Freight Electric Vehicles in Urban Europe

D3.4 Report on attitudinal and social impacts of EFVs

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Glossary

BEV	**Battery Electric Vehicle**
DNO	**Distribution Network Operator**
DSO	**Distribution System Operator**
EFV	**Electric Freight Vehicle**
GVW	**Gross Vehicle Weight**
HGV	**Heavy Goods Vehicle**
ICE	**Internal Combustion Engine**
ICEV	**Internal Combustion Engine Vehicle**
LGV	**Light Goods Vehicle**
TCO	**Total Cost of Ownership**

Executive summary

Road freight transport delivers many benefits to our society. It allows for the movement of goods and services, supports economic growth and provides employment opportunities. However, despite these benefits and significant progress of technological and efficiency improvements over the years, road freight transport is a major contributor to greenhouse gases (GHGs) and air pollution. It also contributes considerably to urban traffic congestion. These negative impacts result in a deterioration of both human health and the environment, and thereby cause significant economic costs to our society.

To respond to these challenges, the FREVUE project is deploying 80 fully electric freight vehicles (EFVs), from light vehicles under 3.5 tonnes to 18 tonne trucks for various logistics operations across eight European cities. 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.

The aim of the work reported in this deliverable is to measure, analyse and quantify the wider social and attitudinal impacts of FREVUE. One of the key benefits of the demonstrators is that they give a wide variety of stakeholders an opportunity to gain first-hand experience of EV-based freight and logistics operations. This experience extends beyond immediate functional impacts on vehicle performance and logistics and transport system outcomes to include wider impacts on attitudes and perceptions of EFVs. These wider impacts are important since they shape the business and policy context of future procurement and deployment decisions. To capture these wider impacts, both paper-based and telephone-based interviews were carried out of a range of stakeholders, including drivers, fleet/depot managers, logistics operators, traffic network managers, electrical grid managers and customers including senders and receivers to understand their attitudes and experiences before and after the deployment of EFVs.

Our surveys of the drivers have shown that in general drivers speak highly of EFVs. Many drivers who used to operate an ICE vehicle complained that these very dusty, smelly and they had to keep working on the gear and clutch. With the EFV, however, they enjoyed instant power, quietness, as well as clean and simple operations. They also think EFVs have significant environmental benefits and are hence take pride in using them.

In terms of range limitations, the majority of drivers are happy with the range of their vehicles after a year of operation compared to the early stage of the demonstration. minority of drivers (15%) remained concerned about the range or have range anxiety issues, and this was directly related to a low state of charge of the battery when the vehicle was returned to its depot. Hence it is important to plan and optimise the delivery workload carefully to keep a healthy margin. In addition, seasonal variability has been reported by some drivers, especially in Northern Europe where a drop of 30% of range performance was reported in cold winter months, which also contributed to range anxiety.

The survey of fleet and depot managers shows that the respondents are very satisfied with the overall experience of running EFVs and the low maintenance requirement was welcomed. For the majority of depots, there has been no change of operational arrangement and EFVs were integrated easily into existing fleets, based on their range and load capabilities. A significant shift of attitudes over time was also observed for fleet and depot

managers. The longer they work with EFVs, the more confident and positive they are towards the vehicles.

Most of the fleet managers are content with their EFVs' capability for the existing delivery tasks they are assigned for. However, many of them are also concerned that the range of EFV is a limiting factor which means there is little operational flexibility. The change of operational routines or depot locations may result in EFVs being unsuitable to the new task. Hence many of the fleet and depot managers would like a better range capability from the vehicle.

Logistics operators reported that they were motivated by a variety of reasons to electrify their freight fleets. The most common reason given is sustainability and environmental responsibility. Many are also motivated by the opportunity of EFVs or want to test the EV technology for freight delivery.

The lack of OEM products means that all operators had very limited choices of suitable EFVs, which is especially the case for electric heavy goods vehicles (HGVs) where operators have to rely on smaller suppliers or retrofit their existing or new diesel vehicles. This led to increased delivery times and complexity. However, as more vehicles are being converted by the same supplier, the process becomes less experimental and the vehicles increasingly reliable.

In terms of the plan for future EFV deployment, the responses were mixed. 50% of the operators responded that have already committed to more EFVs or are planning to deploy more in the short-term because of the positive experience they had. Another 30% said there is no plan in the short-term because of the limitation of EFVs in terms of range and capacity and the high purchase costs. These operators are waiting for better products need to be developed. There are also operators who have positive business case and a clear vision and roadmap for decarbonising their fleets. Hence EFVs are going to be deployed as a part of a wider plan based on their characteristics and suitability compared to other alternative fuel technologies.

The survey of transport network managers showed that they had very positive attitudes towards EFVs and they were all in favour of replacing ICE vehicles with EFVs, mainly due to the environmental benefits. Many of the cities surveyed, including for example, London, Madrid, Milan and Stockholm already had restrictions in place to stop certain types of old vehicles entering the city centre, or to charge a fee for the use of polluting vehicles. The traffic managers are also in support of using privileges to improve the uptake of EFVs. However, such schemes have to be managed carefully to ensure fairness and positive experience to both logistics operators and the general public.

Apart from the environmental benefits, most of the transport network managers do not think deployment of EFVs would have any significant impacts on the road traffic network or on other road users, although some respondents did point out that EFVs still contribute to urban traffic congestion and it is important to balance the policy tools to not only encourage the electrification of the freight fleets, but also improve efficiency and reduce freight traffic mileage. They also do not think the use of EFVs and their characteristics would have any impacts on their current urban traffic management systems.

There hasn't been any report of an accident during the FREVUE demonstrations. However, the existing literature contains mixed evidence regarding the impact of electric vehicles on accident rates in general, and especially those involving pedestrians and cyclists. More data and analysis are required before a quantitative conclusion can be made.

The survey of electrical grid managers shows that the distribution network operators (DNOs) are also very positive about the deployment of EFVs. They believe the impact of additional demand at the network level from charging EFVs can be very positive if managed properly because of the potential it offers for improved load balancing and optimisation. They also observed that the charging profiles from heavy duty commercial vehicles are highly predictable due to the nature and operational mode of their business and that this regularity and predictability can help DNOs develop new products to benefit both the commercial customers and DNOs themselves.

During the FREVUE demonstration, some of the logistics partners have experienced problems with capacity of their local grid. However, this does not mean the grid capacity issue will necessarily be a common problem for the future. For example, in London, UK Power Networks has proposed a four-stage plan, which is echoed by other DNOs, to help resolve this grid capacity problem in future, which includes engagement, smart intelligent solutions such as smart charging, demand side management and timed/profiled connections, and costed plans for new connections.

A wider uptake of EFVs may lead to diverse integration issues, due to the difference in grid infrastructure and electricity mix in different countries. Additional electricity generation capacities may be required to meet the additional demand from charging EFVs, and in regions with a weak network infrastructure, additional grid reinforcement or implementation of specific smart charging approaches might be required to ensure stable functioning of the infrastructure. However, smart intelligent technology, such as smart charging and vehicle to grid technology will have a very important role to play to reduce the cost and better manage the grid system.

Analysis of the surveys of senders and receivers has shown that the respondents in general have very positive attitudes towards electric freight vehicles. They believe that EFVs have a key role to play in resolving poor air quality, global warming and traffic noise problems that many cities in Europe face. However, only half of the respondents have ever heard of electric freight vehicles and far less have seen one in their local area.

The majority (60%) of respondents reported that they would consider green delivery as one of the factors when making choices of which logistics company to use. A similar proportion of respondents said they would always choose their goods to be delivered by an EFV if the price is the same to them and if an option between EFV and ICEV is given by the service provider. In addition, 30% of the respondents are willing to pay more to get their goods delivered by an EFV or other low emission vehicle.

Senders and receivers who responded the questionnaires also said they have positive views on both a logistics company and a retailer who are using EFVs or other low emission vehicles for delivery. However, 94% of the respondents said they did not know whether their goods were delivered by an EFV or an ICEV. Therefore, more has to be done to increase the visibility of EFVs and to convey the positive image to the customers.

Overall, this report shows that although continued electrification of freight fleets is not straightforward and a number of barriers still exist, confidence and favourable views have been observed from many stakeholders towards EFVs. To resolve those barriers it will take time, financial support and collaborative commitment from industry, government and society and by working together, continued electrification and decarbonisation of freight fleets can be achieved.

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.

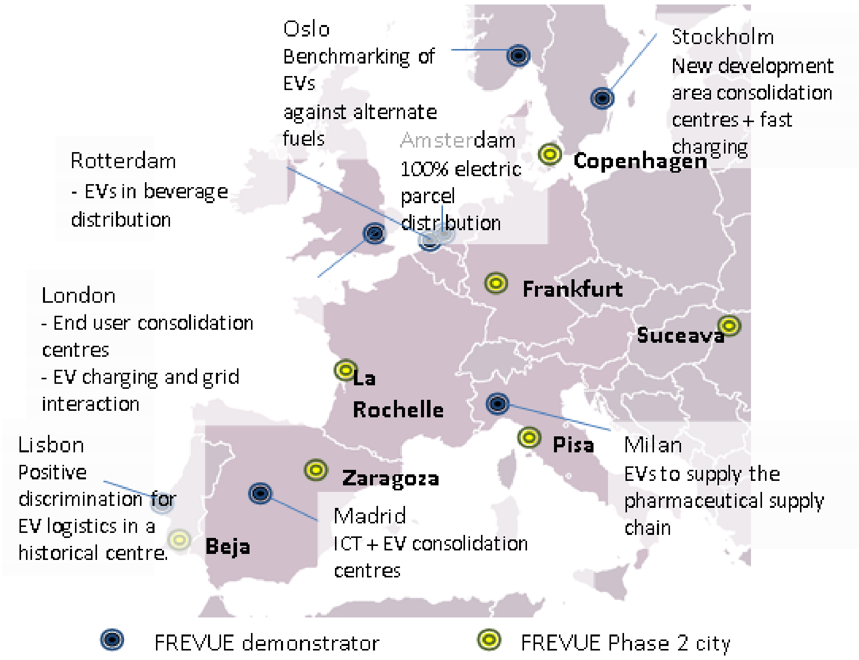

Figure 1: FREVUE demonstrator activities

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 will 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 Deliverable objective and scope

This deliverable documents the findings from Task 3.4 attitudinal and social impacts of EFVs in logistics, which is a part of work package 3.

Objective

One of the key benefits of the FREVUE demonstration is that it will give a wide variety of stakeholders an opportunity to gain first-hand experience of EV-based freight and logistics operations. This experience extends beyond immediate functional impacts on, for example, vehicle performance and logistics and transport system outcomes to include wider impacts on attitudes and perceptions of EV. These wider impacts are important since they shape the business and policy context of future procurement and deployment decisions.

Therefore, the objective of this report is to measure, analyse and quantify the wider social and attitudinal impacts of FREVUE demonstration activities on various stakeholders. To be specific, it aims at answering the following questions:

1. What are the overall experiences of running EFVs from various stakeholders? Do they welcome the change? Do they think it is a viable option to replace the conventional diesel trucks?
2. What are the lessons learned? What are the most important factors for a successful implementation of EFVs from the key stakeholders' point of view?
3. What are the future plans in terms of electrifying their fleets? Any requirements for improvements on the vehicle, policy or other factors to facilitate the uptake of EFVs?

Scope

According to the description of work, the social and attitudinal impacts to be taken into account include the following areas:

- Response and acceptance of operators to new EV and ITS processes, systems and interfaces and requirements for system enhancements
- Changes in driver's network routing and driving styles
- Changes in driver's loading/unloading behaviour
- Analysis of incidence and distribution of positive and negative attitudinal impacts and effects on different groups (e.g. operators, customers, network managers, general public etc.)

The primary research method is the use of experience surveys of the stakeholders affected. Surveys are designed for different stakeholder groups in order to ensure both quantitative and qualitative insights against the metrics above. The survey format is mainly based on questionnaires, with follow-up telephone interviews with some of the key stakeholders (such as the logistics operators).

Efforts have also been made to try to obtain dynamic vehicle data for the base line scenario (i.e. before the conventional internal combustion engine vehicles were replaced by EFVs). However only a very limited amount of data has been provided which means that it is not possible to conduct any quantitatively conclusive studies on the change of driving styles, network routing and change of loading/unloading behaviours. However, these aspects are covered in our experience survey to provide a qualitative analysis.

Target audience

The target audience for this deliverable includes but is not limited to:

1. logistics operators: the lessons learned and first-hand experience from other operators is invaluable to help them make an informed decision about whether to deploy EFVs and what is required to have a successful implementation. It is also useful for them to understand the attitudes and experiences from their customers, drivers and key policy makers about the EFVs.
2. the (local) authorities/policy makers: they are the acting group on promoting the EFVs and their decisions are important to the future uptake of EFVs. The analysis in this deliverable will provide important feedback from the operators about both the impacts and further requirements of their policy. This will help the policy makers to identify the area that needs their intervention allowing for an informed decision to be made.

Added value

Over the recent years, there has been a lot of studies on consumers' attitudes and experiences on the electric vehicles (EV). Most of these studies are focused on passenger cars. Hence there is a gap in the literature about the attitudinal impacts of commercial EVs from various stakeholders. This deliverable aims to explorer this gap and the results from the report provide insights to the key issues faced by the logistics sector when deploying EVs.

1.4 Structure of this deliverable

This deliverable is structured as follows:

Chapter 2 presents an overview of survey design, survey groups and the definition of each group where the survey is carried out, data collection procedure, data availability and the limitations of the data collection.

Chapter 3 presents the results of experience surveys on drivers. A number of dimensions are analysed, including the general attitudes and experience toward EFVs, range anxiety and its causes, changes in operational arrangements and charging experience.

Chapter 4 reports on the attitudes from fleet and depot managers. As they are dealing with the management and maintenance of the vehicle fleets on a daily basis, the analysis focuses around the area including operational and maintenance impacts of EFVs and the important factors for future EFV deployment.

Chapter 5 summarises the experience and attitudes from logistics operators. As they are the decision makers, they have first-hand experience and knowledge of many aspects of EFV deployment, including but not limited to procurement, after sale support, infrastructure expansion and future development plans. The lessons learned are also summarised for successful future deployment of EFVs.

Chapter 6 reports on the attitudes from traffic network managers. The analysis is focused around the change of accident rate because of new characteristics of the vehicles, attitudes to the possible change of congestion due to new logistics operational model, and the attitudes of policy changes to facilitate a wider uptake of EFVs.

A number of demonstrators have reported grid capacity problem during FREVUE demonstrations. Hence the aim of Chapter 7, which analyses the surveys of the electrical grid operators, is to understand their views of the impact of EFV implementations on the grid operation, how to prepare and deal with the potential grid capacity issues because of the additional electricity demand from EFVs, their experience and lessons learned from the project and plans for the future electrification of freight fleets.

Customers have an important role to the future deployment of EFVs because they can be a driving force to accelerate the process. Chapter 8 aims to summarise the survey on the customers on many dimensions, including the environmental issues they care about, awareness of EFVs, visibility of EFVs to the customer, whether the preferential attitudes to companies using EFVs are real and whether customers are willing to pay an additional fee for green delivery and if so, by how much.

2 Survey design and data collection

This chapter presents the survey method and data collection of the before[1] and after[1] experience surveys based on different survey groups. Both the before and after surveys were carried out using questionnaires for the following six survey groups:

- Drivers
- Fleet/depot managers
- Logistics operators
- Electrical grid operators/managers
- Transport network managers
- Customers (including senders and receivers)

The before survey was conducted between June 2014 and June 2015 when the EFVs were not deployed or at the early stage of deployment for each of the FREVUE demonstrators. The after survey was conducted between June 2016 and February 2017 when most of the operators had at least one-year experience of running the EFVs.

Analysis of the survey responses are focusing on three areas and are presented later in the following chapters:

- The experience of EFVs, including each of the survey group's attitude towards EFVs and what they liked and disliked based on the relevant categories including acceptance, operational impacts, comfort, reliability, safety, wider benefits and scalability.
- Whether there has been any shifts of attitude or opinions towards EFV as a result of the FREVUE demonstration
- Any lessons learned for successful future EFV deployments from the FREVUE demonstrations

2.1 Survey data collection

The survey is mainly based on the format of paper questionnaires with follow-up telephone interviews if further discussions are required or the results need clarification.

The survey questionnaires are mainly produced by Imperial College, with inputs from other research partners. The questionnaires are centrally distributed to all the FREVUE city leads through the project coordinator, with translation provided if required. Then the city leads have the management role of distributing and collecting the questionnaires to the key contacts of their local project partners. The key contacts then ask the local project partners to complete the questionnaires for the relevant survey groups. Through the project coordinator, the completed questionnaires are returned to Imperial College for analysis.

The data flow can be summarised in the following chart:

[1] Here "before" means before the deployment of EFVs (i.e. when the conventional freight vehicles were still being used), and similarly "after" means after the implementation of EFVs. However, due to very diverse progress at different demonstrators, when the "before" survey was carried out a number of demonstrators had already started their EFV demonstrations.

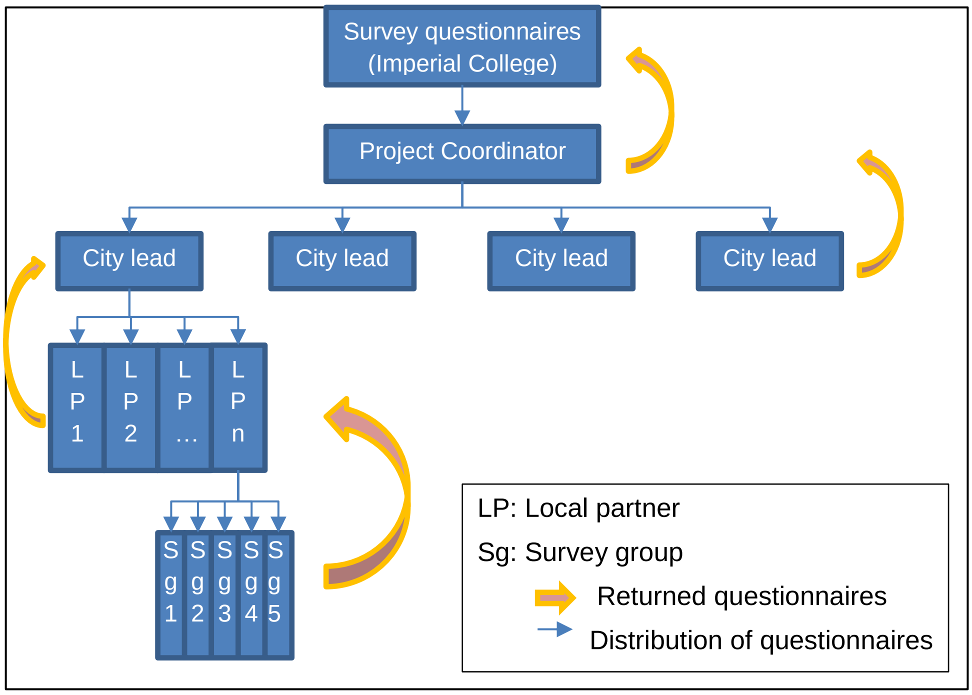

Figure 3: Organisation of the experience survey

2.2 Survey groups

Survey questionnaires are developed separately for the six survey groups. The definition of each survey group is presented in the table below.

ID	Survey groups	Who should be given the survey questionnaires	Numbers to be surveyed at each demonstrator
1	Driver	Drivers who are expecting to or have been operating EFVs.	All eligible drivers
2	Fleet/ Depot Manager	Managers who are expecting to or have been managing / maintaining EFVs at depots.	All eligible managers
3	Freight Operator	People from the logistics operators who have a management or decision-making role related to the possible wider deployment of EFVs.	Key staff as defined
4	Traffic Network Manager	People from the traffic management bureau overlooking the traffic and road transport network in the cities where EFVs are planned to be deployed.	Key staff as defined
5	Electrical Grid Manager	People from the utility company that supply electricity to the charging stations, with understanding of electricity supply and grid constraint.	Key staff as defined
6	Customer (senders and receivers)	For residential customers, they are the people who are expected to send or receive deliveries made by the EFVs. They should be strictly located within the planned EFV operating area. For commercial customers, they should be chosen based on the above criteria. However, it is challenging to get the right person to complete the survey within a commercial	An online survey webpage (http://frevue.limequery.com) and a separate flyer have been designed to facilitate the process. Sent to all eligible customers who are

		organisation. Ideally we would prefer someone who is in a position to manage delivery or to make decisions about which supplier to use for goods delivery.	receiving deliveries from the EFVs.

Table 1: Definition of survey groups

2.3 Data availability

The number of returned questionnaires from before and after surveys are shown in Table 2 and Table 3.

"Before" Questionnaires	*Type*	*Ams/Rot*	*Lisbon*	*London*	*Madrid*	*Milan*	*Oslo*	*Stockholm*	*Total*
Drivers	Received	19	20		4	1	4		48
Fleet/Depot Managers	Received	4	5	1	3	1	3	2	19
Logistics operators	Received	2	5	5	2	1	1		16
Transport Network Managers	Received				1		1	3	5
Electrical Grid Managers	Received		1	1	1	2	1	1	7
Customers	Received	7	20	1				3	31

Table 2: Summary of returned before survey questionnaires

"After" Questionnaires	*Type*	*Ams/Rot*	*Lisbon*	*London*	*Madrid*	*Milan*	*Oslo*	*Stockholm*	*Total*
Drivers	Received	4	16	15	4	1	4	1	45
Fleet/Depot Managers	Received	3	5	3	3	1	2	1	18
Logistics operators	Received		1	4	2	1	2	1	11
Transport Network Managers	Received				1	1	1	2	5
Electrical Grid Managers	Received		1	1	5	1	3	1	12
Customers	Received	7		10	15	15		6	53

Table 3: Summary of returned after survey questionnaires

For the driver category, the questionnaires are returned from more than 50% of all the drivers who have been working on a FREVUE co-funded EFV. For the fleet/depot managers and logistics operators categories, almost all demonstrators have returned at least one questionnaire for their survey group and the number is consistent with the total number of participants working on the FREVUE demonstrations. For the transport network managers group, many of the cities did not provide a response, which was probably due to the limited scale of FREVUE demonstrations. Hence the impact on the transport network, given the number of vehicles deployed, is negligible. For the electrical grid managers, most of the cities have provided at least one valid response. However, for some other cities, it was not possible to achieve this. The return rate from the customers group is very low, which is likely to be caused by survey fatigue or lack of interests in this subject from their customers.

2.4 Limitations of data collection

Overall, the number of returned questionnaires is broadly in line with expectations. While every effort has been made to encourage and improve the number of returned questionnaires, it is inevitable that some participants are less motivated. It should be noted that because the scale of FREVUE demonstration activity is small and a 100% return rate has not been achieved from all demonstrators, results analysed in this deliverable do not reflect every scenario in the FREVUE demonstrations.

It should also be noted that, as shown in Table 2 and Table 3, imbalances existed in many survey groups in terms of the number of returned questionnaires from each city. As a result, some of the cities or logistics operators are over-represented, while others with less returned questionnaires are under-represented. To resolve this problem, we not only focus on the summary figures, but also detailed feedback from each of the respondents to make sure valuable experiences are not missed.

Both the before and after surveys are designed specifically around the FREVUE demonstrations, the representativeness of this survey is constraint by the selection of FREVUE logistics partners. Although there is a good combination of operators running small, medium and large sized EFVs, bias can still be present in the results. For this reason, the results discussed in this report are indicative, rather than conclusive.

Quantitative analysis was not undertaken in this report as sampling was undertaken on an opportunistic basis by operators, rather than following an explicit sampling design, and because the number of responses was small. With an unknown sampling structure and small numbers of respondents, it is impossible to draw statistically robust conclusions with respect to the underlying population of users. Due to this constraint only qualitative analysis is undertaken in D3.4.

3 Drivers

Unlike the drivers of electric cars, who have been subject to constant research interest due to their decisive role in the EV purchasing decision, the drivers of electric freight vehicles are not normally in a position to greatly affect the decision of EFV deployment. However, they are still of great importance due to the role they play in the logistics chain. Logistics companies care about the welfare of their drivers and they believe happy drivers lead to improved customer experience, good company image and increased income.

Because the first-hand experience driver had with their vehicles, and the deployment of EFVs has great impact on drivers' day-to-day life due to significant differences of vehicle characteristics between an EFV and an ICE, the purpose of this survey is to understand the attitudes towards and experiences with the EFVs from a driver's perspective. This includes things they like and dislike most about EFVs, their charging experience, and whether there is a problem of range anxiety as reported by drivers of electric passenger cars.

3.1 Background

In total, 48 drivers have responded to the "before" survey. The number of drivers from each city is shown in Table 2. Out of these respondents, 98% are male drivers and only 2% are female drivers. The majority of respondents (64%) had already started driving EFVs, while 36% of the drivers were driving ICEs at the time of the before survey. For those drivers who had started driving EFVs, 43% of the drivers had less than 6-month experience, 50% had between 6-month and 2-year experience and 7% had more than 2-year experience with their vehicle. In terms of the distribution of gross vehicle weight (GVW), 82% of the respondents were driving vehicles with less than 3.5t GVW, 18% between 3.5t and 7.5t GVW and no drivers of vehicles above 7.5t answered the survey. In addition, 77% of the drivers reported that their average daily driving distance are up to 100 km, 21% between 100 and 200 km and only 2% are more than 200 km.

There are 45 drivers who have responded to the after survey. Similarly, 98% of the respondents are male and 2% are female. The drivers who answered the after survey were not necessarily the same drivers that responded to the before survey. Vast majorities of the drivers drove only EFVs on a daily basis (93%), while the remaining drivers (7%) drove both EFVs and ICEs. For the drivers who only worked with EFVs at the time of survey, 93% had previous experience working with conventional ICE vehicles. 49% of the respondents had less than one year experience working with their EFVs and the rest had more than one year experience. 89% of the drivers reported that their average daily distance was up to 100 km and remaining 11% of the respondents drove their vehicles between 100 km and 200 km on average. In terms of vehicle weight distribution, 74% of the respondents' vehicles weighted less than 3.5t, 20% of the vehicles are between 3.5t and 7.5t, 2% are between 7.5t and 18t and 4% are over 18t.

3.2 Attitudes and experiences towards EFVs

When drivers were asked whether they are in favour of EFVs replacing ICE freight vehicles, 72% of the drivers stated to be in favour, 23% didn't think it would make any difference to them and 5% were against this. Comparing to the results of the same question conducted in the before survey, there is a 12% increase of the number of drivers who are in favour of this, as shown in Figure 4, while the number of drivers who are against this or don't think there is any difference are both reduced.

There is also an increase in the percentage of drivers who think EFVs are a viable alternative to ICE vehicles. Results from the after survey show that 70% of the drivers are positive about this.

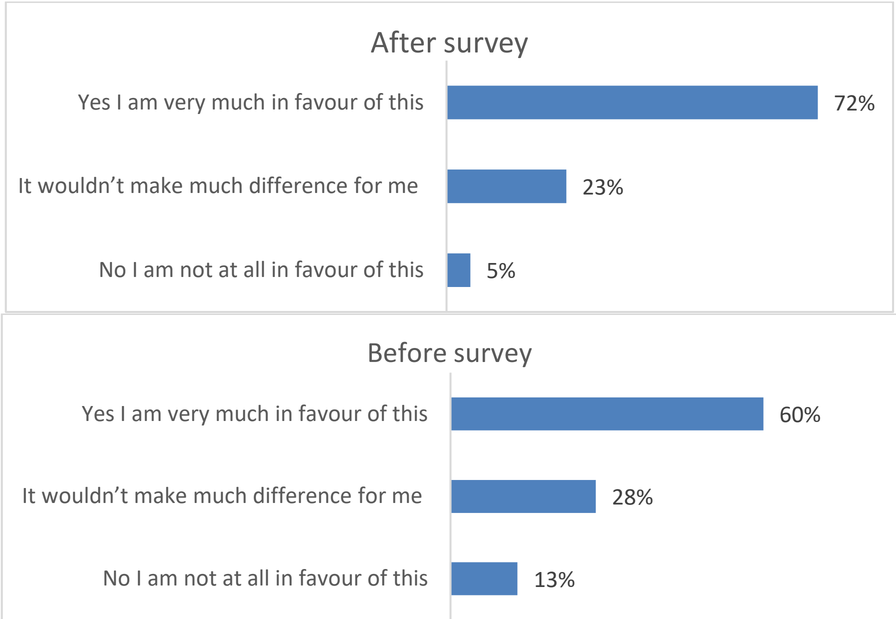

Figure 4: Drivers' attitudes to EFVs replacing ICE freight vehicles

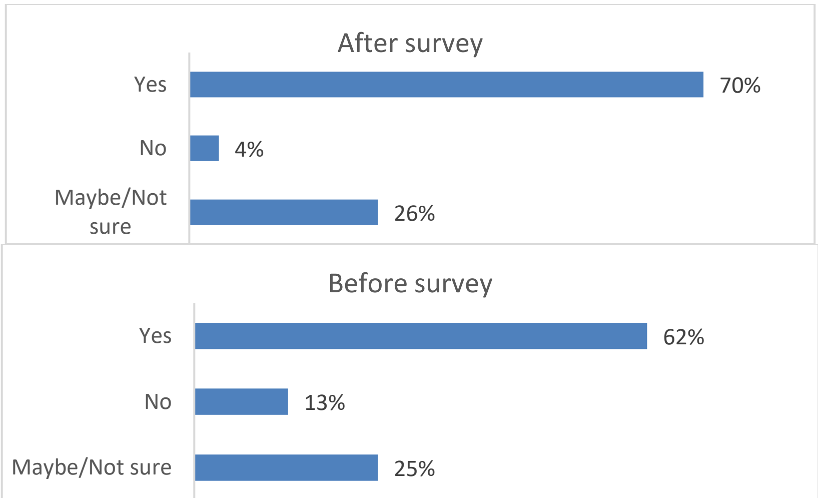

Figure 5: Drivers' attitudes to whether EFVs are a viable alternative to ICEVs

Drivers were asked openly on what they like and dislike most about EFVs. Results are summarised and categorised into Table 4 and Table 5.

In general, drivers speak highly about EFVs. Many drivers who used to operate an ICE vehicle complained that these were dusty, smelly and they had to keep working on the gear and clutch. Now with an EFV they enjoyed instant power, quietness, clean and simple operations from their electric freight vehicles. They also think EFVs have significant environmental benefits and hence are very proud to drive them around in the cities.

However, drivers also reported frequently that the range or battery capacity of their EFVs is the issue they dislike most, although most of the drivers confirmed that they are confident their vehicles are able to cope with the current delivery tasks in any given weather and climate conditions (range anxiety is discussed separately in 3.3). Some drivers also complained about the quietness of EFVs which can sometimes lead to pedestrians being unaware of the presence of their vehicles. This can be dangerous when pedestrians suddenly walk out in front of the vehicle to cross the street, although no accident has been reported so far. A number of other things were mentioned by a few drivers, such as poor reliability, poor comfort and unsatisfactory equipment which are vehicle/manufacture specific and are not specifically caused by the use of electric engine.

	Number of open responses
Environmental benefits	6
Simple operation	5
Instant power / Fast acceleration	4
Comfortable	3
No need to fill up at petrol station	3
Quietness	2
Smoothness of ride	2
Good company image	1
Pride	1

Table 4: what do drivers like most about EFVs

	Number of open responses
Limited range/Battery capacity	13
Too quiet	4
Equipment not available/satisfactory	3
High purchase price	2
Poor reliability	2
Limited load capacity	1
Reduced performance in winter	1
Uncomfortable	1

Table 5: what do drivers dislike most about EFVs

Although 73% of drivers reported that they had experienced a breakdown while driving an EFV, drivers still reported positively on various aspects of EFV driving experience. 70% of the respondents had a good or very good overall experience. Only less than 10% of the drivers reported a bad overall experience, as shown in Figure 6.

Looking at categories in detail, the categories achieving highest scores are comfort, safety and ride and handling. Range has the lowest score with around 20% of the drivers being unhappy with it.

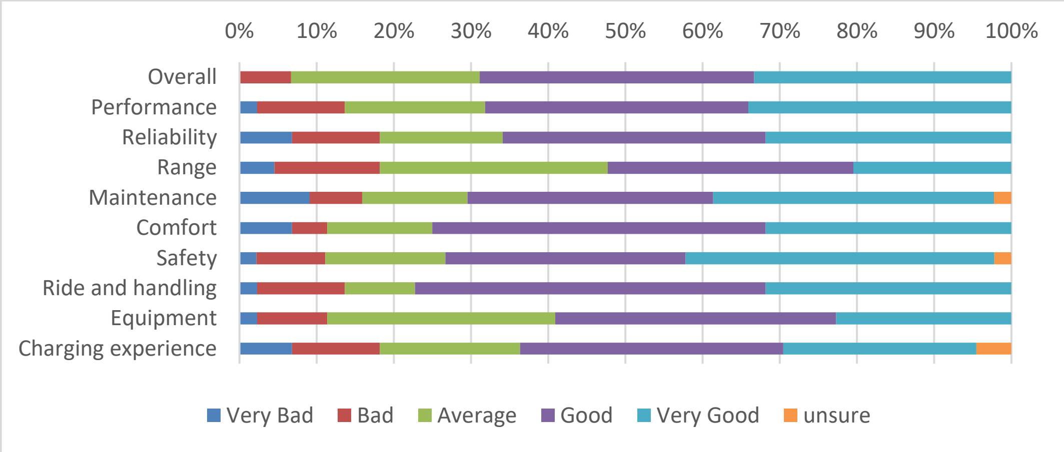

Figure 6: summary of drivers' EFV experiences

Drivers were also asked to compare EFVs with ICEs directly on a number of dimensions shown in Figure 7. Unsurprisingly, drivers voted EFVs overwhelmingly for their environmental performance and company image/reputation. They also think EFVs are better than ICEs for maintenance, ride and handling and customer satisfaction. Equipment and range are the only two areas where ICEs are believed to be better.

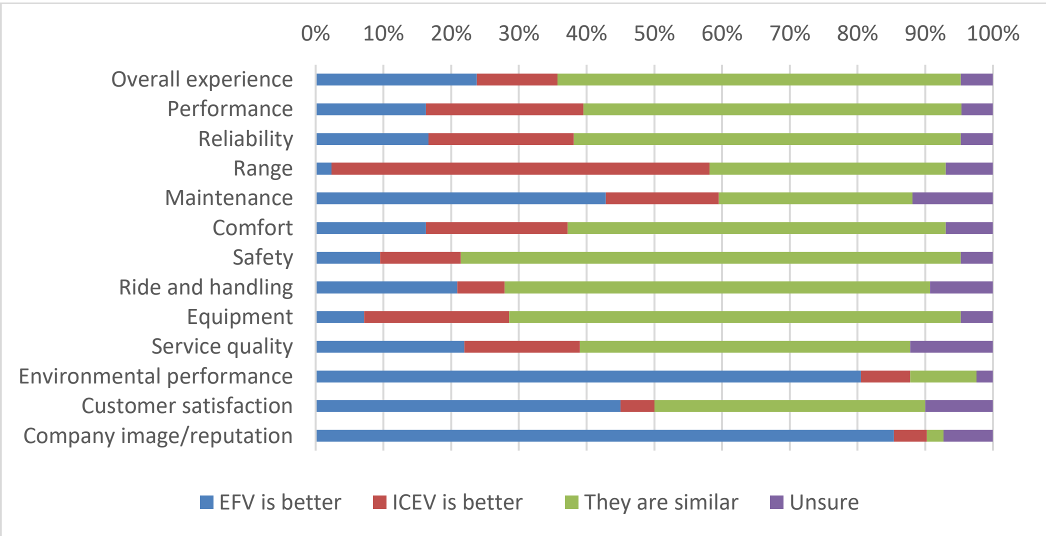

Figure 7: comparisons between EFV and ICEV from drivers' perspective

3.3 Range anxiety?

Range anxiety is the fear that an electric vehicle will run out of power before the destination or a suitable charging point is reached. It has been a well-studied topic for electric cars, for example, by Neubauer and Wood (2014) and Rauh et al. (2015). The experience from electric freight fleets has been rather limited.

In the FREVUE survey, we asked drivers how often they are concerned about running out of battery during a delivery roundtrip and their responses are summarised in Figure 8. Around 15% of drivers reported that they were always or very often concerned about running low on battery. Nearly 55% of the drivers were rarely or never concerned about range, and the remaining 30% of drivers were sometimes concerned.

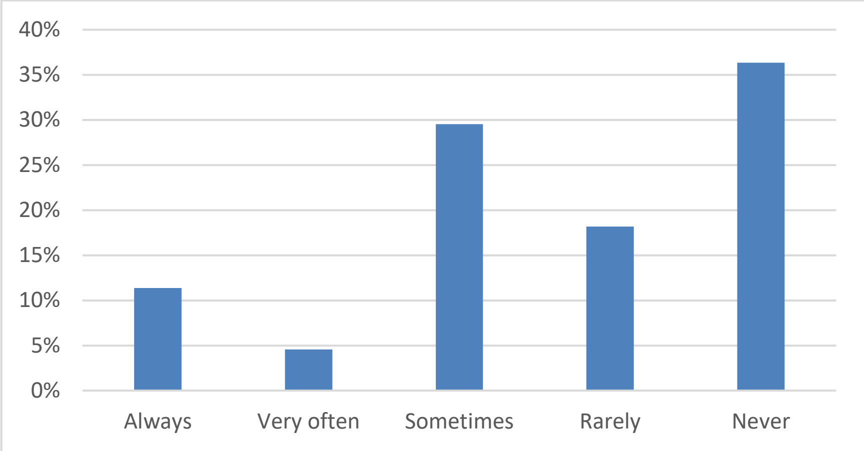

Figure 8: how often are drivers concerned about running out of battery

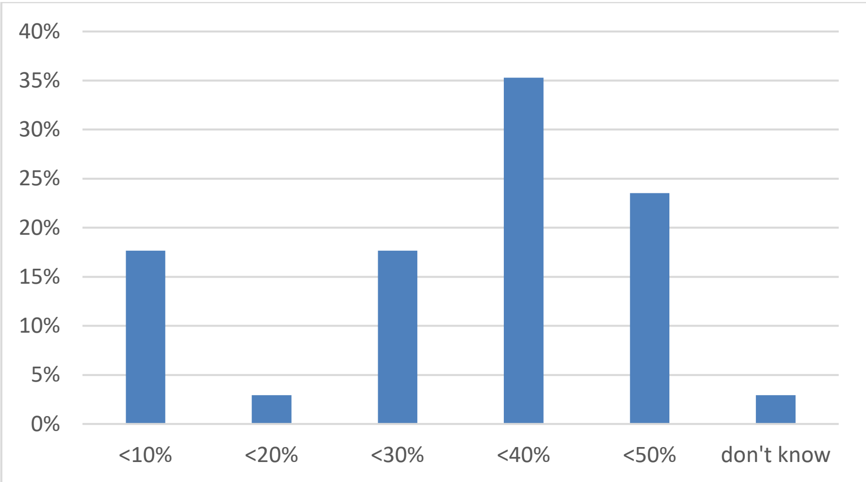

Figure 9: average remaining state of charge when vehicle is returned to depot

It is also discovered that range anxiety is affected by the following two factors:

1. Planning and optimisation of the delivery arrangements. Range anxiety is directly related to the remaining battery state of charge when the vehicle is returned to its depot. Most of the drivers who reported they are very concerned about range also reported that their average battery state of charge was below 10% when returning to the depot. Therefore, it is important to leave a healthy safety margin when planning the delivery workload and total distance.
2. Seasonal variability: 25% of respondents reported that they noticed a significant change of range due to seasonal impact. This has been mostly mentioned by drivers in Oslo where a range reduction of 30%-40% in winter was reported. Drivers in Madrid and Lisbon also reported a reduction of range in winter, but to a lesser extent (10% - 15%).

Range anxiety also affects drivers' comfort. It has been reported by the drivers that 17% of them do not use air conditioning or only use it under unbearable conditions (including both heating and cooling), in order to reduce battery usage. For some drivers, this became a trade-off in winter about whether to heat their vehicle to improve comfort or to preserve battery for their piece of mind.

A number of solutions were proposed, for example, in Amsterdam, TNT adapted the controller of the heating system which allows the system to function with the engine switched off. This allows the vehicle to be pre-heated in winter while still plugged-in and means that no capacity of the fully charged battery had to be sacrificed at the start of the day to first heat the vehicle. Heineken, on the other hand, had been informed that a separate a gas or petrol heating system can be installed. However, Heineken believes this to be a reputational risk when claiming that the vehicle is 100% electrically powered. Therefore all their vehicles have an electrical heating system. It was also reported that some vehicles were equipped with a separate battery pack to provide the heating functions while not compromising the range of their vehicles. However, it worth to be mentioned that for majority of the drivers, heating their vehicles were not a problem and most of them were able to use air conditioning whenever they feel necessary.

When drivers were asked about the preferred range from their vehicles in the after survey, 47% responded they were happy with what they had or less than 100 km. This is significantly different from the results from the before survey, where only 9% of the drivers chose the same option (see Figure 10). Drivers' perceptions to EFV's range limitation have improved after working with the vehicles and they have recognised that EFVs are well suited for certain type of delivery, such as urban last mile delivery.

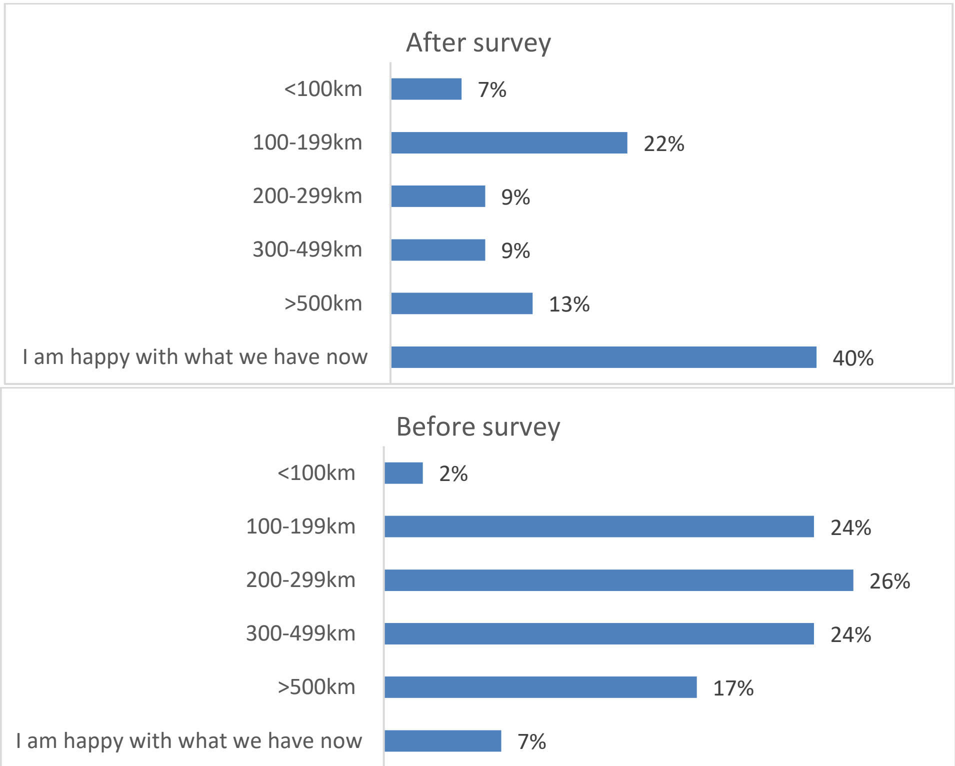

Figure 10: Preferred EFV range - Drivers

In addition, although 27% of the drivers reported that they have experienced a depleted battery during their delivery operation, in total 77% of the drivers are confident that their vehicles are able to cope with the current delivery tasks under any weather and seasonal conditions.

3.4 Operational characteristics

Almost all EFV drivers confirmed that their daily delivery area, total distance and the total number of stops are about the same or vary only slightly.

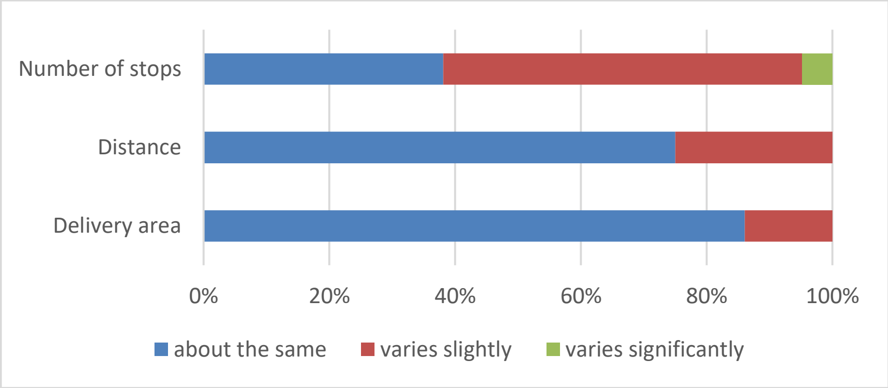

Figure 11: EFV daily operation characteristics

When drivers were asked whether there had been any changes of loading/unloading routine or behaviour due to the deployment of electric freight vehicles, most reported no change. For the majority of demonstrations, the new EFVs operated exactly as their diesel counterparts with the sole exception of needing to be recharged overnight instead of refuelled. In addition, the introduction of the new EFVs did not necessitate any changes to the usual operation of ICE vehicles, except that they were assigned to longer distance routes to allow for the EFVs to operate on shorter routes. The only exceptions were those demonstrators where a cross-docking centre was implemented to help resolve the range limitation, which resulted in a change of loading arrangement.

In addition, a few drivers have reported a longer walking distance due to concern of the remaining battery power. In order to preserve vehicle battery charge, drivers walked a little longer rather than driving around to find a parking spot closest to the delivery address.

3.5 Charging

Drivers reported that the most common charging routine was to charge their EFVs only at the depot overnight (80%), to charge both at depot overnight and between each delivery roundtrip during the day at the depot (11%), to charge at the depot overnight and occasionally during delivery roundtrips (7%) and at the depot overnight and frequently during delivery roundtrips (2%).

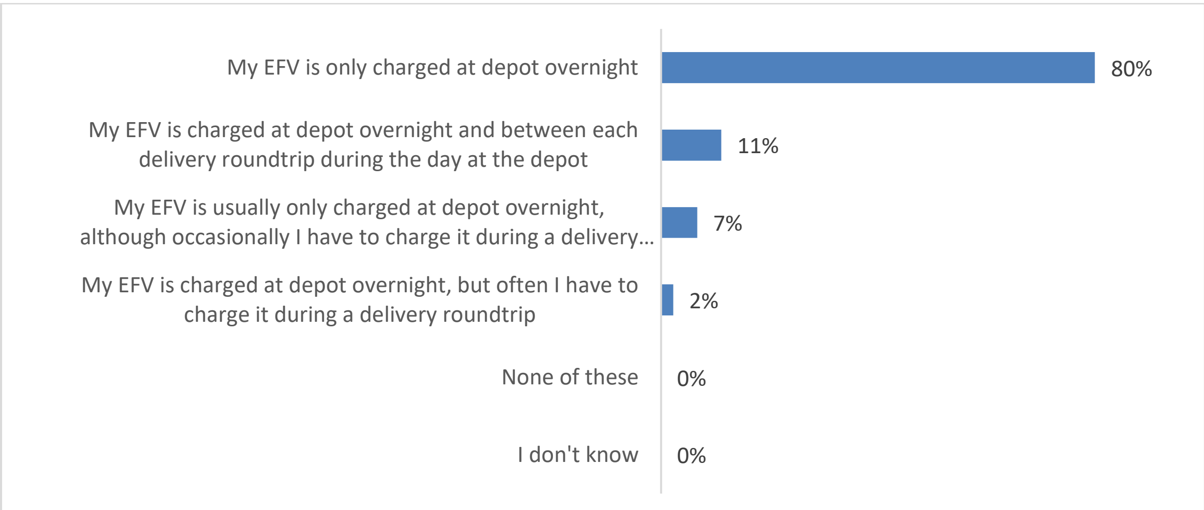

Figure 12: Daily charging routine

Drivers who had to charge their vehicles during delivery roundtrips were mainly those in Oslo where they had to cover a longer distance per day. To make it feasible to charge their vehicles between deliveries, fast chargers are usually required. For example, before the fast chargers were installed as part of the FREVUE project in Oslo, Bring drivers were using other publically available chargers when available. However, this caused some challenges, firstly because of technical problems with some chargers, and secondly due to the queues at some charging points during rush-hour, especially during the cold winter months from December to March. Very long waiting times were reported for the charging of vehicles with drivers often waiting more than an hour to get access to these chargers. This results in loss of time and money for the drivers and for Bring Express. The problems of technical delays and long queues seem to have been eliminated since the new quick charging sites were installed, where the facilities allow for vehicles to be charged to 80% in 20 minutes. The Bring drivers now reported that it is relatively easy to find a charging point when a recharge is required.

3.6 Conclusions

Our surveys of EFV drivers have shown that in general drivers speak highly about EFVs. Many drivers who used to operate an ICE vehicle complained that these were very dusty, smelly and they had to keep working on the gear and clutch. Now they enjoyed instant power, quietness, clean and simple operations from their electric freight vehicles. They also think EFVs have significant environmental benefits and are hence very proud to drive them around in the cities.

As the time spent driving their EFVs increases, there is a shift of attitude towards the range of the vehicles. A significantly larger number of drivers are happy with the range of their vehicles and in general more confident in their vehicles after least one year of operation compared to the early stage of demonstration. A small percentage of the drivers (15%) remain concerned about range and this is directly related to the low remaining battery state of charge when the vehicle is returned to its depot. Hence it is important to plan and optimise the delivery workload to make sure a healthy margin is reserved. In addition, seasonal variability has been reported by some drivers, especially in Northern Europe where a drop of 30-40% of range performance is reported during cold winters, which also contributed to range anxiety.

Most of the drivers operated their vehicles in the same or similar area every day, with similar total distance and number of stops. Charging took place mostly (80%) at the depot overnight. If an additional charge is required between deliveries, fast charging facilities are usually much preferred by the drivers. In terms of the area for improvement, drivers in general would like a larger battery capacity. Some also commented on the quietness of the vehicle meaning that it requires a high state of alertness while driving at low speed in urban areas.

4 Fleet/Depot managers

Since fleet and depot managers deal with the management and maintenance of the vehicle fleets on a daily basis, a reliable and low maintenance fleet will greatly reduce their workload and hence improve the prospect of continued electrification of the freight fleets. The experience and attitude from fleet and depot managers are therefore important to understand for future deployment of electric freight vehicles.

The purpose of this survey is to understand the experience and lessons learnt from integrating EFVs with existing fleets, daily maintenance, operation and charging experience, and key factors to a successful implementation of EFVs from a fleet and depot managers' point of view. In addition, we also try to understand whether the infrastructure is a limiting factor for future EFV deployments.

4.1 Background

In total, 19 depot and fleet managers have responded to the "before" survey. The median size of their fleet was 75, however, it varies significantly at the local level, ranging from 2 to 170 freight vehicles. At the time of the survey, most of the depots already had EFVs in their fleet. The median size of the EFV fleet was 3 and it also varied locally from 0 to 35. 61% of respondents reported they had between 6-month to 2-year experience of managing EFVs, 22% had less than 6-month and 17% had more than 2 years experiences.

For the after survey, in total 18 valid questionnaires were received. The median size of the fleet which was managed by the respondent was now 85 with variations from 4 to 2700 vehicles. The median size of the EFV fleet was 4 and it also varies from 1 to 43 locally. 84% of respondents were from the depots where the gross vehicle weights of FREVUE vehicles are less than 3.5t (light goods vehicle). 16% of respondents were from the depots with EFV gross weight between 3.5t and 10t (heavy goods vehicles). 47% of the respondents reported that they had between 2-year to 5-year experience of managing EFVs, 41% had between 6-month to 2-year and 12% had more than 5-year experience. In terms of the type of the EFVs used, 31% depots reported that they operate retrofitted EFVs only, 44% of the depots only operate in-series produced EFVs and 25% of the depots operate both types of vehicles.

4.2 Attitude toward EFVs

When fleet managers were asked whether they are in favour of EFVs replacing ICE freight vehicles, 100% of the respondents said they were. Comparing with the results of the same question conducted in the before survey, there is a 22% increase of the number of fleet managers who are in favour of this, while the number of fleet managers who are against this or don't think there is any difference are both reduced.

There is also an increase in the percentage of depot managers who think EFVs are a viable alternative to ICE vehicles for their urban last mile delivery task. Results from the after survey show that 72% of the managers are positive about this, which is a significant improvement over the 39% achieved in the before survey (Figure 13).

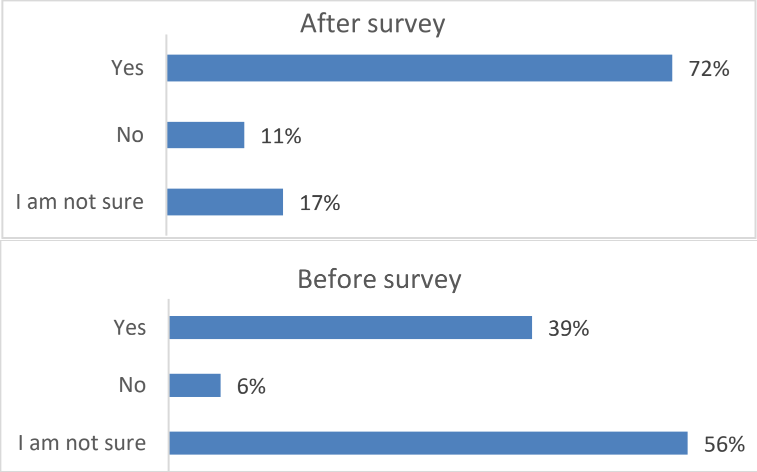

Figure 13: Fleet managers' attitudes to whether EFVs are a viable alternative to ICEVs

The fleet managers were asked for more details if they do not think or are not sure whether EFVs are a viable alternative to ICE vehicles. Most of them mentioned three factors which affect their decision, i.e. range, load capacity and price of the vehicle. They need to have a suitable range and load capacity from the vehicle to comply with operational needs and a positive total cost of ownership (TCO). A few of the managers also pointed out that electric is not the only alternative to ICE vehicles. Many mangers reported that the successful implementation of running EFVs also depends on the support from municipalities, such as providing extra funding, cross docking or consolidation facilities to overcome range limitations.

When fleet managers were asked for their preferred range of EFV, 56% of them are either happy with what they have or the preferred range is less than 100km. There is a significant shift of attitude about the preferred range of EFV in the before survey where only 6% of the respondents chose the same options.

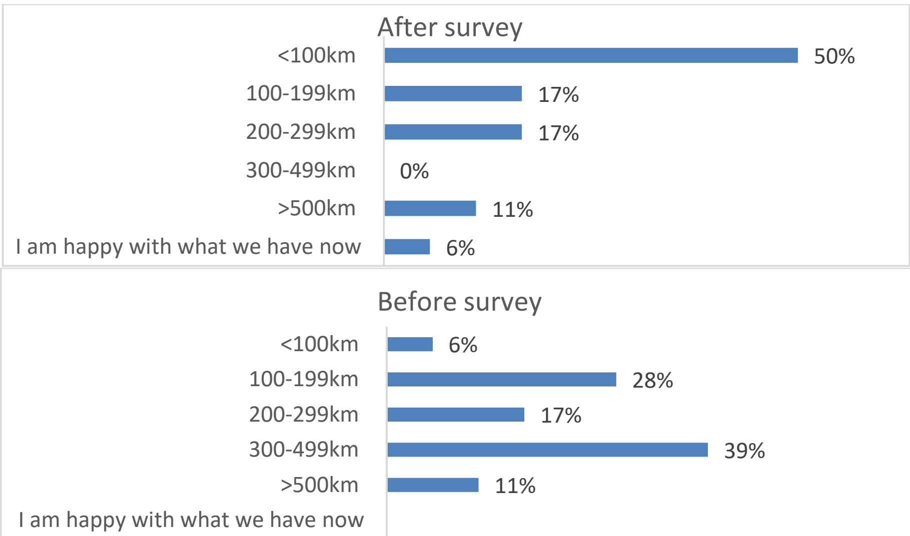

Figure 14: Preferred EFV range – fleet managers

However, even after deploying EFVs for a number of years, 91% of respondents agreed with the statement that EFVs are new and EV technology is still under development and hence EFVs are not yet mature.

4.3 Attitudes towards operation and maintenance

Apart from the need to plug-in EFVs at the end of the delivery round, most of the fleet managers reported that there has been no change of loading and unloading arrangement at the depots to integrate EFVs into their existing fleet operation. For some of the operators (such as Madrid and Milan), because a new cross docking centre is used to address the range limitation, there is a change of loading arrangement.

56% of respondents confirmed that the delivery route and schedule were optimised specifically for EFVs to consider their operational characteristics. 44% also agreed that the range limitation of EFVs did not cause any problem for their operation. However, the same number of the fleet managers thought the opposite. A number of fleet managers explained that there is less operational flexibility because of the limited EFV range. For example, as discussed in the driver's survey, if a delivery vehicle is experiencing problem, an ICE vehicle can take over the job to make additional deliveries, whereas this is difficult for EFVs because of the charging time and range limitations.

The maintenance of EFVs is much simpler than for ICEs due to the reduced number of moving parts. There is no clutch, no gears to change and most of the vehicles have proven to be very reliable, which is especially the case for manufactured light goods electric vehicles. For the retrofitted vehicles, as the largest operator in the FREVUE project in terms of the number of retrofitted vehicles, UPS reported that the major part to be maintained is the battery. Because their converted vehicles are using a modular battery pack, if there is a problem with a particular battery cell, it will be taken out for test and, if necessary, will be replaced.

UPS also suggested that one of the key success factors in deploying EFVs is to have an in-house maintenance team who understand the technology, as this saves time and money. If anything went wrong during the delivery, the in-house maintenance team was able to provide rapid and knowledgeable responses.

4.4 Overall experience of managing EFVs

Fleet managers were also asked to rate their experience with EFVs against a range of measures, as shown in Figure 15. Overall, more than 85% of the respondents rated their EFV experience as good or very good.

Looking at the detailed categories, the best rated areas including safety (100% rated good or very good), environmental performance (87% positive rating), running cost (82% positive rating) and maintenance (82% positive rating). Performance of the vehicle, charging experience and integration of EFVs into existing fleet are rated similarly at 68% good or very good. The worst rated areas including range (50% rated as bad or very bad), available choice of vehicles on the market (50% rated as bad or very bad), purchase cost (44% rated as bad or very bad) and re-sale value (38% rated as bad or very bad). Respondents' opinions on financing options and after sale support are neutral. There is also significant uncertainty about the re-sale value of their EFVs, where 40% of the respondents reported they are unsure.

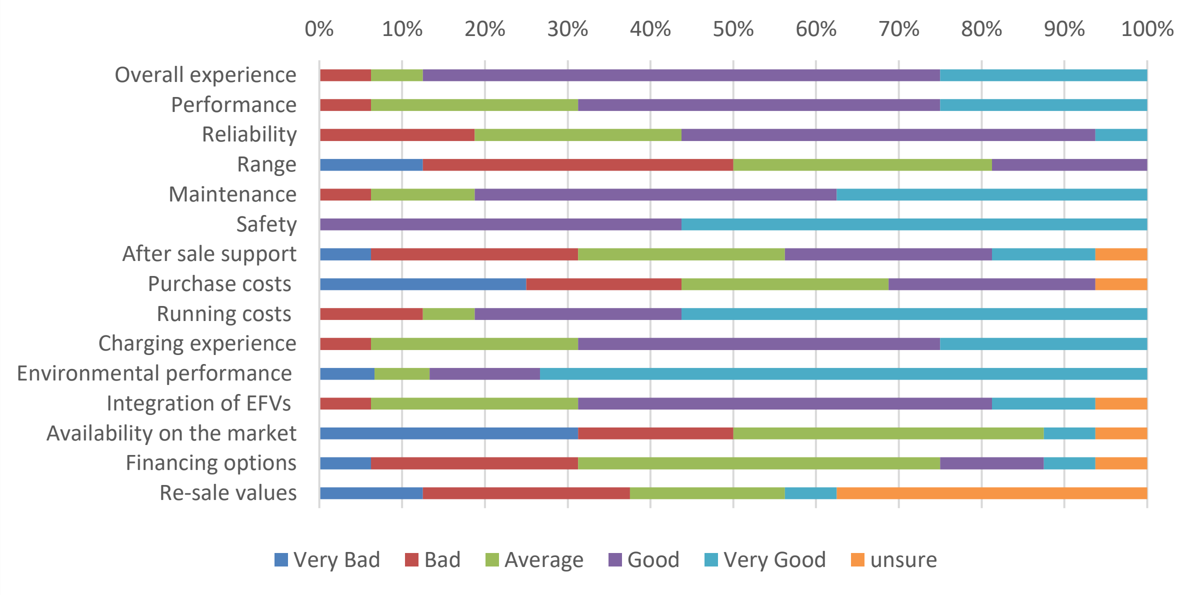

Figure 15: Summary of fleet managers' EFV experiences

In addition, fleet managers were asked to compare EFVs against ICEVs directly on a number of key index, as shown in Figure 16. For the overall experience, 19% of the respondents report that EFVs are better than ICEVs, however, 26% think ICEVs are better than EFVs. The remaining 50% think they are similar or unsure which one is better.

There are some areas where fleet managers think EFVs are significantly better than ICEVs. These areas include maintenance, running costs, environmental performance, operation costs, customer satisfaction and company image/reputation. Other areas, such as performance, reliability, after-sale support and service quality, on balance the fleet managers think ICEVs are better than EFVs.

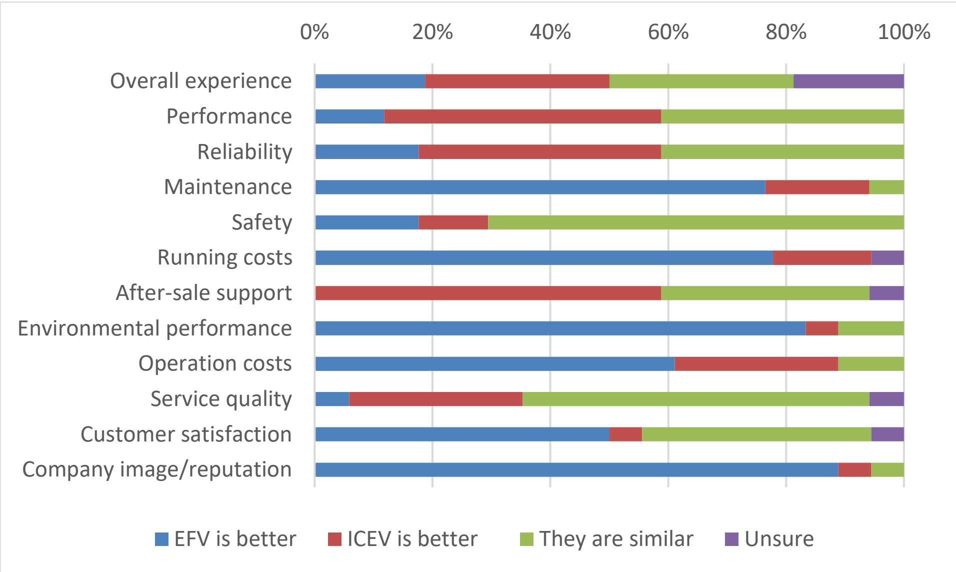

Figure 16: Comparisons between EFV and ICEV from fleet managers' perspective

Similarly, fleet managers were asked an open question about what they like and dislike most about their EFVs. The responses are categorised in Table 6 and Table 7. These two tables further confirm the various aspects that have been discussed above about the experiences of running EFVs. However, one of the disproportionately often mentioned dislikes of EFVs is the battery/range issue. Although most of the fleet managers confirmed that their EFVs were capable for the existing delivery tasks they were assigned for, many of them are concerned that the range is a significant limiting factor which means there is very little operational flexibility. Any change of operational routine or depot location may result in the EFV being unsuitable to complete the task. For example, in the London's Regent Street demonstrator, an increase in round trip of just 24 miles was enough to make the EFV virtually unusable for the purpose it was procured for. The Lisbon demonstrator also mentioned that it is impossible to use EFVs as a backup when another vehicle has broken down.

What fleet managers liked	Number of open responses
Quiet	3
Environmental benefits	3
Easy to drive	3
Low running cost	2
Low maintenance cost	2
Clean	2
Good sale argument	1
Company image	1

Table 6: what do fleet managers like most about EFVs

What fleet managers disliked	Number of open responses
Battery/Range	11
Loading capacity	4
Pricey	3
Performance of the vehicle	2
Charging time	1
Availability of vehicles	1
Reliability	1

Table 7: what do fleet managers dislike most about EFVs

4.5 Important factors for future EFV deployment

Based on the feedback from logistics operators, a total of six factors were summarized as potential barriers for future EFV deployment. Fleet managers were asked to rate them on a scale from 1 to 6 with 6 being the most important and 1 being the least important factor. The results are averaged across all respondents and are shown in Table 8:

	Score
Limitations of EFVs, including but not limited to range, charging time, loads, etc.	5.00
Capital expenditure of EFVs	4.43
Costs associated with upgrading depots, charging stations, power networks	3.50
Limitations of infrastructure, for example limited space (hence difficulties to install charging points), lack of grid capacity etc.	3.25
Lack of suitable vehicles and after sale support from vehicle manufacturers	3.23
Uncertainty about the re-sale value	1.83
Other	0.00

Table 8: Factors affecting EFV deployments – from fleet managers

It can be concluded from the table above that on average, fleet managers reported the most limiting factor for EFV deployment being the limitation of EFVs themselves, including the range, load capacity and charging time. The second most important factor is the capital expenditure of EFVs as they are in general much more expensive than ICE equivalents. The costs associated with upgrading infrastructure, limitations of infrastructure and the lack of suitable vehicles scored similarly.

After four years of FREVUE demonstration activities, it is important to understand whether any of the operators are planning to deploy more EFVs in the future. To do this, we first ask the fleet managers whether there are any other existing ICE vehicles which can be replaced by EFVs, taking the current characteristics of EFVs into consideration, such as the range limitation, load capacity and charging time.

76% reported that there are other conventional vehicles which can be suitably replaced by EFVs at their depots. Fleet managers were then asked if they have any future EFV deployment plan. Based on the FREVUE experience, 53% of the fleet managers reported that they will consider EFVs for their next vehicle purchase. 12% of the respondents said they are not going to consider EFVs for now and 35% reported they will probably consider it.

In addition, 61% of the fleet managers reported that the existing infrastructure is not a problem and their depot can easily accommodate more EFVs. However, the remaining 39% gave various reasons, including limited grid capacity and little space for additional charging facilities.

4.6 Charging and grid constraint

As discussed in section 3.5, most of the vehicles are only charged overnight at the depot. When the fleet managers are asked whether EFV charging time is an issue for their operation, the answer is strongly dependent on their operational model. 66% of the fleet managers who reported that EFV charging time for an empty battery is not a problem for their delivery operation were having vehicles only charged at the depot overnight. The other 28% of fleet managers who stated that it was a problem were those whose vehicles had to be charged between delivery roundtrips. For example, before the fast chargers were installed in Oslo, Bring drivers were using other publicly available chargers when available. However, this caused some challenges, firstly because of technical problems with some chargers, and secondly due to the queues at some charging points during rush-hour, especially during the cold winter months from December to March. Very long waiting times were reported for the charging of vehicles with drivers often waiting more than an hour to get access to these chargers. This results in loss of time and money for the drivers and for Bring Express.

Over the FREVUE demonstration period, it has been reported that the electrical grid capacity has been one of the constraints for a number of demonstrators. For example, UPS has spent a significant amount of time and money to overcome the grid capacity constraints at their central London depot. We asked fleet/depot managers whether they agree that electrical grid capacity constraints are a factor at their depot in restricting further EFV deployment and 39% agreed stating that they have already or are likely to encounter this issue should they want to take on more EFVs. 33% of the respondents thought they have enough grid capacity at the local level and 11% are not sure about this issue as shown in Figure 17. More on the grid capacity issues is discussed in the survey for grid managers (section 7.2)

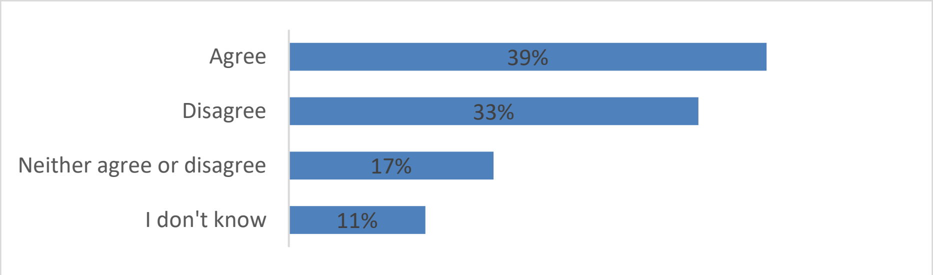

Figure 17: Electrical grid capacity constraint at my depot is restricting further EFV deployment – fleet managers

4.7 Conclusions

Survey results for fleet and depot managers show that the respondents are very satisfied with the overall experience of running EFVs and the low maintenance requirement was very welcomed. For the majority of depots, there has been no change of operational arrangement and EFVs were integrated easily into existing fleets, based on their range and load capabilities. A significant shift of attitudes was also observed for fleet and depot managers. The longer they work with EFVs, the more confidence they have in the suitability of this type of vehicle.

Most of the fleet managers are content with their EFVs' capability for the existing delivery tasks they are assigned for. However, many of them are also concerned that the range of EFVs limits operational flexibility. A change of operational routine or depot location may result in EFVs becoming unsuitable to complete the new task. Hence many of the fleet and depots managers would still like a better range capability from the vehicle.

5 Logistics operators

The survey for logistics operators targets personnel at logistics companies holding a management or decision-making role related to the possible wider deployment of EFVs. As they are the decision makers, they have first-hand experience and knowledge regarding many aspects of EFV deployment, including but not limited to procurement, after sale support, infrastructure expansion and future development plans.

The aim of this survey is to capture and summarise this valuable knowledge and experience, along with their attitudes towards electric freight vehicles.

In total 11 logistics operators responded to the survey questionnaire. The size of the fleet in the company varies from 3 to 2100 vehicles, with median company fleet size of 115 vehicles. The number of electric freight vehicles also varies from 1 to 115, with a median EFV fleet size of 5 vehicles. The percentage of the EFV fleet in the total company fleet varies from less than 1% to 100%. 50% of respondents reported that their companies only operate OEM EFVs, while 25% said their companies only operate retrofitted EFVs and the remaining 25% confirmed both types of EFVs were operated.

5.1 Motivation behind EFV deployments

Logistics operators were asked about their motivations before the EFV deployment because at the time when the FREVUE project started, the consensus on EFVs was that they are very expensive with limited capabilities in terms of range and load capacity. Seven out of eleven logistics operators responded to this question and their feedback can be classified as follows:

1. For the reason of sustainability and environment protection. This is the mostly frequently mentioned reason and it appeared in 6 out of 7 responses.
2. To test green technology and the capability of electric freight vehicles. EFVs were just emerging on the market at the time when the project started and companies want to use this opportunity to test the new technology. This was mentioned by two respondents.
3. EFVs are a good opportunity for business development, providing a sales argument and attracting new customers. For example, the low noise nature of EFVs may provide an opportunity for out-of-hour delivery. This was mentioned by two respondents.
4. The company had a profitable business case for EFVs.

As can be seen from the above, the environmental considerations are still the most important motivations behind the deployment of EFVs. However, increasingly, logistics companies are recognising that by running EFVs they will save money in the long-term under certain conditions, even though EFVs are in general more expensive to procure. This can be facilitated by government policy to charge the use of polluting vehicles in city centres, such as the T-Charge in London which is planned to be implemented in October 2017 and the planned increase of vehicle tax on ICEs in Oslo. Detailed analysis on the economics of EFVs can be found in FREVUE Deliverable 3.2.

5.2 FREVUE Experience

Over 85% of the logistics operators reported that they believe the FREVUE demonstrations have been a success overall in their company. Around 75% of the respondents believed that it is successful at both the operational level and attitudinal level, and 85% reported it as being successful at the financial level as well (see Figure 18).

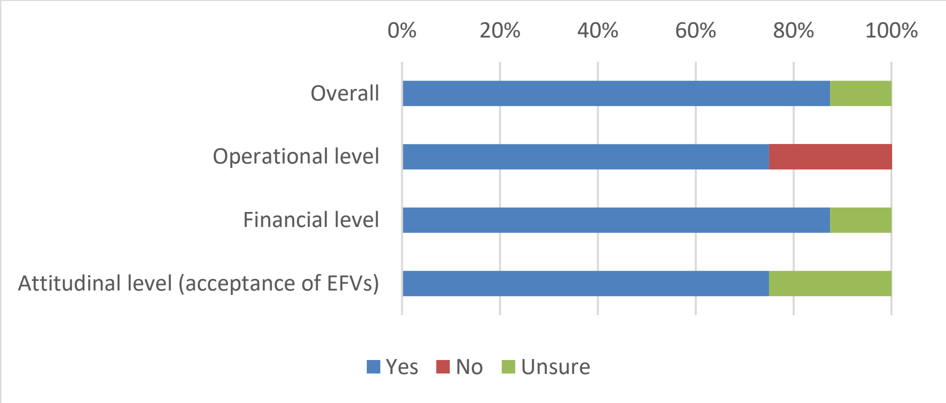

Figure 18: Do logistics operators think the FREVUE demonstrations have been a success?

Looking in detail at those operators who are unsure or do not think the demonstration have been successful, the reported reasons were around the capability of EFVs. For example, in Milan and Madrid, logistics operators have to use cross-docking centres to work around the range issues, which means such centres are usually far from their depots and introduced additional challenges in both management and future deployment. In the London Regent Street demonstrator, the EFV was underused because of an increase of planned delivery distance. Furthermore, the same vehicle no longer can be serviced because the vehicle supplier paused operation due to funding problems.

For the majority of demonstrations, logistics operators are happy with their vehicles. Because of the positive experience, over 50% of the respondents reported that EFVs are a financially viable option for their business even without external funding in future, and 90% respondents reported that they are in favour of EFVs replacing ICE vehicles, especially for the urban last mile delivery to which the characteristics of EFVs are particularly suited.

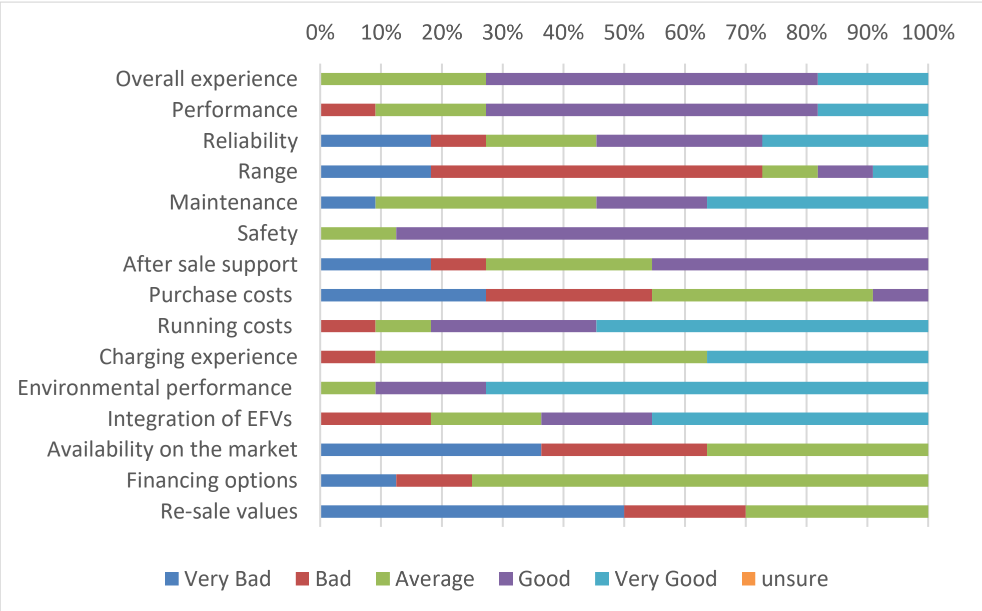

Figure 19: Summary of logistics operators' EFV experiences

Similar to the survey for fleet managers, logistics operators were also asked to rate their experience with EFVs on a number of dimensions, as shown in Figure 19. High ratings can be found on many categories, including for example, overall experience, performance, reliability, maintenance, safety, after sale support, environmental performance, and running costs. On the other hand, the issues rated lowest are range, resale values, availability of vehicles on the market and purchase cost. There is also a lack of financing options for EFVs.

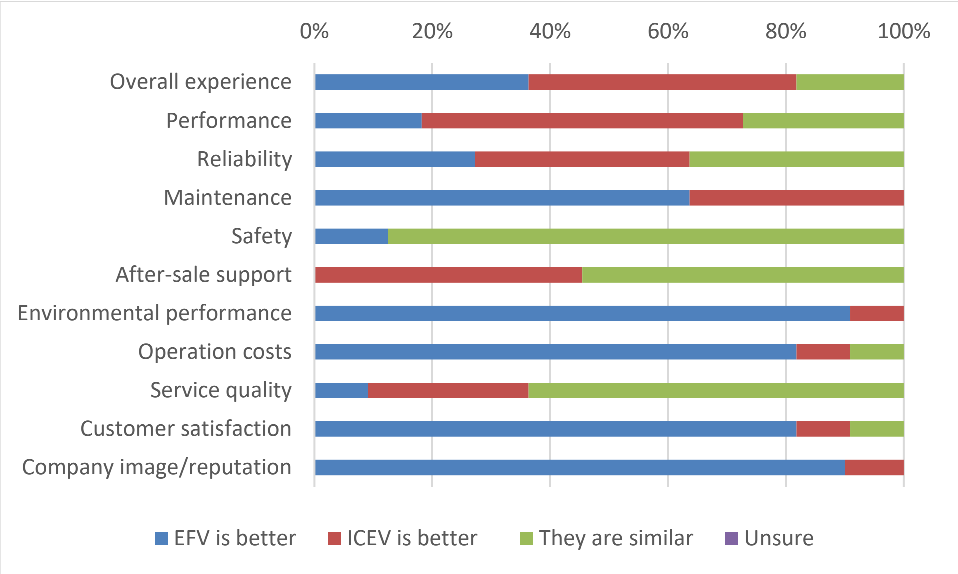

Figure 20: Comparisons between EFV and ICEV from logistics operators' perspective

When comparing EFVs with ICEVs, logistics operators rated EFVs very highly over ICEs on operational costs, environmental performance, customer satisfaction, company image and maintenance. However for after-sale support and service quality, the respondents mostly reported that both types of vehicles had similar performance or ICEs were in general better. For the overall experience, performance and reliability, respondents were divided with slightly more stating that ICEs were better.

Logistics operators were also asked the open question about what they like and dislike about EFVs the most. Results are shown in Table 9. The answers further echoed the attitudes and choices they have made in Figure 19 and Figure 20 which was discussed above.

What they liked	Number of mentions
Environmental Performance	3
Quietness	3
Operational cost	3
Reliability	1
User friendly	1
What they disliked	Number of mentions
Range	6
Purchase cost	2
Charging time	1
Load capacity	1

Grid issues	1

Table 9: what do logistics operators like and dislike about EFVs

5.3 Procurement of the EFVs

The lack of suitable electric freight vehicles on the market has been widely reported by logistics operators.. While a few options were available for light goods vehicles under 3.5t from mainstream vehicle manufactures, the availabilities for heavy goods vehicles over 3.5t were extremely limited.

In the after survey, unfortunately there are still over 70% of the logistics operators who agree that there is a lack of suitable EFVs on the market to suit their logistics operations. Most of the respondents do not think there has been any significant progress made in terms of choice of vehicles available on the market. In addition, the limited leasing options deter operators who are reluctant to take a depreciating asset onto their books, due to the uncertainties of the EFV resale value.

We asked logistics operators what were the key factors that need to be considered in EFV procurement decisions. Their responses were broadly classified into the following categories:

- Operational compatibility (load capacity and volume) – how the EFVs will fit alongside the existing fleet
- Price and TCO
- Range
- Vehicle warranty, service and maintenance
- Delivery time

The availability problem has resulted in a number of challenges for the logistics operators, including for example the lack of bargaining options/power for the logistics operators, delayed progress at a number of demonstrators and reduced demonstration scales.

Due to the difficulties encountered in finding suitable manufactured EFVs, some operators turned to retrofitting vehicles. Some of them retrofitted new diesel vehicles while others retrofitted older vehicles. On balance, retrofitting older vehicles seem to have a number of advantages, including:

1. It makes financial sense. They are cheaper to convert than buying new vehicles and the lifetime of the vehicle is extended
2. The drivers are familiar with the vehicles and the interior of existing vehicles has been optimised to suit the needs of urban logistics delivery. For example, in the case of UPS drivers can walk to the back of the truck from the driving seat. Hence the time it takes to get the goods out of the vehicles has already been minimised.
3. Environmental preference – it makes environmental sense to convert and to extend the life of these trucks rather than take them to waste

However, most of the retrofitting activities have experienced some delays. The reasons include:

- Building retrofitted vehicle from scratch takes time
- Little knowledge is passed on from the OEM to the companies carrying out the electric conversions
- OEMs did not supply software source codes, meaning the software had to be developed from scratch
- Understanding applicable local and national legal regulations

- Electric HGVs are so new that at the beginning of the project this was a trial and error process which required time to get right

During the procurement process, logistics operators gained first-hand experience in terms of what worked well and what didn't. Their lessons learned are summarised below:

- A key lesson learned in the procurement of EFVs larger than 3.5t is that suppliers are often inexperienced and therefore expected delivery times are postponed multiple times. Due to this uncertainty meeting vehicle deployment targets is very difficult.
- Operators should always aim for the largest battery possible as this provides greatest operational flexibility. Retrofitting of larger batteries can be prohibitively expensive at a later stage should capacity requirements increase. However, as discussed in FREVUE Deliverable D3.2 battery packs are the single most important factor influencing an EFV's TCO. The larger the battery the more difficult to reach a positive business case.
- By converting old diesel vehicles, the operators need to consider the condition of the trucks. For example, although the UPS diesel truck was built to a very good standard, there was still noticeable chassis corrosion when the conversion was carried out, which means they expected the vehicles to last shorter than originally planned.
- Converting a large number of trucks from diesel to electric is an advantage because the first few conversions are quite experimental and it is essentially a trial and error process. As the converters gain more experience the vehicles become more reliable.
- It is very useful to have an in-house maintenance team who understand the technology. It saves time and money.
- Retrofitting is better suited to larger and heavier vehicles. For lighter vehicles, the weight of the battery takes a large proportion of gross vehicle weight.

5.4 Reliability and after sale support

Due to the diverse range of EFVs deployed in the FREVUE project, the feedbacks on reliability and after sale support vary widely. For a list of detailed repair and maintenance issues reported by operators, interested readers can refer to appendix two in FREVUE D3.1 Technical Suitability of EVs for Logistics.

In general, for electric light goods vehicles (LGV), the feedback on reliability and after sale support has been positive because most of these vehicles deployed were in-series produced EFVs from renowned suppliers. Reports of malfunction and repair issues from the operators show that in general they do not perceive having more problems with the EFVs than with the ICE vehicles. Although a few of the vehicles were reported problematic, the manufacturer repaired or replaced the vehicle in a timely manner which is comparable to ICE vehicles.

There have been more reported problems with the electric HGVs. There are two reasons behind this. First of all, many of the electric HGVs are newly converted from diesel HGVs hence there is a period of trial and error. This has been reported by both UPS and TNT. After the initial learning and fixing period, the vehicles have shown to be in general comparable to ICE vehicles in terms of reliability. Secondly, many of the electric HGVs are either produced or retrofitted by smaller manufactures. A problem is that, unless the operator has a maintenance and repair team in-house, repairs for these EFVs tend to take much longer than with diesel 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 sometimes repaired vehicles need to be tested again before they can return to full operation.

FREVUE D3.2 Economics of EVs for City Logistics Report provides more information about the impact of technical issues and repair costs on the business, as well as the comparison with the 'before situation' with ICE vehicles

5.5 Experience of expanding electrical grid capacity

During the FREVUE demonstrations, a number of operators reported local grid capacity constraints which prevented them from charging all existing EFVs or from a future expansion of the EFV fleet. This problem was firstly reported by UPS in London where they became aware of a grid constraint when it was discovered that it was not possible to charge all 18 existing Modec EFVs (not related to the FREVUE project) simultaneously.

Following a lengthy learning and decision-making process UPS opted for an upgrade of the third-party local grid infrastructure.

Without the infrastructure to pay for, UPS reported that they could electrify their fleet by themselves, without any requirement of outside support. However, with the infrastructure it is very costly and will need additional funding.

Based on the FREVUE experience, the following lessons learnt are summarised (UPS, 2016):

- Develop good understanding of infrastructure requirements of electric freight vehicles before purchase
- Develop good understanding of local grid infrastructure situation especially in relation to ownership structures and lease agreements
- Infrastructure upgrades tend to be non-incremental in nature: E.g. an upgrade in two steps rather than one can be significantly more expensive
- Not many stakeholders will be in a position to invest in third party infrastructure the way that UPS did. This is a policy issue that will need to be addressed if larger electric freight vehicle fleets are to be encouraged

More on the grid capacity from grid manager's perspective is discussed in section 7.2.

5.6 Plan for future electrification of freight fleets

The feedback from logistics operators on the plan for future electrification of freight fleets can be classified into three situations.

The first situation is that the FREVUE demonstration and experience have been so positive that the logistics companies have already taken on more EFVs, or are planning to deploy more EFVs in future. For example, in Madrid, Calidad Pascual originally procured three EFVs for operation from the Madrid consolidation centre. They have since added 4 Nissan Leaf in 2015 and an additional EFV was incorporated in February 2016. Similarly, SEUR procured two EFVs for operation from its own consolidation centre. In addition to that, in 2016, five electric motorcycles and five electric bicycles were incorporated as well as one Nissan e-NV200 without the financial support of any programme or project. Other operators, such as CTT in Lisbon are also planning to deploy more EFVs in short term.

The second situation is that although the experience with FREUVE demonstration has been positive in general, the operators are not planning to deploy more in the short-term, mostly due to range limitations and high purchase cost. For example, BRING from Oslo reported that many diesel LGV drivers have shown strong interests in EFVs and have specifically asked whether there are any EFVs available on the market that are capable to cover a longer distance. Unless a better product (range and capacity) can be provided, the limitations of existing EFVs restrict a wider uptake level for some of the demonstrators.

Many logistics operators would like continued government support to drive EFV volumes up and prices down. In addition, operators want more government actions on stimulating the green delivery markets and providing help to those front runners who are taking on risks to develop their EFV fleets. They believed that as front runners they are paying for those sceptical operators who wait for the market to mature.

The third situation is that a company has a clear business case for EFVs and a vision to decarbonise fleets according to the characteristics of low emission vehicle technologies. Hence EFVs are implemented as a part of the plan based on its current technology and capabilities. Table 10 below is an example from UPS' Euro alternative technology roadmap which classifies a range of alternative fuel technology based on the distance and operation requirements. The classifications are reported at three levels which use a color-coded system based on the sustainability, feasibility and payback balance. As can be seen from this table, EFVs at the current technology are rated suitable for collection and delivery under 100km per day.

The roadmap as shown in Table 10 is crucial for a consistent and continued decarbonisation of the freight fleets.

	Collection and Delivery under 100 km per day	Collection and Delivery over 100 km per day	Feeder
Walker or tricycle	Green	Red	Red
Electrically assisted tricycle	Green	Red	Red
Electric	Green	Red	Red
Range extended electric or hybrid	Green	Green	Red
Biomethane	Green	Green	Green
Biodiesel	Yellow	Yellow	Yellow
Natural gas (CNG, LNG)	Yellow	Yellow	Yellow
Hydrogen	Yellow	Yellow	Red
Propane (LPG)	Red	Red	Red
key	Green	Good sustainability, feasibility, payback balance	
	Yellow	Backup	
	Red	Poor sustainability, feasibility, payback balance	

Table 10: UPS Europe Alternative Technology Roadmap (UPS, 2017)

5.7 Conclusions

Our analysis on logistics operators shows that logistics companies are motivated by a variety of reasons to electrify their freight fleets. The most common reason is sustainability and environmental responsibility. Many are also motivated by the opportunity of EFVs or want to test the EV technology for freight delivery.

The lack of OEM products means that all operators had very limited choices of suitable EFVs, which is especially the case for electric HGVs where many operators had to rely on smaller suppliers or to retrofit their existing or new diesel vehicles. This led to increased delivery time and complexity. However, it was reported that converting large number of trucks from diesel to electric are an advantage because although the first few conversions were quite experimental, it was essentially a trial and error process. This was important because it allowed the team to learn what went wrong and what worked/what didn't. As more is learned the vehicles become more reliable.

Logistics operators have reported good reliability for light OEM freight vehicles. For HGVs, more problems were reported at the start of the demonstrations. However, as problems were fixed and operators were more familiar with their vehicles, most of them have been running fine.

In terms of the plan for future EFV deployments, the responses are mixed. Some operators have already committed to more EFVs or are planning to deploy more in the short-term because of the positive experience they had. Others said there is no plan in short-term, because of the limitation of EFVs (range and capacity) and the high purchase costs, and better products need to be developed. There are also operators who have positive business case and a clear vision and roadmap for decarbonising their fleets. Hence EFVs are going to be deployed as a part of a wider plan based on its characteristics and suitability comparing to other alternative fuel technologies.

6 Traffic Network Manager

A wider deployment of electric freight vehicles is likely to have significant impacts at many different levels on our road network, for example, reduced noise nuisance, improved air quality around road network and improved quality of life for people living close to busy roads. Some of these aspects are analysed in other deliverables, such as FREVUE D3.3 Systemic Transport and Environmental Impact Analysis.

There are, however, other subtle but important changes, and collectively they are also affecting people's lives and their welfare. These changes include for example, the change of accident rates because of new characteristics of the vehicles, the change of congestion due to a new logistics operational model, and the change of policies to facilitate a wider uptake of EFVs.

Therefore, the purpose of the survey on traffic network manager is to understand the views from the managers of our urban transport network on these potential changes and whether any analysis or studies have been carried out to quantify these potential issues to facilitate future electrification of the fleet for urban last mile delivery.

Although a number of attempts have been made to get to the traffic network managers in the eight FREVUE cities, however, it was proven to be difficult to get good response rates. Identifying the suitable personnel within a city traffic management department which is usually large and complex is also very difficult. Because of these reasons, the survey on traffic network managers have received responses from only four out of the eight FREVUE cities, including Madrid, Milan, Oslo and Stockholm. The road transport network in each city has its own characteristic and is facing both common and unique challenges. Hence the survey results may not be representative. This analysis is based on valid returned responses and literature surveys on the relevant issues.

6.1 Impacts of EFVs on existing traffic management systems

It has been widely reported in the FREVUE project that the drivers enjoy fast acceleration of their electric freight vehicles. Some electric HGV drivers even reported that their vehicles accelerate faster than a normal car at road junctions. Therefore, it is very likely that the deployment of EFVs would have impacts on junction saturation flows. Saturation flow is a performance measure of junction operation. It is an indication of the potential capacity of a junction when operating under ideal conditions. Many factors may affect junction saturation flows, including for example the number of lanes, speed limits, traffic signal staging, the percentage of turning vehicles (left turn or right turn) and the percentage of heavy goods vehicles. A major study carried out by the Texas Transportation Institute shows that junction saturation flow decreases with an increase percentage of heavy vehicles (Bonneson et al., 2005) due to slow acceleration of these vehicles.

The replacement of conventional ICE vehicles with fast acceleration EFVs should in theory improve junction saturation flows hence subsequently reduce journey time and delays to other road users. We asked the traffic network managers whether they think there will be such impacts to other road users and whether the existing systems are required to be updated. However, most of the respondents reported that they do not think it would be a problem, as EFVs would be able to adapt to existing traffic management configuration. Furthermore, there is generally lack of study on this area so quantitative evidences are difficult to find.

6.2 Impacts on accident rates

As analysed in previous sections, there has not been any report of accident for the duration of the FREVUE project. However, due to the quietness of the EFVs, some of the drivers did report that driving EFVs requires a high state of alertness in traffic because some pedestrian and cyclists simply cannot hear them.

We asked the traffic network managers whether there is any statistics on traffic accidents which are caused by electric vehicles. Three out of the four cities reported that they do not have any information specifically related to EV related accidents. The traffic manager from Stockholm reported that there is no noticed increase in accidents related to electric vehicles, and although it might be an issue, he believed the behaviour of drivers, pedestrians and cyclists would change and adapt to the new quieter vehicles.

Looking at existing literatures on this topic, there seems to be mixed evidence on whether there is any difference between the number of accidents involving pedestrians and electric vehicles or ICE vehicles. For example, The National Highway Traffic Safety Administration (NHTSA, 2009) in the USA reported that Hybrid Electric Vehicles (HEVs) were found to be twice as likely to be involved in a slow-moving accident with pedestrians as equivalent ICE vehicles. However, in a review of vehicle accident statistics, the Transport Research Laboratory in the UK found that the likelihood of being involved in a collision with a pedestrian was comparable between EVs/HEVs and conventional ICE vehicles. However, another study carried out by Transport Research Laboratory (Morgan et al., 2011) showed that accidents with pedestrians are no more likely with electric/hybrid electric vehicles than conventional ones pro-rata to the numbers registered. The report also points out that visually-impaired people listening to recordings found identifying electric or hybrid electric vehicles more difficult than conventional vehicles at low speeds and pull away. Despite the lack of strong evidence that there is currently an increased risk to vulnerable road users posed by vehicles with low noise emission, the number of electric vehicles on the road may rise in the future which could increase the risk to these users. So investigation of measures designed to mitigate those risks are of value (Visvikis et al., 2011).

6.3 Attitudes towards EFV priority schemes

To encourage uptake of electric vehicles, many cities have implemented EFV priority schemes. Such schemes might include, for example, access to priority lanes, extended delivery windows, concessions on the location of loading/unloading, extended delivery area and access to restricted parking area or free parking.

Although some of these schemes are very popular among the logistics operators, it affects the operation of transport network and might cause inconvenience to other road users. We asked whether traffic network managers support such priority schemes for EFVs and all of them in general are in support of such schemes, mainly due to the environmental benefits EFVs can bring to the city. They are then asked further to rate how feasible some of the priority policies can be implemented in their cities and the results are shown in Figure 21.

In facts, many FREVUE cities have already implemented a number of priority schemes. For example, in Madrid EFVs are allowed to park for free in the central area of the city whereas other type of vehicles have to pay based on their engine technologies, in Oslo, EFVs do not have to pay parking fee and can use bus lanes.

Although these measures played an important role in encouraging more uptake of the electric vehicles, they also brought controversies. For example, Figenbaum (2016) reported that the bus lane incentive in Oslo was so successful that electric vehicles started congesting bus traffic. From the summer of 2015, battery electric vehicles (BEVs) must therefore have at least one passenger in addition to the driver in the most popular bus lane during rush hour. When the Tesla Model S appeared in the bus lanes, a debate was carried out in the press and among drivers in general about BEV privileges being for the rich. Therefore it is important to balance EV privilege policy carefully to make sure it is consistent, fair and effective. A number of papers looked at this issue, for example Myklebust (2013) and Figenbaum (2016)

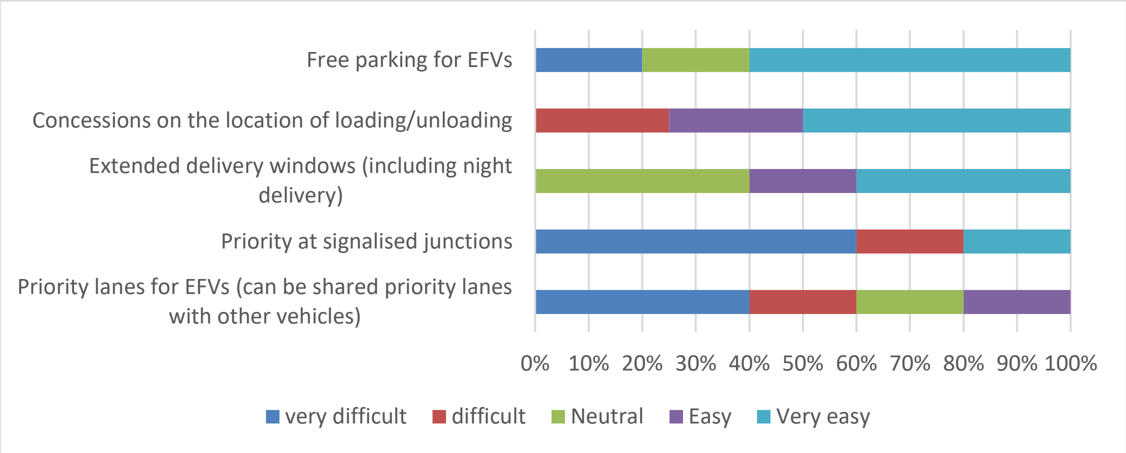

Figure 21: EFV priority schemes

6.4 Conclusions

All of the transport network managers surveyed show very positive attitudes towards electric freight vehicles and they are all in favour of replacing ICE vehicles with EFVs, mainly due to the environmental benefits. Many of the cities surveyed, including for example, Madrid, Milan and Stockholm have restrictions in place to stop certain types of old vehicles entering the city centre, or to charge a fee for the use of the most polluting vehicles. The traffic managers are also in support of using privileges to improve the uptake of EFVs. However, such schemes have to be managed carefully to ensure fairness and positive experience to both logistics operators and the general public.

Apart from the environmental benefits, most of the transport network managers do not think deployment of EFVs would have any significant impacts on the road traffic network or on other road users, although some respondents did point out that EFVs still contribute to urban traffic congestion. It is important to balance the policy tools to not only encourage the electrification of the freight fleets, but also improve efficiency and reduce freight traffic mileage. They also do not think the use of EFVs and its characteristics would have any impacts on their current urban traffic management systems.

There hasn't been any report of accidents during the FREVUE demonstrations. However, currently available literature shows mixed evidence on whether there is any difference between the number of accidents involving pedestrians and electric vehicles or ICE vehicles. More data and analysis are required before a quantitative conclusion can be made.

7 Electrical Grid Operator/Manager

According to the Society of Motor Manufacturers & Traders, in 2013 only 3,500 of newly registered cars in the UK were plug-in electric or hybrid EVs. However, in 2016, the number jumped to 63,000. When electric vehicle penetration reaches higher levels, the electricity demand from electric vehicles will become a relevant factor within the energy system and impact the operation of power plants and grid infrastructure (Kasten et al., 2016).

Therefore, the purpose of the survey on the electrical grid operator is to understand their views on the impact of EFV implementations on the grid operation, how to prepare and deal with the potential grid capacity issues because of the additional electricity demand from EFVs, their experience and lessons learned from the project and plans for the future electrification of freight fleets.

However, in the FREVUE consortium, the number of grid operators is very limited. Apart from UK Power Networks (UKPN) which is a distribution network operator (DNO) for London and south-east England, the only other partner from the energy sector in the consortium is Fortum inStockholm, which is an energy company focusing on electricity sales. In order to obtain a broader opinion from all DNOs in the FREVUE cities, a paper-based questionnaire was distributed to all city leads which was then passed on to local grid managers, in the hope that the experience and attitudinal impacts can be obtained from them. In total, 11 questionnaires were returned, as shown in Table 3 but the respondents have a mixed background, apart from distribution network operators, others include charging point operators, utility companies, mobility service providers and electromobility membership associations. Overall, responses are received from DNOs in four cities, including London, Stockholm, Oslo and Milan. Analysis presented in this chapter is mostly based on the questionnaires and interviews we have carried out with the DNOs, as well as literature reviews on the relevant topics.

7.1 Attitudes on the impacts of EFVs on grid infrastructure

Overall, the impact of EFVs on grid infrastructure varies significantly at the local level. There are many factors which affect the impacts of additional demand from the implementation of EFVs. Such factors include for example, location of the depot, size of the fleet, type of the vehicles, difference of logistics operational model, state of electrical demand at the local level and spare capacity at the local grid. Therefore it is difficult to give a generalised answer. However, most of the DNOs agree that the impacts on the grid are positive if the additional demands from EFVs are properly managed, because of the potential in load balancing and optimisation.

As reported in FREVUE deliverable 3.1 (SINTEF, 2017), the charging data analysis shows a contrast with the charging patterns of private or commercial light electric cars where the diversity in charging is really high. The charging profiles of freight vehicles are less heterogeneous since most of them require to be charged at the same time every weekday. They have a very low energy demand during the working hours followed by a sudden high peak after 6 p.m. They do not require any charging during the weekends.

This type of observation was also confirmed by DNOs. For example, one of the targets UKPN set out for the FREVUE project was to understand and characterise the charging demand from heavy duty commercial users, where the evidence had been missing in the past. Through analysis on the UPS charging data, they confirm that the charging patterns are highly predictable due to the nature and operational mode of their business.

However, the challenges of homogeneous charging patterns are that the additional demand from freight results in high peaks during the evening and night hours. In many cities, this also coincides with household electricity demand during the evening peak which may lead to capacity problem, which is discussed in the following section.

7.2 Attitudes and solutions towards the grid capacity issues

For some demonstrators, such as UPS (Camden depot) where a large number of EFVs were deployed, charging problem was reported as it was not possible to charge all the EFVs at the same time due to constraint of local grid capacity. The problem which UPS have encountered is documented in Dalle-Muenchmeyer et al. (2016).

However, this does not mean the grid capacity issue will be a common problem for any future logistics operators who want to take on EFVs. Many cities did not report any problems caused by grid capacity. Even if in the cities where grid capacity could be a problem at local level, as discussed in 7.1, local grid capacity constraints are affected by a number of factors and it has to be decided on a case-by-case basis. Based on the lesson learned from the FREVUE project, some of the DNOs, such as UKPN, are proposing a 4-stage plan to help overcome the problem:

1. The first step is engagement and this is a two-way process. For any operators who want to deploy a large number of EFVs should get in touch with DNO to understand the current state of local grid. For a DNO, it is also important to raise the awareness of the potential grid constraints to local businesses and to understand their operational needs to help them make an informed decision before they are committed to a large-scale deployment.
2. The second step is that a DNO can always provide a connection to satisfy customers' needs if there is a capacity issue. For commercial customers, requesting a new connection comes with a cost and it is important to understand whether the customer is satisfied with the cost.
3. If the cost is prohibitive, a DNO can explore intelligent smart solutions with the customer. This includes, for example, smart charging to spread charging demand hence reduce peak capacity requirements. Majority of the vehicles deployed in the FREVUE project were charged at depot overnight for more than 12 hours, so the potential for smart charging is both viable and significant.
4. If smart solution is not possible (i.e. there is little flexibility in customer's operation model), a DNO can explore other demand side management options, for example timed/profiled connections. Based on historical data analysis, timed connections are offered by understanding the conditions which would adversely affect the network and limiting the output during certain time periods. As a result, the connection can be accommodated without the need for significant network reinforcement (UKPN, 2017)

The general feedbacks from other cities are very similar to the four-stage plan as proposed by UKPN. However due to the variances of local regulations and development of smart technologies, there might be some differences in terms of the measures to overcome the grid capacity issue. For example, Endesa / ENEL in Madrid is testing V2G[2] chargers in order to use EV during night to monetise the capacity of storage of the batteries participating in electricity markets. In this case, and depend on the market, the fleet company could be a partner of the utility company and share costs and revenues. In Stockholm, if the size of

[2] V2G (vehicle-to-grid): is a system which uses electric vehicles as an aggregated large scale storage option.

electric fleet is very large, a commercial customer has the option to connect to a medium voltage network. Although the customer has to pay for the connection itself, they have ownership of the substation and its facilities. AEDIVE from Madrid also suggested that it is possible to recover part of the cost from local and state government for grid reinforcement if the reason to carry out the upgrade is related to sustainability and air quality improvement.

Based on the FREVUE experience, UKPN is also working on a product or a toolkit of flexible development solutions. The aim is to present various connection options along with cost estimates to a commercial customer based on their business needs, their characteristic of the business and local and network wide constraints. They believe such toolkit is a key to ensure a successful EFV deployment in future from a grid operator's point of view.

7.3 Attitudes and solutions towards a wider uptake of EFVs

As electricity generation mixes and grid infrastructure are very diverse across countries and regions, a wider uptake of EFVs may lead to diverse integration issues (Kasten et al., 2016). Even between countries with similar renewable energy shares, the appropriate strategies for charging can be very different depending on the renewable technologies and the remaining types of generation capacities.

Although most of the respondents are confident that the power generation capability is sufficient to cope with a large uptake of EFVs, many of them also confirmed that they do not work for electricity generation company hence are not most up to date with the current capacity of generation. Research on the additional electricity demand from a wider uptake of EFVs seems to be lacking at the moment. However, a study funded by the EEA (Kasten et al., 2016) analyses a number of scenarios of electric cars penetration levels. It is reported that a high electric car uptake level (80%) in Europe would require 150 GW of additional on-demand capacity in 2050. This is equivalent to 40 Drax[3]-sized power stations. Therefore additional electricity generation capacities are required.

The environmental benefits of electric vehicles are strongly related to the carbon intensity of the electricity grid. As fossil fuel fired power plants have significant negative environmental effects and they do not fit into a future energy sector that needs to complement fluctuating renewable energy supply, additional renewable capacities should be installed to replace the required additional coal and nuclear capacities. Assuming constant electricity mix to the reference scenario in 2013, by converting fossil fuel electricity to renewable source, the additional electrical demand from converting 80% of the passenger cars would require additional 87 GW wind, 45 GW solar, 24 GW hydro and 13 GW biomass capacities according to the EEA report. This requires significant investment and an increase of land use for the purpose of electricity generation. In addition, in countries with high fluctuating renewable energy supply the coordination of the electric vehicle demand with fluctuating supply will become a major challenge.

Therefore, to better and more efficiently manage the additional electricity demand at both local and grid level and to reduce unnecessary costs associated with grid reinforcement, all of the DNOs confirmed that smart charging technology plays a very important role in future. In fact, different smart charging strategies may be applied depending on the chosen goal of electric vehicle demand management. These goals might include, for example, network-oriented charging which aims at reducing grid constraints by smoothing load profiles, renewable energy-oriented charging which tries to maximizing utilization of renewable

[3] Drax is a large coal-fired power station in North Yorkshire, England, which provides about 7% of the United Kingdom's electric supply

energy production to reduce CO_2 emissions or cost-oriented charging by minimizing charging cost through shifting charging to low-costs periods of electricity generation. These strategies might run contrary or be complementary to each other depending on the local and national context of the energy system (Kasten et al., 2016). The success of smart charging depends strongly on the user acceptance of smart charging concepts, because smart charging approaches imply reduced freedom compared to user-driven charging. Concepts on incentivizing smart-charging might become a key challenge with increasing penetration of electric vehicles.

There are more innovative responses to EV rise, too. Nissan, in partnership with Italian energy provider Enel, has announced it will install around one hundred 'vehicle-to-grid' (V2G) charging points across the UK[4]. With this V2G technology, cars plugged into these sites will be able to both charge their batteries and feed stored energy back to the National Grid when necessary. When there is a peak in demand, the Grid could access the cars' stored energy to help meet it. However, most of the DNOs confirmed that the V2G technology is not as mature as the smart charging technology at the moment and it is not possible for them to implement V2G technology as a short-term solution to the grid capacity problem. There are a number of reasons behind this, including the low overall storage capacity, additional wear and tear of the vehicle battery and the competition with other more cost-efficient storage options. Nevertheless, the potential of V2G is still significant and electric vehicles could potentially provide important system services to contribute to grid stability.

Although the smart technology to some extent can reduce the need of new capacities from existing electrical grid, in regions with a weak network infrastructure, additional grid reinforcement or implementation of specific smart charging approaches might still be required to ensure stable functioning of the infrastructure. During the FREVUE demonstration, the City of Stockholm identified an issue not previously encountered in the city, where the installation of one fast charging unit in their preferred identified location had to be discounted due to grid capacity issues. This is something that has not been experienced in the city previously and further emphasises that grid capacity is one of the key issues emerging from the FREVUE project.

7.4 Conclusions

The survey on electrical grid managers shows that the DNO is very positive about the deployment of EFVs. They believe the impact of additional demand at the network level from charging EFVs can be very positive if managed properly because of the potential in load balancing and optimisation. They also concluded that charging profiles from heavy-duty commercial vehicles are highly predictable due to the nature and operational mode of their business. The regularity and predictability of the additional demand can help DNOs develop new products to benefit both the commercial customers and DNOs themselves.

During the FREVUE demonstration, some of the logistics partners have experienced problems with capacity of their local grid. However, this does not mean the grid capacity issue will be a common problem for all future logistics operators who want to take on EFVs. This is due to the number of factors which affect the impacts of additional demand from the implementation of EFVs. UKPN has proposed a four-stage plan, which is echoed by other DNOs, to help resolve this grid capacity problem in future, which include engagement, smart intelligent solutions such as smart charging, demand side management and timed/profiled connections, and costed plans for new connections.

[4] http://newsroom.nissan-europe.com/uk/en-gb/media/pressreleases/145248

A wider uptake of EFVs may lead to diverse integration issues, due to the difference in grid infrastructure and electricity mix in different countries. Additional electricity generation capacities may be required to meet the additional demand from charging EFVs, and in regions with a weak network infrastructure, additional grid reinforcement or implementation of specific smart charging approaches might still be required to ensure stable functioning of the infrastructure. However, the smart intelligent technology, such as smart charging and vehicle to grid technology will have a very important role to play in future to reduce the cost and better manage the grid system.

8 Customers (including senders and receivers)

The attitudes from customers have an important role to play in future electrification of freight fleets. This is not only because most of the logistics operators are convinced that by using EFVs (or emission free vehicles in general) they can build a positive company image to their customers, but also they believed that it is a good sale argument and can give them the edge over their competitors who do not have emission-free vehicles (or green deliveries) when customers are choosing which logistics company to use. In addition, from the FREVUE experience, commercial customers have significant impacts on the deployment of EFVs. For example, it is not uncommon that some of the commercial customers specifically asked their goods to be delivered by EFVs.

However, most of the logistics operators strongly believed that customers are not willing to make additional payment to get their goods delivered by an EFV. They think majority of their customers are price sensitive and under most circumstances logistics companies have to pay the additional costs of the vehicle themselves, without any contribution from their customers.

With these observations in mind, the aim of the survey on the customers are trying to discover a number of attitude and experience from the customers, including the environmental issues they care about, awareness of EFVs, visibility of EFVs to its customer, whether the preferential attitudes to companies using EFVs are real and whether customers are willing to pay an additional fee for green delivery and if so, by how much.

However, it worth to be noted that due to low return rate of the customer survey and relatively small total number of returned questionnaires, bias might be presented in the results. Therefore, the analysis presented in this chapter is a good indication of customers' experience and attitudinal towards electric freight vehicles, but quantitative conclusions cannot be drawn.

8.1 Background

The survey for customers, including both senders and receivers, was designed in two formats: a paper based survey and a web-based survey to suit the needs of customers and the operational model of logistics operators. The questions are the same from the two formats and the returned questionnaires are mostly received from the web-based survey, with a small number of paper based survey responses.

Most of the respondents are either senders or receivers of the logistics operators that are partners of the FREVUE project. However, in Madrid, to encourage a better number of responses, one of the FREVUE municipality partner, EMT, made the web-based questionnaire available through their social media channels. As a result, there are a small number of participations from citizens as well.

Similar to other survey categories, the survey on customers was also done in two stages: before or at the very early stage of EFV implementation and after at least one year of EFV operation. However, as shown in Table 2 and Table 3, there are large differences in terms of the number of responses in each city between the before and after survey. In addition, differences in demographic of respondents are considerable as well (discussed in the following sections). So given the limited total number of respondents in both surveys, the difference or shifts of attitudes in the before and after survey should be treated with care.

In total, there are 31 received questionnaires in the before survey. Two thirds of these questionnaires are from customers in Lisbon. The remaining questionnaires are received from Amsterdam, Rotterdam, London and Stockholm. It should be noted that TNT in the Netherlands had distributed the web based survey questionnaire to 270 customers but the return rate is only around 3%. Over 60% of the respondents are commercial customers in which 44% of them are decision makers in terms of which logistics company to use for their goods delivery. The demographics statistics is summarised in Table 11.

For the after survey, as shown in Table 12, there are in total 53 responses from five cities. In London, UPS distributed the web-based questionnaires to a total of 90 customers and the return rate is around 10%. Out of the 53 respondents, 68% are male and 32% are female. Over 80% are commercial customers and most of the commercial respondents (83%) are decision makers in choose logistics operators.

	Male	Female				
Gender	58%	42%				
	Under 25	25-34	35-44	45-54	55-64	65 and over
Age distribution	3%	13%	23%	17%	37%	7%
	Commercial	Residential	Both			
Type of customer	60%	27%	13%			
	Yes	No				
Decision maker if commercial	44%	56%				
	Amsterdam	Lisbon	London	Rotterdam	Stockholm	Other
By cities	13%	65%	6%	6%	10%	

Table 11: Information about the respondents – customer before survey

	Male	Female				
Gender	68%	32%				
	Under 25	25-34	35-44	45-54	55-64	65 and over
Age distribution		17%	31%	33%	15%	4%
	Commercial	Residential	Both			
Type of customer	80%	16%	4%			
	Yes	No				
Decision maker if commercial	83%	17%				
	Sender	Receiver	Both			
Type of customer	19%	36%	45%			
	Amsterdam	Rotterdam	London	Madrid	Milan	Stockholm
By cities	7%	6%	19%	28%	28%	11%

Table 12: Information about the respondents – customer after survey

8.2 General attitudes to the local traffic and environmental issues

Customers were asked to choose the issues they are concerned about and Figure 22 shows that the most concerned issue among the respondents are air pollutions (66%), followed by global warming (53%), traffic congestion (45%) and traffic noise (36%).

In addition, 50% of the respondents confirmed that they suffered from poor air quality in general. 43% think that the air quality problem they have experienced are directly linked to the freight traffic. 65% think that the freight traffic in general significantly contribute to air quality problems (see Figure 23).

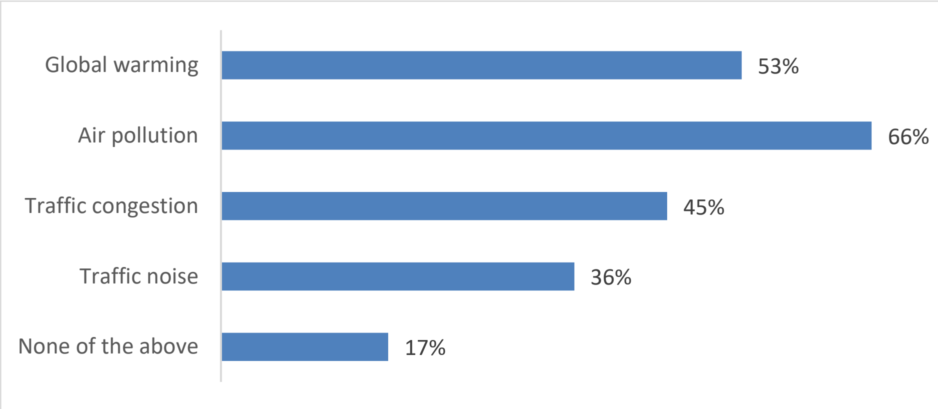

Figure 22: Issues that are concerned by customers

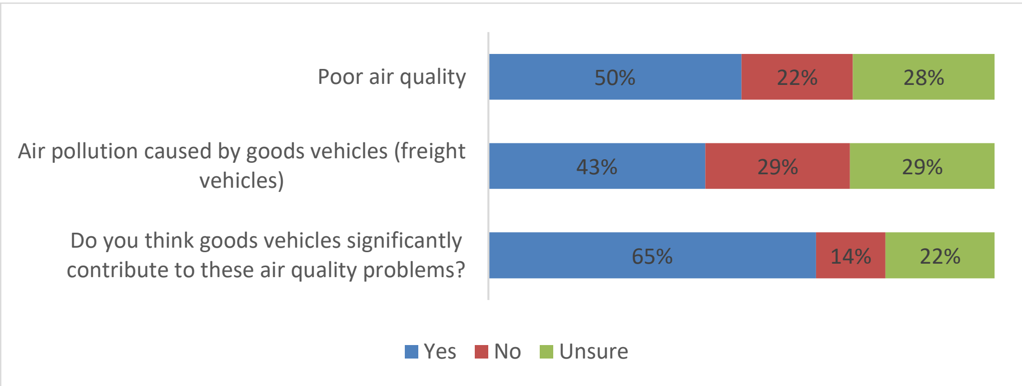

Figure 23: customers' experience with air quality issues

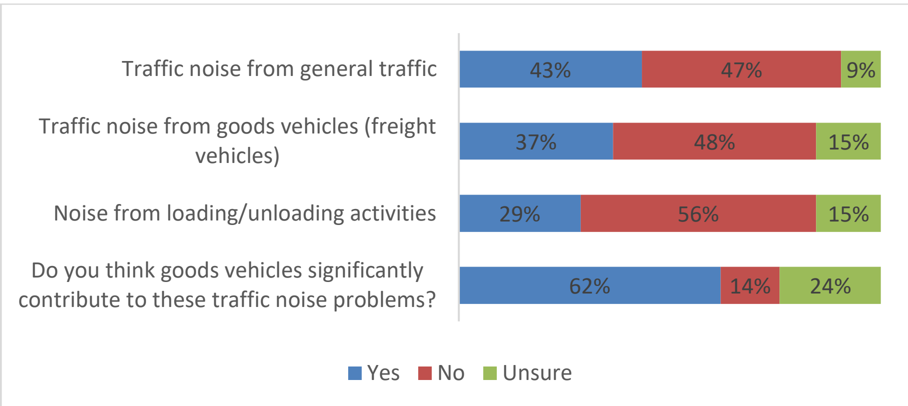

Figure 24: customers' experience with traffic noise issues

We also surveyed customers' experiences with regards to traffic noise problem, which is strongly depended on the locations of the customers and is a very subjective matter. Our results show that in general, 43% of the respondents confirmed that they have traffic noise problem from general road traffic. 37% reported that the noise problem they experienced was directly contributed from freight traffic. A sizeable 29% also reported that they have experienced noise nuisance from loading and unloading activities. In general, 62% of the respondents agreed that the goods vehicles significantly contribute to traffic noise problem.

8.3 Awareness and attitudes towards EFVs

Based on the after survey, 51% of the respondents reported that they have heard of electric freight vehicles, while the remaining 49% said they haven't. For those who had heard of EFVs, only 35% reported that they had seen one of them in their local area. Unlike electric cars where most people are getting more and more familiar with, more has to be done to raise the awareness of electric freight vehicles.

When the customers were asked whether they are in favour of EFVs replacing conventional freight vehicles, such as diesel internal combustion engine vehicles. 63% of the respondents gave the positive answer, and 29% did not think it would make much difference to them and 8% were against the idea. The numbers were very close between before and after survey results.

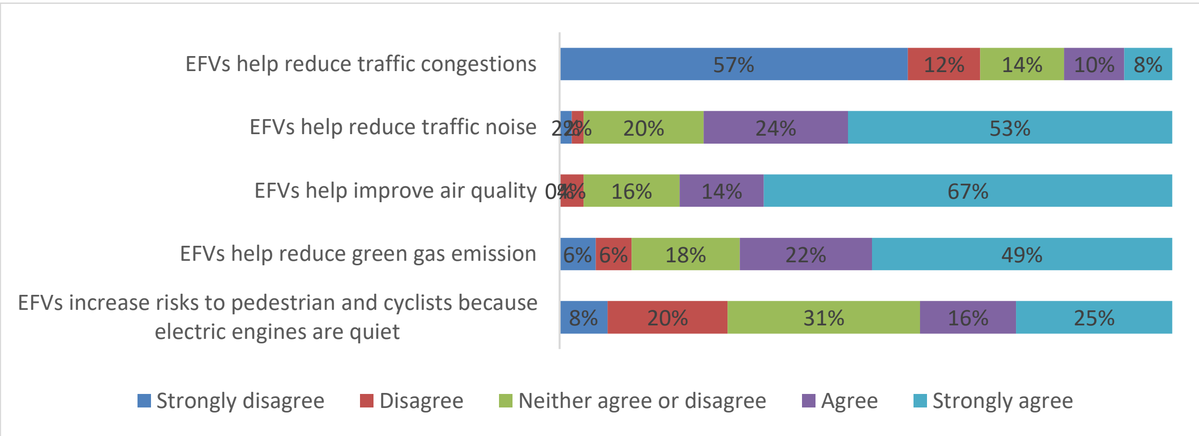

Figure 25: Customers' attitudes towards EFVs

Customers were further asked their opinions on a range of statements related to EFV's safety, environmental performance and traffic system performance. The results show that 81% of the respondents agree that EFVs would improve air quality, 77% agree that EFVs would reduce traffic noise, 71% agree EFVs would reduce greenhouse has emission, but most of the respondents (69%) disagree that EFVs would help reduce traffic congestion. In addition, 41% agree that EFVs would increase the risks to pedestrians and cyclists because they are very quiet (see Figure 25).

Furthermore, many customers provided additional comments to the deployment of EFVs. These comments can be summarised into the following categories:

- Support of electrification of logistics fleets and there should be more of EFVs
- Not only road freight should be electrified, other mode should also be done (for example, rail freight)
- To say that the customers are very in favour of electric freight vehicles and logistics companies will have their business if they keep the same price but use electric vehicle for delivery

- Concerned whether EFVs can truly reduce carbon emissions or improve air quality because of the fossil fuel used in electricity generation
- Suggestion that low volume sound should be introduced to EFV when travelling at low speed in urban area for cyclist safety

8.4 Would EFVs affect customers' choice on the logistics operators?

Customers were asked whether they would take "green delivery" [5] as one of the considerations when making their decisions about which delivery company to use. The results are shown in Figure 26. Overall, 58% of the respondents confirmed that "green delivery" is indeed one of the factors they would consider. 32% said it would not affect their decision and the remaining 9% are not sure.

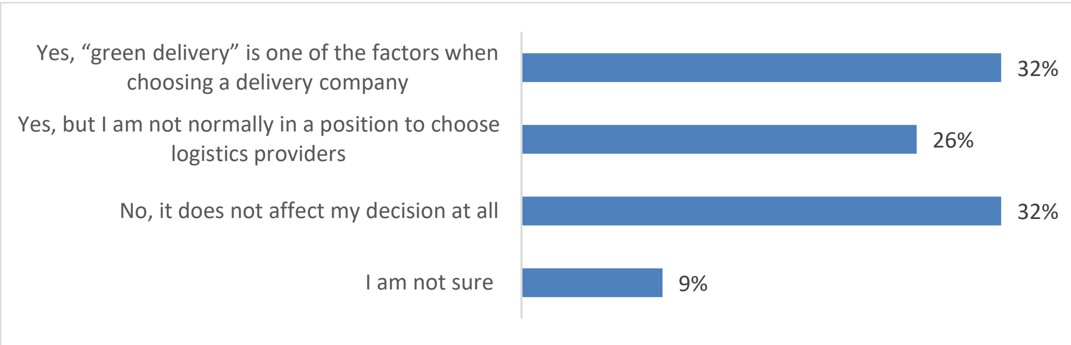

Figure 26: Whether "green delivery" is a factor in customer's choice of logistics company

Customers are then asked what would they choose if their preferred logistics company is offering two types of freight vehicles for delivery including EFVs and ICEVs at the same price. 62% of the respondents reported that they would always choose EFVs and remaining 38% said they do not care the type of the vehicle as long as the service offered is the same (see Figure 27).

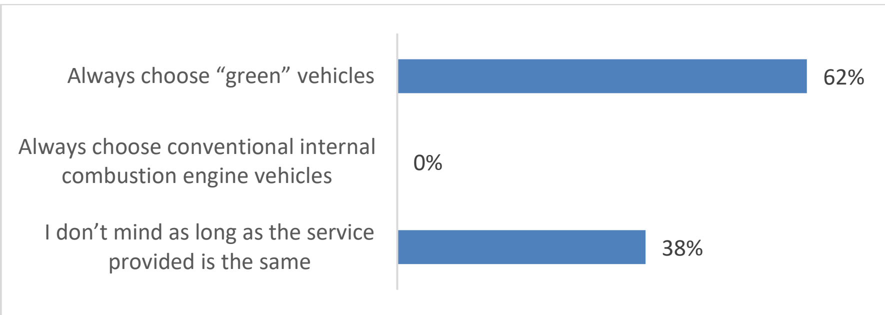

Figure 27: what would customer choose if EFV and ICEV are offered as separate options at the same price

8.5 Attitudes to monetary contribution for green delivery

Most of the logistics operators believed that customers are not willing to make additional payment to get their goods delivered by an electric freight vehicle. Our survey confirms that 51% of the respondents are indeed against the idea of paying more for the green delivery.

[5] Green delivery can be defined as goods delivered by environmentally friendly vehicles

Another 19% said they are not sure. However, there are still a sizeable 30% of the respondents said they would be happy to pay a bit more for the green delivery.

When we asked further on those customers who agree to pay more to define how much more exactly would they accept in their local currency in a percentage format based on the existing delivery fees, 45% said they are willing to pay up to 1% more, and 41% reported that they are willing to pay between 1% and 5% more of existing fees to get green delivery and 14% said they can accept an increase of 5% to 10%, as shown in Figure 28.

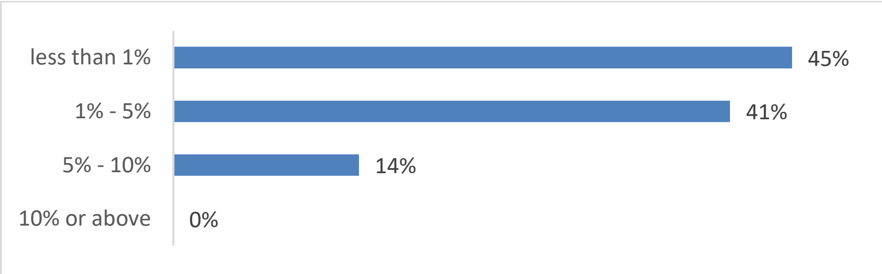

Figure 28: How much more would a customer pay to get their goods delivered in EFVs (based on the current delivery fees in percentage format)

Although the percentage of customers that are willing to pay for green delivery looks much better than expected, it is worth to be noted that this is based on a small sample size with potential bias, as discussed in detail in section 8.1.

8.6 Attitudes towards companies operating low emission vehicles

75% of the respondents reported that they would have favourable attitudes or views towards a logistics company who is operating electric freight vehicles, or low emission vehicles in general.

In addition, 70% of the respondents also said that a retailer who is using "green delivery" service also gain positive attitudes and values such as improved company image and environmental responsibility.

Although these numbers look very positive, 94% of the respondents reported that they did not know whether the goods delivered to them was transported by an electric freight vehicle or not. Only 6% of the respondents were able to confirm that their goods are delivered by an EFV.

This low number is very disappointing because although logistics companies believed that by using EFVs they would gain business from new customers and our surveys also confirmed that most of the customers would indeed have favourable views and attitudes towards them, this positivity cannot be materialised unless the customers are aware whether EFVs or low emission vehicles are used to deliver their goods. Therefore, logistics operators need to think a better way to convey the message to their customers.

8.7 Conclusions

Analysis of the customer surveys has shown that the respondents in general have very positive attitudes towards electric freight vehicles and they think EFVs have a key role to play in resolving poor air quality, global warming and traffic noise problems that many cities in Europe face. However, only half of the respondents have ever heard of electric freight vehicles and far less have seen one in their local area.

The majority (60%) of respondents reported that they would consider green delivery as one of the factors when making choices on which logistics company to use. A similar proportion of respondents said they would always choose their goods to be delivered by an EFV if the price was the same to them and if an option between EFV and ICEV was given by the service provider. In addition, 30% of responders are willing to pay more to get their goods delivered by an EFV or low emission vehicle.

Customers who responded the questionnaires also said they have positive views towards both a logistics company and retailer that are using EFVs or low emission vehicles for delivery. However, 94% of the respondents said they did not know whether their goods were delivered by an EFV or an ICE. Therefore, more has to be done to increase the visibility of low emission vehicles such as EFVs and to convey the positive image to the customers.

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