gaining a valuable experience and critical knowledge on what should be addressed in order to facilitate the E(F)Vs uptake. Uptake of EFVs by transport operators may increase if the municipality shows a clear example. Finally, public authorities have a big influence on public transport fleets. Support for the introduction of the electric buses is specifically important for the development of EFVs, as further development and practical implementation of this segment is beneficial for the further upscaling of medium and heavy duty EFVs.

Towards a zero emission city logistics

Many people believe electricity will replace fossil fuels. Much research is taking place within this area, mainly relating to battery capacity and extended driving range of EFVs. The

transition to EFVs is unlikely to accelerate by itself: collaboration and coordination is needed. The responsibility lies with all parties. Governments and the EC have a major role to play in establishing clear long-term principles. Governments must also develop rules and regulations to ensure that municipalities have the required tools by way of legislation, e.g. relating to parking benefits for electric vehicles, car pool vehicles and environmental zones for different vehicles. Establishing national definitions of clean vehicles is also an important measure.

Municipalities are the central enablers of EFVs adoption and are responsible for a number of important control instruments: parking, traffic lanes, environmental zones and a large proportion of the charging infrastructure. They are also major customers of electric (freight) vehicles. Coordinating procurements within and among municipalities can act to increase the demand for the EFVs. Municipalities are often perceived as neutral information carriers and have an important role to play when it comes to conveying the message and raising awareness about technical, economic and environmental benefits of EFVs. Public authorities can also be coordinators of electric freight car events and test driving, involving different car and plug-in infrastructure suppliers.

For zero emission transition to occur, it is crucial that companies review their vehicle usage and start replacing conventional vehicles with electric models. For this, firm policy message should be communicated to OEMs and businesses, backed up with clear and effective measures. Considering the time that OEMs will need to organize the mass production of the EFVs, and taking in to consideration that it takes more than 12 years for a transport operator to replace large vehicle fleet, more active and concrete measures facilitating the uptake of the EFVs have to be taken now. Table 4 below summarises the key actions local authorities can undertake in order to further support widespread adoption of EFVs.

Table 4. Roadmap for the local authorities in assisting the transition for the EFVs

Barriers	Type of measures	Actions	Time horizon
High vehicle purchase costs	• Economic/fiscal • Regulatory/legal • Planning	• Targeted financial help for procurement • Operational incentives • Infrastructure installation	• Until the business case looks more favourable especially for medium and heavy duty trucks • Until infrastructure needs are met
Additional infrastructure cost	• Economic/fiscal • Planning	• Provide public infrastructure network, including fast charging • Targeted financial support for installation of infrastructure	• Ongoing. Now to 10 years
Long depreciation time	• Economic/fiscal • Regulatory/legal	• Targeted financial help for procurement • Operational incentives	• Until EFVs prices are comparable to ICEs
Limited vehicle range	• Planning • Communication and awareness	• Assistance with installation of fast charging network • Communication and awareness on current capabilities of the EFVs • Support of research and development	• Ongoing

Limited availability of public charging infrastructure	• Planning	• Support installation of public charging infrastructure	• Ongoing
Limited vehicle offer	• Planning • Communication and awareness	• Joint demand statement • Green public procurement initiatives	• Ongoing
Limited information about vehicle availability	• Communication and awareness	• Organize information campaigns informing public about EFV availability • Continuously raise awareness about the importance of the zero emission transition • Provide vehicle catalogues	• Until EFV use becomes ubiquitous • Ongoing • Continuous

To accelerate EFVs vehicle uptake, a set of steps can be identified:

- Facilitate series production of the EFVs in the near future;
- Ensure that charging infrastructure is available in a timely manner;
- Ensure that this charging infrastructure is interoperable in all aspects;
- Ensure a steady increase of the EFV market, encouraging more fleets to acquire plug-in vehicles;
- Facilitate the aftermarket of electric vehicles in terms of residual value by supporting the use of vehicles after their economic lifetime for other purposes (such as low range distribution in cities) and reuse of the batteries of the vehicles;
- Create an efficient policy mix, providing a good balance between the financial and operational incentives for the use of EFVs.

The combination of these factors can initiate to the steady increase of EFVs.

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