



Final Report

Treatment of logistics activities in Urban Vehicle Access Regulation Schemes

Technical report

Non-binding guidance documents on urban logistics
N° 2/6

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Glossary and definitions

ANPR:	Automatic Number Plate Recognition System
BESTFACT:	Best Practice Factory for Freight Transport
BESTUFS:	Best Urban Freight Solutions
CB:	Cargo Bike
CC:	Congestion Charging
CIVITAS:	City Vitality Sustainability: Cleaner and better transport in cities
CO2:	Carbon Dioxide
DVLA:	United Kingdom Driver and Vehicle Licencing Agency
EU:	European Union
FREVUE:	Freight Electric Vehicles in Urban Europe Project
GL:	Green Logistics
HDV:	Heavy Duty Vehicle
HoReCa:	Hotels/Restaurants/Cafes
KPI:	Key Performance Indicator
LEZ:	Low Emission Zone
LDV:	Light Duty Vehicle
NBGD:	Non-Binding Guidance Document
NO2:	Nitrogen Dioxide
NOx:	Nitrogen Oxide
OHD:	Off-hour Delivery
PM:	Particulate Matter
PM10:	Particulate Matter smaller than 10 microns
PM2.5:	Particulate Matter smaller than 2.5 microns
PM1:	Particulate Matter smaller than 1 micron
UCC:	Urban Consolidation Centre
UVAR:	Urban Vehicle Access Regulation

Executive Summary

This technical report is the second of a series of six, prepared within the scope of the Study on Urban Mobility - Preparation of EU guidance on Urban Logistics (MOVE/C1/2014-370) commissioned by the EC. The study's Technical reports aim to help stakeholders understand the challenges brought about by logistics activities in an urban context, and identify the most suitable measures and actions to overcome these challenges. The technical report is the theoretical and research basis for the related Non-Binding Guidance Documents (NBGD 2).

This report presents **technical information** used as a support to the preparation of the EU **Non-Binding Guidance** document (also one in a series of six) on ***Treatment of Logistics Activities in Urban Vehicle Access Regulation Schemes***.

Policy makers face multiple urban logistics challenges which include resolving issues such as road congestion and occupancy, emissions, noise and other negative externalities, whilst maximising efficiency, safety and liveability. The consultation this study is based on, carried out by Ecorys in 2015^[1], confirms that these challenges are driving stakeholders' efforts to improve their urban conditions. For instance, emissions and road congestion have been ranked as the most important challenges posed by urban freight and logistics.

In the consultation^[1], additional challenges were also highlighted, such as the lack of parking areas for loading and unloading, lack of space for logistics facilities leading to relocation and concentration in suburban areas (logistics sprawl), regulatory procedures, noise, poor liveability in urban areas, high costs for logistics suppliers, poor enforcement, high energy costs and infrastructure wear and tear.

In the Ecorys 2015 consultation^[1], as part of this study, stakeholders identified two preferred UVAR schemes for addressing local challenges related to urban logistics:

- Low Emission Zone (LEZ);
- Congestion Charging (CC);

and four mitigating solutions:

- Urban Consolidation Centre (UCC);
- Cargo bike (CB);
- Off-hour deliveries (OHD).
- Green Logistics (GL)

This technical report describes the two UVAR schemes and three of the four solutions in detail. The fourth solution, Green Logistics, will be addressed in a separate technical document. It covers the implementation of electric freight vehicles^[2-6] (FREVIEW), green logistics fleets and alternative fuels.

The Low Emission Zone (LEZ) scheme has come into being as a result of increased public health concerns which means that policymakers are paying more attention to clean air policies. There are many public health issues associated with freight transport in metropolitan areas, the most serious being particulate emissions. Research has shown that fine particulates are associated with an increased incidence of morbidity and mortality from asthma, lung cancer and other respiratory diseases^[7].

Policy has therefore targeted Particulate Matter (PM), starting with PM₁₀ - the class of PM smaller than 10 microns - a significant contributor to pollution from vehicle emissions. In response to perceived health risks, the European Commission published the 2008/50/EC Directive on Ambient Air Quality and Cleaner Good Air for Europe, which marked an

unprecedented attempt to mandate low levels of PM₁₀^[8]. Current targets concern even smaller PM levels (PM_{2.5}).

The most frequent recommendation by experts concerning LEZs relates to long-term planning and to an awareness of the need to align basic LEZ parameters in EU countries, particularly unified vehicle registration according to emission categories and the unification and determination of evaluation indicator definitions for subsequent comparative EU studies^[9, 10].

Congestion charging (CC), the second type of UVAR schemes this publication deals with, is an efficient way of alleviating traffic congestion, whilst simultaneously reducing the environmental impact of vehicles and generating revenue^[11]. However, cities have a limited influence on the demand for pickups and deliveries in urban areas, and consequently CC has rather limited effectiveness^[12] in reducing freight traffic. Key success factors of the London CC case, which should be borne in mind by policymakers considering to implement a CC, are^[13]:

- Lengthy participatory processes which involves continuous and extensive public consultation;
- Visible responsiveness where the views of stakeholders were taken into account and led to modifications in the scheme;
- Range of exemptions which increased acceptance of the CC scheme by stakeholders.

As a first guiding solution, Urban Consolidation Centres are proposed. UCCs are defined as a logistics facility situated in relatively close proximity to the geographic area that it serves (e.g. a city centre, an entire town or a specific site such as a shopping centre complex), to which many logistics companies deliver goods, and from which consolidated deliveries are carried out to businesses within that area. Within the UCC, a range of other value-added logistics and retail services can be provided ^[14, 15].

The effectiveness of UCCs seems to depend heavily on the presence of appropriate local regulations, including vehicle access rules for the zone covered by the UCC and benefits accorded to UCC operators^[16]. Public authorities can put legislation or other regulations into place to promote the use of the system that is being offered. These regulations can be restrictive (requiring or strongly inducing vehicles to use UCC) or founded instead on advantages accorded to users. It should be stressed^[17] that this should be linked to dialogue with stakeholders.

Cargo bikes are used for final freight delivery to reduce congestion in cities, and are a second mitigating solution for logistics activities in UVAR schemes. Given the advantages (no greenhouse gases emission, low kerbside space, easy to manoeuvre), and disadvantages (limited payload weight, low travel speed) of cargo bikes, it would appear that they are best suited for the distribution of products with a relatively low bulk density and size and which demand simple storage or handling requirements.

Retailers generally prefer to receive deliveries of goods during their normal working hours. Suppliers schedule deliveries to meet the demands of their clients. As a result, most lorry traffic occurs during the most congested daytime traffic periods. If a critical mass of businesses is able to adjust their schedules to accept deliveries when there is less traffic congestion, it could enable transport companies to deliver goods more quickly and at lower cost. This could result in less traffic congestion, reduced cost of goods, economic benefits and would be better for the environment^[18].

Off-hour delivery (OHD) is therefore a third solution. It is a simple concept, but it can be challenging to implement because the benefits and costs are not always evenly distributed. Carriers generally like the idea because it can save them time and money, but customers often resist it because it can add costs. Communities will benefit from lower congestion but may have concerns about night-time noise. Sometimes, special incentives are needed to encourage businesses to participate. An OHD programme needs to be designed in a manner that balances

the benefits and costs to make it practical for shippers, carriers, customers and the community^[18].

Chapter 1 Introduction

1.1 Study Description

1.1.1 Objective

Urban goods transport challenges result from a wide pattern of developments in society. These include movement towards a post-industrial society, ageing and individualization, urbanisation, and the quest for sustainable economic development. Policymaking in such a context requires well-designed consultation and participation processes, due to the complexity of challenges and the diverse interests of various stakeholders. This is particularly the case for policy-making in urban goods transport, since it involves many different parties with diverging and often conflicting interests. All have to share limited urban space.

An efficient urban transport system is essential for sustainable economic development in urban areas. Urban goods transport is now facing many difficult challenges due to:

- Increasing urbanisation;
- Increasing demand for frequent and just-in-time deliveries in urban areas, including at consumers' homes; new urban supply chains;
- Increasing competition for the use of limited urban infrastructure;
- Increasing complexity of the multidisciplinary issues both encountered and caused by urban goods transport.

Policy-making for urban goods transport is particularly complex and difficult due to the following features:

- Conflicting and diverse requirements of a wide range of participants;
- Complex and diverse operations of urban goods transport and the various issues caused therefrom;
- Lack of expertise from urban practitioners.

So, a smooth urban freight distribution might increase the liveability of cities. On the other hand, especially for urban environments, transport effectiveness and efficiency not only affect local and regional productivity rates, they also have an impact on citizens' quality of life^[19]. In the optimal situation, cities are supplied with minimal negative freight transport effects.

1.1.2 Approach

This technical report is the first of a series of six, prepared within the scope of the Study on Urban Mobility - Preparation of EU Guidance documents on Urban Logistics (MOVE/C1/2014-370) commissioned by the EC. The study's Technical reports aim to help stakeholders understand the challenges brought about by logistics activities in an urban context, and identify the most suitable measures and actions to overcome these challenges. The technical report is the theoretical and research basis for the related Non-Binding Guidance Documents (NBGD 2).

This technical report (N° 2) covers Logistics in Urban Vehicle Access Regulation (UVAR) Schemes. It provides specific information on the most important schemes to achieve more efficient and sustainable urban logistics operations.

The primary target group in this technical report is public authorities, such as municipalities or local agencies, responsible for the management of the traffic, transport and transport infrastructures within urban regions. Furthermore, logistics and freight transport operators with city operations may benefit from this report.

1.1.3 Structure of the Technical Report

Chapter 1 is dedicated to the introduction of UVAR schemes. It includes Study Description, Challenges, Stakeholder needs, UVAR and UVAR Achievements. Chapter 2 characterizes selected UVAR schemes such as LEZ and CC. It provides Description, Implementation, Enforcement, Decision Level and Key Success Factors. Chapter 3 defines solutions in response to UVAR schemes, UCC, CB, OHD and GL. It gives Description, Implementation, Decision Level and Key Success Factors. Chapter 4 presents Conclusions.

The Annex includes summary tables of Key Stakeholders Decision Levels, Table with impacts and Selected Case Studies. The technical Report ends with the list of References consulted to prepare this document.

1.1.4 UVAR Schemes

These schemes focus on access regulations for freight vehicles to urban areas, as a way to manage a number of challenges experienced by people and businesses in cities. Urban vehicle access regulations may take various forms of measures. Regulation-based measures are rules, prohibitions, etc., enforceable by an authority. Market-based regulatory measures are taxes, tolls, or incentives and sometimes have the intention of internalising external transportation costs. Land use planning measures organise urban spaces with the intention to optimise accessibility. Infrastructure measures include the development of transport and storage networks for freight. Technology measures include use of intelligent transport systems to enable or aid implementation and enforcement of Urban Vehicle Access Regulation Schemes, for instance by using dynamic signalling for dynamic re-routing of freight in urban areas. Soft measures are bottom-up approaches and collaborations, shared resources, and coordinated planning among multiple stakeholders.

1.2 Challenges

It has been argued^[20-22] that current road congestion and emissions require urgent actions at city level to improve overall conditions for people, environment and city competitiveness. Increasing freight circulation in urban areas adds to urban congestion if there is no corresponding increase in road capacity. The latter could come from better accommodating freight vehicles, increasing or better organising the freight entry and exit points to/from urban areas and to/from logistics terminals, and making alternative roads for urban circulation^[23] available, or from limiting the demand for transport by improved traffic management^[24] or other measures. Urban congestion from freight transport can be recurring and non-recurring. Recurring congestion is caused by the excess demand for transportation over a limited supply of traffic infrastructure, whilst non-recurring congestion may be caused by incidents, construction sites, events, etc.^[25]

Road congestion affects people, environment and business and certainly applies to the logistics sector because it results in vehicle hours lost. For the logistics sector, congestion leads to reduced reliability and supply chain disruptions which lead to additional costs^[26-30]. Estimates of both passenger and freight vehicles contribution to road congestion varied in 2009 from 0.5% of GDP in Spain to 1.7% in Lithuania, with an EU average of 1%^[31].

One very important contribution to emissions from recurring congestion comes from urban freight distribution^[32]. Urban freight transport's fuel consumption contributes to exhaust

emissions (CO₂, sulphur dioxide, carbon monoxide, volatile organic compound, non-methane organic compound, methane, NO_x and PM). It has been estimated that Germany, France, United Kingdom, and Italy are the top EU emitters of all the listed pollutants^[33]. Approximately 40% of the CO₂ in Europe comes from urban traffic^[34].

Emissions tend to vary according to the vehicle speed, acceleration, number of deliveries, fuel type, distance driven, payload, road conditions and the vehicle Euro standards as defined by the European Union^[35-37]. The Euro standards, which were introduced in the EU as of 1993, define the acceptable limits for toxic exhaust emissions of all new motor vehicles sold in the EU Member States. At present, they cover emissions of NO_x, hydrocarbons, carbon monoxide and PM. For each vehicle type, different standards apply. For light-duty vehicles (LDV) (cars and light vans), the emission standards currently in force are the Euro 5 and Euro 6 standards covered by Regulation 715/2007. For heavy duty vehicles (HDV) (lorries and buses), the standards in force are the Euro VI standards covered by regulation 595/2009^[38]. The following convention generally applies: standards for LDV use Arabic numerals (1, 2, 3...), while standards for HDV use Roman numerals (I, II, III...). When a standard applies to both types of vehicles, we use Arabic numerals in this document.

Using these parameters, studies have shown that over the last 20 years, diesel freight vehicles in general have not, in reality, demonstrated the ability to achieve sufficient reductions in NO_x emissions. Theoretically the Euro VI guidelines, released in 2012 specifically regarding emissions from new light passenger and commercial vehicles will meet the maximum NO_x pollution criteria which is 20 times lower than for vehicles from 1994 (Euro I)^[39].

There are many challenges to consider when developing long-term city planning, such as the effect on the environment and on road safety etc. It has been widely documented that vehicle emissions may contribute to severe health and environmental issues^[40-42]. Thus, it is no longer acceptable to omit to consider these challenges locally when developing long-term city planning^[43]. In addition to health and environmental challenges, urban logistics operations such as parking, loading and unloading can lead to other challenges such as road safety and compliance with traffic rules. Scholars have identified the key reasons as being the lack of good locations and the size and number of loading bays. Furthermore, lack of collaboration on the part of the operators, deficient pricing strategies and lack of well-organised enforcement leads to increasing societal impacts^[44-46].

Other challenges, such as logistics sprawl should also be taken into consideration. Logistics sprawl may cause increased delivery distances, increased CO₂ emissions, and result in logistics staff having to move to a different location for work and potentially receive, lower wages. On the other hand, local congestion may be more manageable as a result of the decentralisation of warehouses in suburban areas^[47]. These sets of issues tend to make citizens complain and request the elimination of freight from their neighbourhood. Yet harsh regulations on trucks would put businesses in urban areas at risk. Thus, the challenge is for policy makers to find the correct balance between freight traffic, liveability and people's safety in urban areas.

Balanced urban freight planning requires the engagement of all relevant stakeholders. However, meeting the conflicting and diverging interests of multiple stakeholders is a highly challenging goal^[48]. One main reason is that urban freight policies are usually not at the top of local policy makers' agendas nor are they taken into consideration by local businesses^[49]. Thus it can be stated that whilst vehicle access regulation schemes can be used to control the access, time, size, or other factors of freight vehicles having access to or circulating within urban areas, to make these schemes successful requires policy makers to be engaged and other business stakeholders to disclose their needs, in order to jointly develop optimal city logistics solutions^[50].

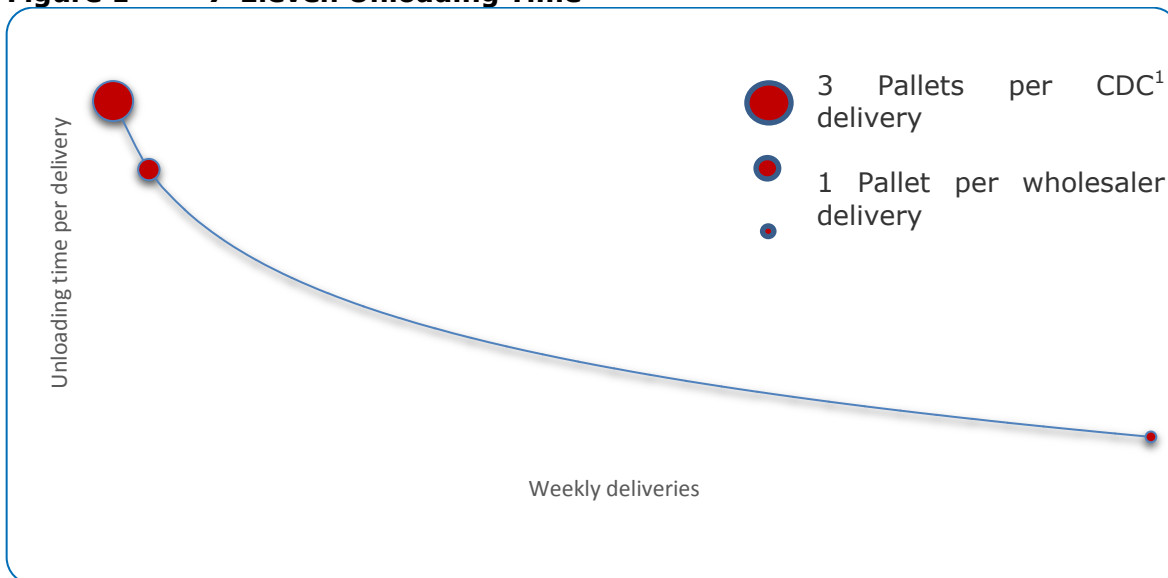
1.3 Stakeholder Needs

Vehicle access regulations need to take into account the needs of the shippers and commercial sector (i.e. cluster of shops, HoReCa (hotels, restaurants, cafes) sector, small and large retailers and warehouses, and residential areas) In order to better identify needs, there are mainly four characteristics to consider: urgency of delivery, frequency of delivery, volume to be delivered in terms of number of shops and load per shop, and whether routes are scheduled.

For instance, logistics operators may respond to retailers' demand for high volumes and few deliveries per week, or for lower volume and more frequent deliveries weekly, as described in Figure 1 below. For the case of large retailers, even the ones located in urban areas, it is difficult to conceive low-volume deliveries, and they usually need heavy duty vehicles capable of carrying full lots of pallets.

Examples of the relationship between delivery volume and frequency of delivery are the delivery alternatives. When one pallet can contain 10 displays and outlets have a demand of 30 displays per week in average, then, the first replenishment policy can be three pallets to be delivered once a week; a second policy can be one pallet to be delivered three times per week; a third policy can be six displays to be delivered daily, from multiple suppliers, all totalling 30 weekly displays (see Figure 1 below).

Figure 1 7-Eleven Unloading Time



1. Central Distribution Centre. 2. Direct Supplier Deliveries.
Source: Borbon-Galvez, Dewulf ^[51] based on Chumley ^[52].

Marcucci and Danielis [53] indicate that logistics operators need city logistics measures that do not have too many negative effects. Other needs include fair allocation of exemptions based for example based on the type of goods distributed, and not losing control of operators' own logistics strategies^[54].

For Taniguchi [55], based on experience in Japan, authorities or public representatives ideally need to remain in the same positions for as long as the urban logistics policies or measures are in place. This would allow authorities to identify and engage shippers, freight operators, end customers, authorities at multiple levels, public transport operators, vehicle manufacturers,

trade associations, commercial organisations, land/property owners, citizens and visitors throughout the urban freight policies implementation^[56].

In sum, when implementing an UVAR policy, authorities should aim at guaranteeing accessibility, good governance, compliance with the law, and avoiding negative environmental and health effects. Finally, all stakeholders need to be certain and confident of a medium/long term legal framework^[57].

1.4 Urban Vehicle Access Regulations (UVAR)

As defined in the European Commission Staff Working Document "A call for smarter urban vehicle access regulations"^[58] UVAR are measures to regulate vehicular access to urban infrastructure. UVAR schemes can be shaped on the basis of different access restriction criteria. The majority of European examples take account of emissions and vehicle weight; often these are called Low Emission Zones (LEZ). Some also consider pricing as a separate or additional access restriction policy, the so called congestion charging schemes (CC). Combining Low Emission Zones and Congestion Charging is also possible.

Access regulations for freight transport can differentiate on:

- Access time;
- Vehicle characteristics (tonnage, dimensions, age, Euro emission category);
- Load factors;
- Access charges.

Access regulations can fall within three categories: prohibitions, which are command control measures; charging (pricing), which gives the freedom to adhere to the standards; and prioritisation, providing incentives to use best practice.

Therefore, the policy maker has to make choices to specify the scheme (its characteristics), and to make sure the scheme is optimally adjusted to the local circumstances and the nature and size of the issues. Moreover, a choice needs to be made how to enforce the UVAR scheme.^[59]

1.4.1 Access Time

Access time regulation is one of the policy measures in city logistics that, especially in Europe, has become increasingly popular. Time windows for delivering goods have become a somewhat common phenomenon in municipalities, and especially in larger agglomerations. Over time, in some cities the established time windows, have become increasingly strict^[60].

1.4.2 Vehicle Characteristics

Another result of access regulation is that vehicle characteristics have had to change. Logistics operators have increasingly had to invest in light commercial vehicles for their last-mile deliveries. This is partly a result of increased access regulation schemes based on vehicle characteristics such as weight and size^[61]. As a result, these regulations are not always efficient, as they may lead to an increase in the total number of freight vehicles in cities and can form an obstacle to improving freight consolidation.

1.4.3 Load Factors

More rarely, load factors are taken into account when developing access regulation schemes, with the policy objective being to reduce the number of LDV and HDV running without cargo on board and to increase consolidation of shipments, thereby increasing logistics efficiency, reducing traffic and improving environmental performance. Some low emission zones only permit access to vehicles with high load factors. For instance, in the city of Göteborg in 2007, HDV were allowed to access low emission zones provided the driver could demonstrate a load

factor greater than 70%^[62]. This standard was abandoned after one year of testing due to enforcement complexities.

1.4.4 Low Emission Zone and Congestion Charging

One important consideration is whether to combine a LEZ and CC. For instance, in the London LEZ and CC scheme, the former apply to most of the Greater London area, and the latter to the London central area only. In Milan, the "Area C" access regulation scheme combines a LEZ and CC. It applies to both passenger and freight vehicles and allows less polluting vehicles to enter the city's central area; all other vehicles can enter but have to pay in proportion to their emissions^[59].

1.5 UVAR Achievements

UVAR schemes have impacts that vary according to their implementation (See Table 1 below). For instance, CO₂ emissions from all traffic were reduced by 18% in Stockholm from 1996 to 2007. Although measurements were made from all traffic, policies were applied to lorries heavier than 3.5t and busses in the city, leading to a reduction of the age of the vehicles in Stockholm^[63]. In Berlin, diesel particle emissions were reduced by 58% between 2007 to 2010 for all traffic^[64].

Table 1 Local impacts of LEZ, CC and UCC

Impacts	LEZ ^[64]	UCC ^[65, 66]
CO ₂	Milan (-22%. 2002/2008)	Brussels (-23%)
	London (-19%)	London (-75%)
	Stockholm (-18%. 1996/2007) ^[63]	
PM	Berlin (-58% 2007-2010)	Brussels (PM _{2.5} -58%; PM ₁₀ -22%)
	Stockholm (-60%. 1996/2000)	
	London (-12%)	
Noise		Monaco (-30%)
NO _x	Berlin (-20%. 2007/2010)	/
	Milan (-10%. 2002/2008)	
	Stockholm (-10%. 1996/2000)	
	London (-12%)	

Impacts	CC	UCC ^[65, 66]
Liveability		Monaco (-42% used space)
Road Congestion	London (-39 %. 2003 to 2007) ^[67]	L'Hospitalet de Llobregat (load from 68% to 73%)
	Milan (-28.6%. 2015 vs 2011) ^[68]	London (-70% freight journeys)
	Stockholm (-29,1%. 2006 to 2011) ^[69]	Monaco (-38% congestion)

Impacts	UCC ^[65, 66]
Commercial attractiveness	Bristol (100% on time delivery)
	London (delivery reliability 97%)
Logistics costs	L'Hospitalet de Llobregat (-25%)

It will clearly depend on the initial CO₂ levels at the start of the implementation stage. In case of road and congestion charging applied exclusively to urban areas, there are only a limited number of cases. Yet, all report important reductions in congestion levels.

UCCs have clear impact at all three levels of challenges: Environment, People, and Economic benefit^[70]. This is important, as it can be said that, although UCCs require a great deal of stakeholder coordination and investments, they can also be monitored with respect to contributions to address most challenges.

Chapter 2 Urban Vehicle Access Regulation (UVAR) Schemes

In the Ecorys 2015 consultation^[1], stakeholders identified two UVAR schemes for addressing the challenges related to urban logistics:

- Low Emission Zones (LEZ);
- Congestion Charging (CC).

This second Chapter describes the two UVAR schemes.

2.1 Low Emission Zones (LEZ)

2.1.1 LEZ Description

While road transport contributes significantly to the growth and development of economies, this positive impact comes at an environmental cost. Externalities in relation to particulate matter (PM) emissions are one of the main current concerns. Additionally, traffic-related air pollution is considered to be of particular importance^[71] ^[39, 72]. This partially stems from fine particles, diesel soot, ultrafine particles in ambient air or nitrogen oxides. Some indicators of road traffic exposures reinforce the impact, such as living or working close to major roads or ^[72, 73].

A reason for the increase in pollutant emissions from road transport during the last decades is the increased utilisation of diesel technology, as diesel engines tend to generate more NO_x emissions than petrol engines of equivalent power and weight^[74]. Another is increasing traffic flows and congestion.

In order to reduce the impact of traffic on air quality and meet the European Union limit values, local authorities have to take action and attempt to reduce the emissions of the most influential sources within their jurisdiction^[71]. As a result, air quality action plans are applied which have a strong emphasis on traffic regulation and involve policies such as stimulation of public transportation usage, ring road utilization, traffic flow improvement, speed limit reduction and implementation of access regulations such as low emission zones (LEZs), CC and traffic limited zones^[71].

Policies that aim at mitigating the impact of particulate matter often focus on road transport in cities^[73]. In 1999, the European Commission established limit values for PM₁₀ and some other air pollutants in the Air Quality Directive 1999/30/EC, which was replaced in 2008 by the new Directive 2008/50/EC on ambient air quality and cleaner air for Europe^[72].

The existing air quality guidelines for PM₁₀ are currently being exceeded at many locations throughout Europe. One widely-used, measure to meet the policy targets for PM₁₀ is the implementation of Low Emission Zones (LEZs)^[72]. The low-emission zone (LEZ) can be defined as a geographically delineated area with no entry of vehicles which fail to meet certain requirements^[75]. LEZ is a defined area (mostly located around the city centre) where the vehicles that enter have to meet certain emissions standards^[39, 72]. Only vehicles with pollutant emission levels lower than a certain limit are allowed to enter^[71] and the most polluting vehicles are regulated^[64]. In some of these zones, more polluting vehicles have to pay higher fees if they enter^[8].

The scheme would work by imposing area-wide minimum emissions standards on vehicles – targeting older, heavier diesel-fuelled vehicles that produce the most pollution^[76]. Low Emission Zones set standards that are limited in geographical scope, namely to the zone in question, and do not impose any limits on overall traffic throughput within this zone^[73].

2.1.2 LEZ Implementation

The implementation of LEZ schemes in Europe has followed different approaches, as can be seen from implementations in London, Germany, Italy, Sweden and Greece.

LEZ in London

The implementation of the LEZ in London took place in four phases: in 2008, it applied to HDV weighing over 12t. Six months later, all HDV had to comply with the Euro III PM standard which applies to HDVs only. In 2012, LDVs with an unloaded weight of over 1.205t had to comply with the Euro 3 PM standard, which applies to LDVs while the standard for HDV was raised to Euro IV PM. What defines the London LEZ, apart from its size and its inclusion of light duty vehicles, is its extensive use of Automatic Number Plate Recognition cameras^[74] (ANPRs). Future phases include the emissions surcharge from October 2017 for pre-Euro 4 vehicles and the Ultra-Low Emission Zone which is planned for 2020 and which intends to heavily charge all diesel vehicles (including private vehicles such as passenger cars, ~16€ light duty, ~130€ heavy duty) which do not meet the Euro 6 standard in the area currently covered by London's Congestion Charging Zone^[77].

LEZs in Germany

In Germany, the first LEZs were introduced in Berlin, Cologne and Hannover in 2008. The German government has categorised all vehicles into four mutually exclusive classes according to PM₁₀ emissions. Coloured stickers showing the emission group of a vehicle were introduced in order to identify low-emission vehicles. Every vehicle in an environmental zone in Germany must display the required sticker on the windscreen, making it easier to monitor in the environmental zone. The stickers apply in every low emission zone in Germany. Each city specifies which sticker is required to drive in its environmental zone^[78].

As of 2015, 83 German cities have implemented LEZs, and only two out of the 83 LEZs do not require the green sticker to enter equalling Euro 4(PM) and above, for diesel and Euro 1 and above, for petrol vehicles. Determination of the appropriate sticker is based on the tax class and Euro standard recorded in the car registration book, which is regulated by the labelling regulation in the 35th Ordinance for the Implementation of the Federal Emission Control Act (35. BImSchV)^[79].

In Germany, it has been identified that the average LEZ decreases PM₁₀ by approximately 9% in traffic areas, ranging from 0% for smaller LEZs such as Tübingen to a significant 15%^[8] in the case of a more populated LEZ (Berlin with 1.1 million residents). It can also be observed that the decrease in PM₁₀ has been larger for traffic stations inside the LEZs than for those outside^[8].

LEZs in Italy

In Italy, although the initial aim of local policymakers was to implement LEZs to reduce traffic and congestion rather than to improve air quality or reduce noise, increasing difficulties with air quality, particularly in winter, soon informed these policymakers' decision-making and ultimately to the air quality issues were primordial in the introduction of LEZs^[74]. Urban tolls were, in general, first introduced in central districts and subsequently extended to cover other areas of high congestion.

One consequence of the system of local politics in Italy, where each municipality has the freedom to decide its own criteria, is that Italian LEZ access regulations are diverse, even within a given city. For example, in central Rome, some LEZs require payments while others impose night-time regulations on certain types of vehicle. Moreover, zonal boundaries vary according to the time of day and day of the week. This diversity in regulations leads to overlaps and a

number of exceptions, which is unsurpassed in Europe. The LEZ regulations, whatever they may be, are also applicable to foreign vehicles and are applicable 24 hours a day, seven days a week^[74].

Milan LEZs include Area C (Circle of Bastions) and a city-wide LEZ and the limited traffic zones of Paolo Sarpi and Naviglia. Area C is delimited by entrances with 43 cameras. From 14th February 2017, diesel freight vehicles Euro 4 without a particulate filter can no longer access the Area C. In the limited traffic zone Paolo Sarpi it is forbidden the transit and parking of vehicles used for freight between 00.00 and 24.00 on all days of the week and all vehicles or combinations of vehicles having length exceeding 7.50 meters^[80].

LEZ Naviglia operates from 20.00 to 07.00 every day of the week. In these hours it is forbidden access, circulation and parking of unauthorized vehicles. Freight vehicles are excluded from the ban on access from 5.00 to 7.00, for the time necessary for loading/unloading in the spaces that purpose. Controlling access to traffic regulations in the area is secured by cameras connected to the operative centre of the Local Police^[80].

LEZs in Sweden

In Göteborg (Sweden), a LEZ was introduced in 1996, introducing emission controls for diesel PM and hydrocarbons, then in 2002 added NO_x control. Swedish LEZ are intended to prevent vehicles more than 3.5t that do not comply with current emission standards from entering cities, such as Göteborg. The basic requirement for entering the Environmental Zones was that all HDV Euro 2 and 3 must not be more than eight years old. Currently, the age limit is 6 years.

The vehicle's year of registration is irrelevant for Euro 4 and 5. Vehicles certified for compliance with Euro 4 classification will enter the environmental zone until 2016 (inclusive). Vehicles certified for or complying with Euro 5 classification will enter the zone until 2020 (inclusive).

Adapted vehicles must meet all the emission standards of the set Euro standard. It is possible to upgrade a Euro-2 and Euro-3 vehicle to Euro-5 via retrofitting emission control devices such as particulate trap with Selective Catalytic Reduction, approved by the Swedish Transport Agency. The environmental zones rules have had the greatest effect, on HDV with a total weight of under 16t, PM₁₀ from these lorries have been reduced by 67%^[81].

LEZs in Greece

The Athens LEZ is only effective from September to July each year, with different access regulations for the city centre and for the rest of Athens. Vehicles up to 2.2t are allowed to enter the city centre on alternating days depending on the last digit of the licence plate. Vehicles over 2.2t first registered before January 1991 were banned in the whole of Athens when the LEZ was established (for 2013). Each calendar year the banned registration date is increased by one year^[64].

2.1.3 Enforcement of Low Emission Zones

At the present time, modes of LEZ enforcement in the EU vary considerably and it should be noted that the means of enforcement has an impact on the rate of compliance. Two main modes of enforcement are used for LEZs in the EU: visual surveillance using windscreen stickers and cameras with ANPR technology^[74].

The Netherlands, the UK, France and Germany all enforce LEZs in different ways. The Netherlands started surveillance of its LEZs manually, until the ANPR cameras were able to be put in place. When the city of Amsterdam put a system of ANPR cameras in place for its LEZ in 2009, the compliance rate rose from 66% (2008) to 97% (2010). In Germany and France, however, data protection legislation restricts the use of ANPR cameras whereas in the UK, just like in most other countries, Transport for London has been given access to the complete DVLA

(UK Driver and Vehicle Licensing Agency) national vehicle registration database and compares all data collected by ANPR cameras with the said database^[74].

Elsewhere in the EU, the main Italian LEZs (Rome and Milan C) have ANPR cameras. In Denmark, all LEZs set out three manual enforcement methods^[64]:

- Municipal inspectors when lorries are visiting a company;
- Town traffic wardens checking vehicles parked on the street;
- Police at routine roadside checks.

Elsewhere in Europe, the planned Norwegian LEZs intend to expand on the EU enforcement model by using the same electronic device system as is currently used for Norwegian motorway tolls (Autopass), and supporting it with both ANPR camera and manual enforcement^[64].

2.1.4 LEZ Decision Level

Country's national legislations can determine specific LEZ regulations related to freight vehicles across the country^[75]. Countries such as Germany, The Netherlands and Sweden have national LEZ frameworks to ensure a consistent approach and to increase the ease of driving across the country. However, each municipality has the option of establishing a LEZ and determining its scope and in Germany its standard. In other countries, such as Italy, no national framework exists and for that reason, each municipality determines its own criteria^[39]. Comparing access regulation schemes between EU cities remains difficult as the LEZ regulations differ from city to city^[72].

In France, national legislation was passed in 2010 allowing large urban communities to introduce LEZs. After failing to promote LEZs, the law was changed in 2015, with more facilities provided to municipalities to implement LEZs. In July 2015, a LEZ was introduced which covers the whole of Paris inside the orbital road from 8.00am to 8.00pm daily; access is restricted for HDV which do not meet Euro I. Standards in January 2017 are Euro 2 and 3. The emission standard for all vehicles will be increased year on year until 2020^[64].

2.1.5 Key Success Factors for LEZs

Frequent recommendations by experts are:

- To bring basic LEZ parameters in EU countries into line with each other;
- Unify vehicle registration according to emission categories
- Standardize evaluation indicator for subsequent comparative EU studies^[9, 10].

Experience gained from research carried out within the EU, for example in London and Berlin clearly shows that before LEZs are implemented, drivers' feedback on LEZ parameters is needed^[82, 83].

Stakeholder acceptance has been obtained in London because the London LEZ has been the subject of a particularly sophisticated awareness and public relations campaign, as well as because of the severity of the original problem. Transport companies were alerted about seven years in advance leading to the measure being better received as the companies were able to prepare themselves. Some firms admit that the introduction of an LEZ benefitted them as it forced them to improve their efficiency, optimise their vehicle routing, and become involved in projects to increase the size of their vehicle fleet^[74].

Transport for London reports significant reductions in PM, Black Carbon and NO_x. More negative impacts on shipping costs, organisation of business, or the transport industry are not yet known^[12].

In general, however, determining the impact on air quality is difficult, due, in part, to meteorological influences, but also to other factors such as the amount of traffic, the changing nature of vehicle fleets, policies such as the introduction of vehicle scrappage schemes (a government attempt to clear the roads of old vehicles and get people into newer ones), the composition of traffic close to the monitoring stations as well as changes in vehicle flows^[39].

Experts are suggesting that it may be more appropriate to assess the impact of LEZs in terms of the reduction in elemental carbon, black carbon (a fine carbon powder produced by the incomplete combustion of hydrocarbons) or black smoke (a marker for diesel soot or the organic fraction of particles) rather than PM₁₀, PM_{2.5} or even PM₁^[84]. The PM_{2.5} monitoring network is not extensive

Over time, fleet emissions will become similar to those which would have occurred without the introduction of a LEZ, however the introduction of the LEZs have made the drop in emissions faster. For further benefits, it will be necessary to periodically tighten the scheme's criteria. Assessment of the impact of LEZs needs to take other policy measures implemented within the same time frame into account^[39].

2.2 Congestion Charging (CC)

2.2.1 Models of CC schemes: description

CC is a topic which has been intensively discussed over the past decade and the body of scientific literature has grown substantially during this period. There are two main reasons why this topic is attracting increasing attention:

- Firstly, congestion charging is an efficient way of alleviating traffic congestion, whilst simultaneously reducing the environmental impact and generating revenue.
- Secondly, researchers have realised that low stakeholder acceptance of road pricing is the main obstacle to its implementation^[11] although its efficiency is generally appreciated.

It has been generally accepted among transport planners and economists that charging directly for the use of congested road space is a potentially effective measure to reduce externalities and traffic congestion in particular^[85, 86]. CC in general is a cost-efficient and effective policy to reduce congestion, generate income and improve the local environment. Theoretically, revenues raised by optimal congestion charging completely cover the cost of ensuring optimal road capacity^[87].

There are several excellently documented examples of CC. The CC schemes in London and Stockholm apply to both passenger and freight vehicles. More recently, cities have introduced charging schemes based on environmental performance criteria. The AREA C scheme in Milan also applies to both passenger and freight vehicles and allows the less polluting vehicles to enter the central area of Cerchia dei Bastioni^[59].

2.2.2 CC Implementation

An overview of CC implementation shows the different approaches which have been implemented across the EU for freight, using examples from London, Rome, Milan and Sweden.

CC in London

Introduced in February 2003, the CC covers London's central business district; an area of eight square miles. All vehicles entering the zone are required to pay a daily fee during business hours (07:00 to 18:00). When it was introduced, the fee was £5; it is currently £11.50 since June 2014. There is an exemption for vehicles which emit 75g/km or less of CO₂, the Euro V

standard for air quality^[88]. Operators using automatic payment have a fleet discount of £1 per vehicle per day.

Freight traffic in London has proven to be price inelastic, as freight needs to be delivered, irrespective of destination and time. For 2005 to 2006, when there was a 60% increase in price, a 3-10% decrease in goods vehicle traffic was observed, implying low elasticity. From 2010 to 2011, after a price increase of 25%, the number of LDVs declined slightly, but HDV traffic increased, implying that they are inelastic to price, and/or that several LGVs were replaced by a single HDV so as to compensate by economies of scale^[88].

LDVs were most likely to be able to adjust, and showed a consistent slight elasticity to these price changes. Furthermore, average travel speeds inside the CC have fallen back to pre-CC levels over the decade since it was implemented, mainly due to road space reallocation to bicycles and signal timing changes prioritising pedestrian safety^[88]. The number of bus passengers, cyclists and pedestrians has also increased

CC in Rome

In Rome, there is a CC scheme in the inner area including the historic centre. The area covers 4 km² and is subject to access regulations between 6.30 am and 6.00 pm. Certain categories of vehicles qualify for an access permit. Freight vehicles pay the same charge as passenger vehicles. In order to be granted a permit for goods delivery and/or maintenance work, operators must provide documentation which includes signed contracts with the customers located in the CC area^[59].

This requirement, together with the charge, has generated opposition from operators. The enforcement of the charging scheme is automatic thanks to electronic checkpoints at the CC Zone entrance points^[59].

CC in Milan

In Milan, a CC scheme called ECOPASS was introduced in January 2008. In 2012 ECOPASS was replaced with AREA C, a combination of CC and LEZ. The area under the scheme covers 8 km². Vehicles are granted access between 7.30 am and 7.30 pm (Thursday from 7:30 am to 6:00 pm).

The charge varies according to the emission class of the vehicle identified on the basis of the Euro class. Charges apply to both passenger and freight vehicles and vary from a minimum of €2 to a maximum of €15 per day. AREA C scheme is automatically enforced thanks to electronic checkpoints at the Congestion Charging Zone entrance points^[59, 80].

The first ex-post evaluations of CCs in Italy showed a decrease of approximately 18% in the number of freight vehicles entering a charged area compared to the pre-scheme period (probably mainly due to a reduction in through traffic). There is also evidence that among freight vehicles there has been a change in the composition of the circulating fleet with an increase in the number of vehicles in the less polluting classes. Commercial vehicles (freight vehicles and private buses) exempted from payment have increased from 26.5% to 43.1% (of the total number of commercial vehicles).

This indicates that the incentives created by the schemes for operators to use less polluting vehicles have been effective^[59]. In 2015, City of Milan reported a reduction of 28.6 % of vehicles entering AREA C (2015 vs 2011). This reduction is an evidence AREA C scheme has been successful in reducing congestion^[68].

CC in Sweden

In Sweden, a CC was introduced in Göteborg in 2013 for all vehicles. Its operating cost, including costs for maintaining the technical system, customer service and invoicing, was approximately €12 million for the first year of operation. This corresponds to 17% of the revenue generated by the scheme on a yearly basis^[89].

The Göteborg CC uses automatic number plate recognition (ANPR), (the same technology as in Stockholm). The accuracy of number plate recognition improved during the first year with the percentage of correctly identified passages increasing from 80% in January 2013 to 94% in the autumn of 2013^[89].

2.2.3 CC Decision Level

With the increasing use of CC schemes throughout the EU, HDV charges may be more difficult to set than charges for passenger cars because of policymakers' limited understanding of the complexity of devising charging schemes which cover the cost of transporting freight in terms of time - also known as 'transport value of time' - taking into account multiple externalities^[90] such as pollution, damage to infrastructure, potential costs of accidents, etc.

For example, the key factor for receiving political support for charging in Stockholm was an agreement with the national government that Stockholm would receive a major infrastructure package, funded by the CC revenue, leveraged with an equally large national grant. This agreement inspired Göteborg politicians to strike a similar deal, co-funding a large infrastructure package with revenues from CCs^[89].

The implementation of CC indeed increased over the past decade, and the London and Stockholm experiences may well have served as models for other cities considering CC ^[91, 92].

One concern amongst businesses in the CC area, particularly small ones, is that CC imposes additional direct and administrative burdens both on them and on their customers/clients who may choose to shop/eat or do business where transaction costs are lower^[93].

There is also concern among retailers that the CC adds to their customers' household expenditure, thus reducing the customers' disposable income. However, CC is beneficial in helping to reduce both delays and the unreliability of journey times caused by congestion, two factors that may also discourage customers/clients from travelling to the charging area^[93].

The 2011 European Commission White Paper on Transport ^[94] supports the concept of charging drivers for using roads, the so-called "user pays" principle. In order to achieve a competitive and efficient transport system one of its stated goals is to move towards:

- Full application of 'user pays' and 'polluter pays' principles;
- Private sector engagement to eliminate distortions, to generate revenues and to ensure financing for future transport investments.

The strategy outlined by the said White Paper for the internalisation of externalities includes the following:

- The cost of local externalities such as noise, air pollution and congestion could be internalised through charging for the use of infrastructure;
- The long-term goal is to apply user charges to all vehicles and on the whole network (internalisation) to at least reflect the maintenance cost of infrastructure, congestion, and air pollution (externalities);
- A validated framework is developed for urban road user charging and access regulation schemes and their applications, including a legal and validated operational and technical framework covering vehicle and infrastructure applications;

The implication of this approach is that some form of road-user charging should be adopted so that those who choose to travel on the more congested roads at the most congested time will pay more than they do without the internalisation.

2.2.4 Congestion Charging: Key Success Factors

One important factor for high public support for CC is to highlight benefits to society rather than revenue-related aspects^[95]. Hence, the vital role of communication, marketing and information dissemination in a CC implementation process must not be underestimated^[96].

In addition to the well-known and successful example of London, there have also been failures. One such failure was the rejection of CC by the citizens of Edinburgh in 2005, two years after the London CC started. Lessons learned from the Edinburgh case suggest^[97]:

- Drafting clear enabling legislation;
- Appointing a political sponsor. The sponsor is an individual or a group who acts at the senior level to be as an advocate for the project and ensure that the project delivers the desired outcomes, under the allocated resources. The sponsor provides internal political support and ensures right prioritization of available funds and resources.
- Establishing clear objectives;
- Keeping the CC scheme simple;
- Engaging stakeholders from the beginning;
- Maintaining the active promotion of congestion charging benefits.

The London case, is an interesting example of how the freight industry negotiated with Transport for London regarding the fee for HDVs. The industry wanted to be exempted from paying, as there is no alternative mode of transport (goods cannot be carried by public transport). Transport for London argued that HDVs should pay more than cars because they damage roads to a greater extent. The final decision was a compromise where trucks pay the same as cars^[98]. In London and Milan, income is also ring-fenced for sustainable transport.

Chapter 3 Solutions to Mitigate Side-Effects of UVAR Schemes

In the Ecorys 2015 consultation^[1], stakeholders identified four solutions for addressing the challenges related to urban logistics:

- Urban Consolidation Centre (UCC);
- Cargo bike (CB);
- Off-hour Delivery (OHD).
- Green Logistics (GL)

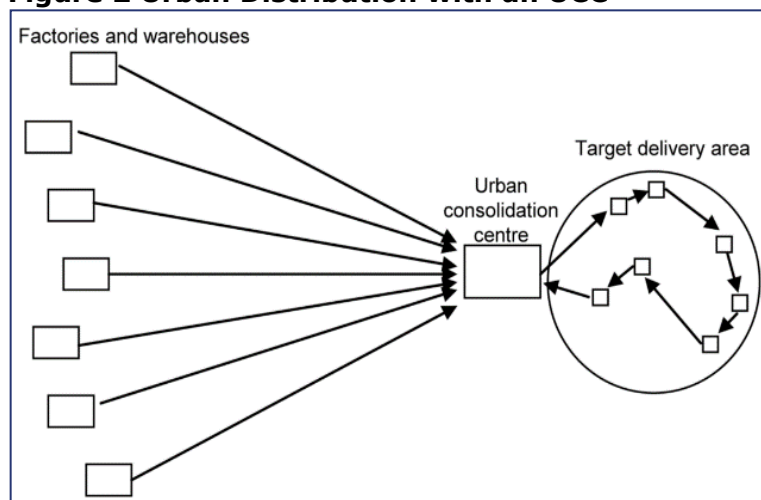
These four solutions can mitigate the impact of UVARs on the logistics sector, while still reaching the objectives set for decreasing congestion and emissions. In the next section we explore some of the advantages and disadvantages of these solutions, as well as identifying some key success factors, implementations issues and impacts to be expected. Green Logistics will be covered in detail by a separate technical document.

3.1 Urban Consolidation Centres (UCC)

3.1.1. UCC description

UCC is defined as a logistics facility situated in relatively close proximity to the geographic area that it serves (be that a city centre, an entire town or a specific site such as a shopping centre complex), to which many logistics companies deliver goods, and from which consolidated deliveries are carried out to businesses within that area. Within the UCC, a range of other value-added logistics and retail services can be provided ^[14, 15]. The Figure 2 below shows urban distribution using an UCC.

Figure 2 Urban Distribution with an UCC



Source: ^[14]

Many different configurations and logistics systems are currently being implemented to deal with urban freight consolidation, and several cities in Europe are considering the establishment and set-up of UCCs together with the use of clean trucks and vans for UCC area deliveries^[99].

Final delivery from UCCs is often organised using environmentally-friendly vehicles such as electric and gas-powered goods vehicles, and, in some cases, electric bicycles; the European Union is active in researching the latter^[100]. The EU Freight Electric Vehicles in Urban Europe (FREVIEW) project has successfully tested electric freight vehicles from small vans up to 19t HDV, which are more than sufficient for the vast majority of urban movements and which do not have exhaust emissions^[3].

A large number of other academic publications have been released on the best practices for setting up UCCs and possible management solutions. The current debate focuses on defining best practices by analysing success stories, in order to better understand how to avoid past mistakes and limit the risks associated with setting up an UCC^[16, 101]

UCCs have become more professionally organised (as seen by the involvement of experienced logistics companies such as DHL, Fedex and Transdev), and the legal framework used for setting up delivery consolidation activity is becoming more robust^[102].

3.1.2 UCC Implementation

Public authorities can introduce regulations to promote the use of a specific system. These regulations can be restrictive requiring or strongly inducing freight forwarders (who coordinate the shipment of goods from one place to another via a single or multiple carriers), to use a certain alternative or founded on incentives instead or a combination thereof.

In order to implement UCC according to best practice gathered from benchmarking studies, the following typology has been identified^[16]:

Typology:

- *Private or semi-private UCC.* These are carriers' or shippers' projects for internal operations, without direct influence from public authorities other than limited financial assistance. These UCCs essentially have an economic purpose, and contribute to their users' business development strategies. They are generally created by a freight carrier or logistics provider;
- *Multi-user UCC.* These are projects created by municipal authorities or groups of businesses, with the intention of providing a service open to all potential users. These terminals are generally combined with services which are promoted and supported by public authorities, and are sometimes referred to as "public freight services", though this term is still rarely used and, has no legal definition in many EU countries;
- *Specialised UCC* (mainly for construction and airports). They may be temporary (centres associated with a specific construction site) or permanent (in airports, in entertainment parks). However, they do not always serve an urban environment, unlike the two categories described above.

UCCs in Italy

In Italy, there are examples of active UCCs in several Italian cities. Among these, the one in Padua is one of particular interest as an example of EU good practice because it has been in operation since 2004 and has proven to be financially sustainable and successful in reducing adverse environmental emissions. The main factors determining its success are the following^[103, 104]:

- The UCC results from an agreement among the main local public authorities and business associations;
- It is hosted in a pre-existing intermodal infrastructure;
- The majority of transport operators agreed to use the UCC to deliver their goods in the city centre;

- Its low emission vehicles are exempted from time-window regulations and can use bus lanes. An interesting legal case involving the city of Vicenza, Italy and large parcel transport operators in 2008 demonstrated that a city that is actively considering implementing a scheme for consolidating urban deliveries must take additional financial and regulatory measures to guarantee a comparative advantage for the UCC and to accompany plans with regulations favouring its use^[16].

3.1.3 UCC Decision Level

The importance of coordination, partnership and collaboration among urban stakeholders in order to effectively address sustainable urban freight development has long been recognised^[105-107].

However, many UCC case studies indicate that residents living close to an UCC are often the main opponents of UCC development for a number of reasons. The concentrated freight transportation may negatively impact the local community in terms of noise and safety despite the fact that an UCC creates employment in the local area^[16].

3.1.4 UCC Key Success Factors

Before approval of an UCC project, it is critical to perform a careful financial feasibility analysis. Focusing solely on the direct monetary costs associated with an UCC and its operation may lead to a misunderstanding about the potential longer-term benefits.

Factors critical to the success of an UCC scheme are^[14, 108]:

- Level of demand. A sufficient UCC user and product delivery volume is required to drive down the costs per unit handled, thereby making the UCC competitive with traditional urban distribution systems.
- Cost and benefit sharing. UCC costs and benefits need to be shared between the various supply chain parties involved in the scheme.
- Location.
 - Specific and clearly defined geographical areas where there are delivery-related issues.
 - Town centres that are undergoing a “retailing renaissance”.
 - Historic town centres and districts suffering from delivery traffic congestion.
 - New and large retail or commercial developments, both in and out of town.
 - Major construction sites.
- Availability of funding. There is strong evidence to suggest that many UCCs without funding may fail.
- Strong public sector involvement in encouraging their use through the regulatory framework.
- Significant existing congestion/ pollution concerns within the area to be served.
- Bottom-up pressure from local stakeholders (e.g. retailers in a Street Association).
- Locations with a single manager/landlord.

Awareness of the concept of an UCC and its different potential applications needs to be increased, as there is considerable lack of knowledge and misunderstanding in both the private and public sectors at present. A clear organisational structure is necessary to lead the development and operation of an UCC, with clear (realistic) objectives required. It appears that some UCC trials have been based on intuition rather than on a quantified assessment and, as a consequence, are not likely to be viable^[108].

Suppliers often consolidate at origin (e.g. in their Distribution Centre), but for cities, consolidation at destination is more advantageous. It is recommended to establish a good spread of UCCs in order to have an optimal delivery range and in order to avoid the overload of a large scale UCC in one urban area^[109].

The effectiveness of UCCs seems to depend heavily on the presence of appropriate local regulations, including vehicle access rules for the zone covered by the UCC and benefits accorded to UCC operators^[16]. Public authorities can put legislation or other regulations into place to promote the use of the system that is being offered. These regulations can be restrictive (requiring or strongly inducing vehicles to use UCC) or founded instead on advantages accorded to users. It should be stressed^[17] that this should be linked to dialogue with stakeholders.

Many UCC trials and schemes have been initiated by the public sector with the key objective being to reduce the negative impacts of urban freight transport. However, in order to have a long-term future, it is important that a strong business case for the UCC is made and that a strong business model exists^[14].

While the UCC concept is interesting, UCCs alone are not sufficient to resolve congestion and other freight-related issues. It is therefore important to study alternatives to the single-operator urban consolidation model such as collaborative solutions, the free use of terminals with incentives for consolidation, dedicated delivery areas, Low Emission Zones and, above all, a mixture of public policy, technological solutions, and organisational systems which promote urban goods flow rationalisation whilst both respecting legislation on free competition and incorporating any changes agreed upon by stakeholders^[16].

3.2 Cargo Bikes (CB)

3.2.1 CB Description

CBs are used for final freight delivery to reduce congestion in cities, in response to Urban Vehicle Access Regulation. They range in payload from approximately 25kg for conventional two-wheeled bicycles with a front basket or tray, to approximately 250kg for three- and four wheeled cycles (equipped with rear-mounted boxes, cages or trailers). Electric bicycles can reach a speed of approximately 15 kilometres per hour in free-flow traffic^[110].

The move towards shifting more goods by bicycle has led to a range of different CBs, some of which can carry up to 400-500kg of goods. Some are lengthened bicycles so that a large container can be fitted between the handle bars and the front wheel, while others have been fitted to take items that require refrigeration.

3.2.2 CB Implementation

CBs as freight carriers can/are used where access regulations affecting freight transport are in place.

In Europe, examples of the use of CBs for urban freight transport have, for example, been documented in France (especially in Paris), The Netherlands (Arnhem, Lochem, Nijmegen and Apeldoorn), Belgium (Antwerp and Brussels), and the UK (London, York, Nottingham, Cambridge).

CB in the Netherlands

DHL Netherlands replaced 33 trucks with 33 CBs, thus saving 152 metric tons of CO₂ and €430,000 per year, with 10% of their vehicles being CBs^[112].

CB in France

In Paris, over the past 10 years, 700 kilometres of bicycle lanes have been constructed. These lanes have now been officially opened up to electrically assisted tricycles and CBs. Companies such as “La Petite Reine” or The Green Link estimate that this enhances the productivity of their delivery operations. La Petite Reine (a subsidiary of Groupe Star’s Service) operates approximately 100 CBs, from several consolidation centres throughout the city. In 2010, an assessment study showed that, at that time, 30 CBs were operating from a 600m² terminal, and this saved emissions equivalent to those produced by running diesel vehicles for 660 000 km^[111].

CB in Belgium

In Brussels, the example of Ecopostale can be noted, which began with four bicycles, seven CBs and one electric van, delivered 400 packages per day to banks, lawyers and other corporate customers and reached savings of 13t of CO₂.

CB in the UK

In Central London, research shows that replacing diesel vans by electric vans and tricycles operating from a micro-consolidation centre would lead to a decrease in total distance travelled and the CO₂-equivalent emissions per parcel delivered by 20% and 54%, respectively. The research is based on an experiment, similar to the aforementioned Paris assessment, carried out by Office Depot between 2009 and 2010. This experiment tested six CBs, three electric vans and one truck and resulted in a total decrease of 62% in CO₂ emissions (kg/parcel)^[113].

3.2.3 CB Key Factors of Success

The advantages offered by CBs for urban distribution work are that^[113]:

- They require less kerbside loading space than a motor vehicle;
- They are easier to manoeuvre in heavily congested situations than motor vehicles;
- In some cities they have dedicated lanes and may also use bus lanes (unlike motor vehicles);
- They do not emit greenhouse gases and produce very low noise levels;
- They have lower purchase and running costs than motor vehicles;
- They have smaller space requirements for overnight storage than vans and other goods vehicles;
- They are not usually subject to on-street parking charges or parking fines;
- They are not usually subject to the charges imposed by CC schemes;
- Cyclists do not require driver licensing;
- The public has a positive perception of cycles especially as a result of them having a far lower environmental impact than motor vehicles;
- They are likely to be safer in areas with high pedestrian activity than motorised goods vehicles;
- CBs are generally viewed as less intimidating and safer than vans and other goods vehicles in a busy urban area with limited space.

Figure 4 Urban Distribution with Cargo Bike in Brussels

Source: Ecorys / Jochen Maes

The disadvantages associated with cargo bikes include^[110]:

- The limited payload weight and volume they offer for the carriage of goods compared to motor vehicles. This limits the type of goods they can carry and the type of supply chains they can be used in;
- They travel at lower speed than motor vehicles in free-flow conditions. This can result in longer journey times when traffic conditions are good and makes cycle delivery most advantageous in central or inner urban areas;
- Their lower speeds in free-flow conditions limit the distance over which they can feasibly make deliveries;
- Existing supply chains often involve distribution centres located on the edge of, or outside, the urban area. It can prove difficult to operate cycles for urban deliveries from such locations, given the distances involved and the lower speed of cycles in outer urban areas;
- Supply chain reconfiguration may be necessary to facilitate urban deliveries by cycle. Ideally, this requires the implementation of a distribution centre located in the delivery catchment area.

Given the advantages and disadvantages of CBs, it would appear that they are most suited for the distribution of products with a relatively low bulk density and size and which have simple storage or handling requirements.

3.3 Off-hour Delivery (OHD)

3.3.1 OHD Description

Another solution to urban freight-related concerns is the use of off-hour delivery. Retailers generally prefer to receive deliveries of goods during their normal work hours. Suppliers schedule deliveries to meet the demands of their clients. As a result, most lorry traffic occurs during the most congested daytime traffic periods. If enough businesses are able to adjust their schedules to accept deliveries when there is less traffic congestion, it could enable transport companies to deliver goods more quickly and at lower cost. This could result in less traffic

congestion, reduced cost of goods, economic benefits and would be better for the environment^[18].

One possible approach to relieve traffic congestion in urban areas would be to shift a percentage of deliveries from regular daytime hours to the night time, or from the peak hours to the non-peak hours. Such deliveries made before or after peak-hour traffic are referred to as off-hour deliveries^[114] (OHDs). OHDs are defined as the delivery to retailers and shops in the city area during the evening or night hours when the city is usually quieter. Typical time slots^[18, 115] start anywhere between 7.00 pm and 11.00 pm and end between 5.00 am and 7.00 am.

3.3.2 OHD Implementation

Off-hour delivery (OHD) is a simple concept, but it can be challenging to implement it because the benefits and costs are not always evenly distributed. Carriers generally like the idea because it can save them time and money, but customers are often sceptical because it can add costs. Communities will benefit from lower congestion but may have concerns about night-time noise. Sometimes, special incentives are needed to encourage businesses to participate. An OHD program needs to be designed in a manner that balances the benefits and costs to make it practical for shippers (individuals or firms sending freight), carriers (firms providing transportation services), customers and the community^[18].

OHD can be/are introduced where access regulations affecting freight transport are in place.

Businesses that are most receptive to OHDs are those that are likely to be open during off hours, such as restaurants, bars, hotels, convenience stores, 24-hour supermarkets, hypermarkets and medical facilities^[116]. "Unattended deliveries" (deliveries made in the absence of the customer's staff, for example in buffer zones) are also a potential solution, although they require trust and a clear legal framework^[117].

As a promising solution to mitigate traffic congestion, OHD programs have been implemented not only in New York, but also in Beijing and in the EU in large cities such as Barcelona, Paris and London^[114]. Mercadona, a supermarket chain in Barcelona, has tested OHD and expanded its use to over 100 of its store locations throughout Spain^[118]. London began its OHD implementation in preparation for the 2012 Olympic Games^[119] and has continued since. In The Netherlands, silent vehicles and delivery equipment for OHD (PIEK technology) are promoted and the maximum noise level is regulated by law. The PIEK technology is currently being exported to other European countries.

Finally, a municipal regulatory framework must be established to promote off-hour deliveries, with delivery time windows available during off-hour times.

OHD in New York

For example, a study of OHD in New York City in 2009 and 2010 showed that implementing various OHD policies would generate total savings of between \$100 and \$200 million/year in travel time savings and pollution reduction^[117]. OHDs are estimated to be 30-40% cheaper for carriers than regular daytime deliveries^[116, 120].

OHD could switch more than 20% of the (currently congested) daytime freight traffic deliveries to off hours, and could achieve sizeable pollution reductions^[115] (e.g., 20.9% of OHD leads to reductions of: 202.7t of carbon monoxide, 40t of hydrocarbons, 11.8t of NO_x, and 69.9 kg of PM₁₀).

The OHD pilot programme in New York City demonstrated how this form of traffic demand management could benefit a wide variety of stakeholders. In the pilot programme, pedestrians and cyclists experienced increased safety and improved quality of life with less interference

from deliveries; daytime non-freight travellers benefitted from faster travel speeds; freight carriers saw increased productivity; and customers enjoy increased reliability^[120].

Many of the benefits of off-hour delivery, such as reduced congestion, improved air quality and safety would serve the greater community, not just the carriers or customers. For example, in the New York pilot, it was estimated that 90% of the congestion reduction benefit was region-wide, not just in the pilot project area^[121]. Using traffic simulations and a transportation planning model in the New York pilot, results showed that the status quo (4-5% of OHD) is indeed suboptimal; the optimal participation level was estimated to be in the range of 14-21% (staffed OHD)^[115, 122] and over 40% for unassisted OHD^[122, 123].

3.3.3 OHD Decision Level

Although other stakeholders are involved, the interactions amongst shippers (individual or firms sending freight), carriers (firms providing transportation services), and customers are the most important ones. In most cases, carriers are the weakest stakeholders, for economic reasons that originate in the deregulation of the freight industry in most urban markets since the 1980s.

The excess of transportation services resulting from this deregulation forces carriers to reduce rates and their influence in negotiations is affected. As a result, important decisions that are generally perceived to be the carriers' responsibility are heavily influenced, and in some cases, determined, by shippers or customers^[120].

It has been seen that the customer is the key decision-maker concerning delivery times^[124]. To understand and influence carrier behaviour, one must determine how to affect the behaviour of shippers and customers. Moreover, these interactions do not take place in a vacuum; they are further determined by market conditions^[120].

Low readiness on the part of local retailers (the customers) to act often originates from them being mostly unaffected by access regulations. Due to competition following deregulation, carriers are paying for access but often do not pass on the cost to the retailer for fear of losing contracts. The retailer thus simply profits from a more attractive environment.

The difficulties encountered by policy makers in dealing with the complex environment of OHD are magnified by the natural proximity and interaction among stakeholders characterised by contrasting objectives^[124-127].

Transport providers favour OHD since it facilitates loading and unloading operations and the use of uncongested roads. Retailers (customers) would, on the contrary, prefer to have the goods delivered during regular opening hours, while citizens are interested in having a quiet environment during the night and fully re-stocked shelves when shopping. Policy interventions^[45] usually aim to re-balance social costs and benefits (i.e. access time regulations, vehicle size regulations, lorry and traffic route regulations, lane management, traffic signals, signs, and general infrastructure investments)^[12]. The effectiveness of any policy aimed at changing freight delivery times will be determined by the joint response of carriers and customers^[114].

The most significant negative social impact of OHD is the noise produced by unloading operations at night^[122]. However, it is fundamental to have methods and models in place to allow for an ex-ante assessment of policies and measures proposed by local administrators in order to achieve more sustainable urban freight mobility. There are a limited number of empirical studies that provide evidence on observed behavioural influences and there is no general behavioural theory that could explain the complex interactions underlying freight decision making^[128]. The clever use of incentives and penalties could play a key role in ensuring that the majority of stakeholders benefit, or at least are not negatively affected by the

implementation of off-hour delivery. Achieving this balance may smoothen the way for implementation, engender political support^[120], and open the door to further collaboration.

3.3.4 OHD Key Success Factors

Examples in Europe, where shippers and trucking organisations generally support OHDs, include the cities of Dublin, Barcelona, and Paris. These cities benefit from the results of the Dutch national PIEK program, which provided research and development efforts for quieter delivery trucks and handling equipment. PIEK equipment is used, with PIEK labels made visible on the trucks operating at night^[12].

Unattended deliveries have greater potential for long-term success, subject to the requisite infrastructure. After the New York pilot concluded, almost all customers receiving unassisted OHD remained in the off hours, without any additional incentives, because of off-hour delivery reliability^[117]. At a regional level, public policies need to be aligned to maintain the congestion reduction benefits of off-hour delivery. These could include measures such as road pricing on major roads as well as parking regulations and fees, all of which could vary by the time of the day. Public policies and regulations may also be significant in order to incentivise, or induce, businesses to participate in an OHD programme^[18].

Freight deliveries can operate more efficiently if there is dock access during off hours when businesses are closed, thereby spreading the number of delivery vehicles and their competition for limited loading facilities over a longer period of time. However, building managers are reluctant to allow access to docks during non-business hours due to potential additional operating costs and/or security issues^[129].

Although the benefits of congestion relief through this OHD strategy could be significant in reducing freight traffic during the day, concern exists outside the EU that increasing freight traffic at night may lead to safety issues. According to the U.S. Department of Transportation, more than 50% of fatal crashes occur at night, despite relatively fewer vehicles travelling. The safety impacts of shifting freight traffic from regular daytime hours to night-time off hours have also been studied. The safety effects of daytime and night-time truck volumes could not be regarded as significantly different. These results showed, against expectations, that OHD programs were not expected to increase the overall risk of crashes involving lorries significantly^[114].

Within the EU, Transport for London has developed a Code of Practice in partnership with the Freight Transport Association and the Noise Abatement Society which provides guidance on how best to minimise noise disturbance when carrying out night-time deliveries.

The code is relevant to all sectors receiving and making deliveries and consists of three parts^[119]:

- the use of newer, quieter delivery vehicles and equipment;
- Behavioural changes to reduce noise (especially in relation to goods-vehicle drivers and staff employed by the customer at the site);
- training for all staff involved, from shipper to customer.

3.4 Green Logistics (GL)

The fourth solution, Green Logistics will be addressed in a separate technical document. It will include the FREVUE project which demonstrates the use of electric freight vehicles in city logistics in eight European cities. FREVUE gives effect to the European Commission's Roadmap to a Single European Transport Area, which seeks to achieve CO₂ free city logistics by 2030^[4, 5].

FREVUE is co-funded by the European Commission under the Seventh Framework Programme and has been designed to ensure the range of conditions that are common across Europe are covered, including^[2, 3]:

- Goods delivered (including food, waste, pharmaceuticals, packages and construction goods).
- Novel logistics systems and associated ICT (with a focus on consolidation centres which minimize 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.

FREVUE includes over 100 electric-powered vehicles in the cities of Amsterdam, Lisbon, London, Madrid, Milan, Oslo, Rotterdam and Stockholm. The data includes operational, attitudinal and financial data for the before situation in which conventional vehicles were used and for the first year where electric vehicles were operated^[6].

Chapter 4 Conclusions

Access regulation schemes contribute to address a number of challenges that markets alone are not able to address. UVARs can have various characteristics. They are based on access time, allow certain types of vehicles or regulate access on emission levels of the vehicle, road use (size), fuel use, and trip or vehicle type (See Table 2 in Annex).

Each access regulation affects many stakeholders, and therefore requires specific stakeholders to be involved in the decision making process. Moreover, the engagement of more than one authority level (i.e. local, regional, national) is usually necessary for successful UVAR Schemes implementations. The regulation scheme and the challenge lead to the type of stakeholder authorities that should be engaged (See Table 3 below).

The degree of impact of each measure not only varies from city to city but also depends on the presence of a mix of access regulations. It is often a challenge to assess the extent to which each UVAR contributes to a given impact indicator (See Table 1 above and Table 4 below), due to the many city, regional, national and EU factors and policies in place. Care often needs to be taken in assessing the impacts.

As part of an overall approach, it is important not just to consider managing certain types of vehicles, but instead to manage the allocation of road space for all road users. For example, if only freight vehicles are targeted, then the road space they free up could fill with other vehicles, potentially making congestion and air quality worse. Given this fact, it is crucial that urban freight policy is considered together with other urban mobility policies, with policy makers seeking to strike a balance between all road users.

Since efforts and investments allocated by each stakeholder need to be evaluated against the performance of the UVAR scheme, a number of tools and methods can be used to create the transparency and building trust for long term implementation.

Annex

The UVAR schemes and solutions identified in this report comprise:

- Schemes:
 - LEZ, such as the ones in London, Berlin and Athens;
 - CC, such as the ones in Milan, London and Göteborg.
- Solutions:
 - UCC, such as the ones in Padua and Vicenza;
 - CB, such as the ones in the Netherlands and Paris;
 - OHD, such as in New York.

Each UVAR scheme applies to a variety of geographical and vehicle specifications, and to a set of technological and operational norms and standards.

As illustrated in Table 2 below, CC is a very flexible scheme, whilst UCC is limited geographically speaking for its location constraints. UCC location needs to meet multiple criteria but mainly should be in specific sub-urban areas, and inside the outer rings.

Table 2 Scopes of different schemes

Regulatory Scope	Specification	LEZ	CC	UCC
Geographical Specifications	Specific Roads		✓	
	City Centre	✓	✓	✓
	Historical Centre	✓	✓	✓
	Heritage Urban Area	✓	✓	✓
	Specified Urban Area	✓	✓	✓
	Size of Urban Area	✓	✓	
	Inner-Ring /Outer-Ring	✓	✓	✓
	City/ Metropolis	✓	✓	
	All Urban Area	✓	✓	

Regulatory Scope	Specification	LEZ	CC	UCC
	Cargo Cycle			✓

Vehicle specifications	Small Urban freight vehicle	✓	✓	✓
	Alternative Fuels or Electric	✓		✓
	Truck	✓	✓	✓
	Private	✓	✓	
	Commercial	✓	✓	✓
	Size		✓	✓
	Weight		✓	✓

Regulatory Scope	Specification	LEZ	CC	UCC
Norms and Standards	Presence of Filters	✓		
	Speed Limits			
	Euro-0-6	✓		✓
	Congestion Levels or Vehicles per km ² /hr.		✓	
	Load factor			✓
	Access time			✓

Summary Table of Key Stakeholders Decision Levels

The decision level for each UVAR needs to engage stakeholders that may be affected by the measure. This needs to be considered for each city and scheme.

LEZ decision making may need the participation of shippers, wholesalers, and retailers located within the LEZ if the transportation is not outsourced. Last Mile Logistics Providers are a must in the LEZ stakeholder involvement process. It would be expected that local authorities lead the LEZ decision making. Offline consumers with private cars (traditional walk-in store consumers), and most certainly local dwellers and visitors, are also part of the process. CC will principally require the participation of private and commercial vehicle owners' representatives. Authorities at all levels will be required in the decision making, because coordination is required as CC charging diverts freight and traffic flows from and to local, regional and national roads.

UCCs may require active participation of wholesalers and retailers as they are strong drivers of consolidation and horizontal collaboration between suppliers driving into urban areas. They may require long-haul vehicles to break down cargo into multiple light or low emission vehicles at the UCC in urban areas restricted by truck size/weight or emission standards. Also very important is the participation of local and regional authorities, not only from the regulatory and enforcement view point, but because the important role of funding, financing, and subsidies for the UCC's sustainability in the long run has been discussed in multiple cases.

Urban residents in the proximity of potential locations of UCCs need to be consulted about the decision making as UCCs may affect their daily operations. Last but not least, Logistics Providers should play a key role in the decision making as they are the most suitable to operate UCCs (See Table 3 below).

Table 3 Stakeholder involvement when implementing an LEZ

Stakeholders	LEZ
Shippers/Producers	Need to be consulted over existing shipments, and the related logistic procedures and routing.
Wholesalers	Idem
Logistics providers	Most directly affected by new schemes. They should be consulted on existing solutions for last mile deliveries, on existing use of transportation vehicles and of the feasibility of the proposed transition scheme.
Retailers	To be consulted on flexibility in delivery times and delivery mechanisms
Consumers	To be consulted on possible impacts on shopping behaviour or other logistics related issues
Authorities	Fine-tuning of UVAR is the overall institutional framework
Citizens	Residents and visitors. To be consulted on balancing possible negative impacts (in and outside the UVAR-area)

Summary Table with Impacts

Main UVAR local impacts are shown in the

Table 4 below. Countries and cities also have their own established estimation methods, which may well be preferable. More detailed emissions factors may be available and should also be considered, either as a main tool or for sensitivity testing.

Table 4 UVAR local Impacts

Impacts	Indicator	Expected Impact	Possible Estimation method/ Tool	LEZ	CC	UCC
CO ₂	Yearly CO ₂ by Urban Freight	Yearly % Reduction	COPERT 4 Methodology ^[130]	✓		✓
			External Costs of Transport ^[131]			
PM	Yearly and daily exceedence PM ₁₀	Yearly % Reduction.	COPERT 4 Methodology ^[130]	✓		✓
			External Costs of Transport ^[131]			
Noise	To Be Decided Upon	Yearly % Reduction	COPERT 4 Methodology ^[130]		✓	

NOx	Yearly and daily exceedence NO ₂	Yearly % Reduction	COPERT 4 Methodology ^[130]	✓		✓
Accidents	Number of Fatalities and Heavy/ Slight Injuries very Important by Vehicle Type	Fatalities and Injuries Yearly % Reduction	DaCoTa Method ^[132]	✓	✓	
	Social Costs of Injury (Cents per Vehicle-Km)	Cents Differential Year to Year	Local, Regional, or National Accident Databases			
			External Costs of Transport ^[131]			

Impacts	Indicator	Expected Impact	Estimation Method/ Tool	LEZ	CC	UCC
Liveability	To Be decided Upon	To Be Decided Upon.	To be Decided Upon	✓	✓	✓
Road Congestion /Reliability	Vehicles (or PCU (Passenger Car Units)) per Time Period per Road (or Lane) Length	Maximum and Average V/C % Reduction, and Typical Freight Distribution Times (e.g. Peak Hours)	Local Traffic Data		✓	✓
	Free flow: Volume/ Capacity< 0.25		External Costs of Transport ^[131]			
	Near Capacity 0.75<v/c<1					
	Over Capacity 1<v/c.					

Impacts	Indicator	Expected Impact	Estimation Method/Tool	LEZ	CC	UCC
Commercial Attractiveness	Commercial Agglomeration in the Urban Area	% of New Shops in the Urban Area	Codata ^[133]	✓	✓	✓
	Share of National Retailers	Yearly % Increase				
Delivery Costs by Receivers	Euro per Unit at Urban Store	% Reduction	Retail Cost Structure Data		✓	✓

Logistics Costs	Euro per Unit	% Reduction	Logistics Operators' Cost Structure		✓	✓
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Summary Table of Selected Case Studies

Examples of good implementation cases of Urban Vehicle Access Regulation Schemes and Solutions are shown in Table 5 below. www.urbanaccessregulations.eu also gives details of all European UVARs.

Table 5 Selected Case Studies

Scheme	City	Source
LEZ	Amsterdam	http://www.gatso-usa.com/files/Low%20Emission%20Zone%20Case%20Study_Amsterdam.pdf
	Aalborg	http://civitas.eu/sites/default/files/civitas-plus-case-study-aalborg-lez.pdf
	Berlin	http://tdm-beijing.org/files/Fact_Sheet_Environmental_Zones.pdf
	Leipzig	http://www.unia-miest.sk/VismoOnline_ActionScripts/File.ashx?id_org=600175&id_dokumenty=2853
	Milan	http://pocacito.eu/sites/default/files/Individual%20Case%20Study%20Assessment%20Report_Milan-Turin_feb_2015.pdf
	Norwich	http://laqm.defra.gov.uk/documents/Norwich_lez.pdf
	Paris	http://www.bestfact.net/wp-content/uploads/2016/01/CL1_146_QuickInfo_LEZParis-18Dec2015.pdf
	Sussex	http://www.clientearth.org/reports/lez-event/9-nigel-jenkins-clientearth-lez-event-presentation.pdf

Scheme	City	Source
	Göteborg	http://www.citylab.com/commute/2015/04/swedens-other-congestion-pricing-program-is-also-a-big-success/390933/
	London	http://www.cleanvehicle.eu/fileadmin/downloads/Czech_Republic/Success-stories-Tech_2_2008_final.pdf
	Milan	http://nws.eurocities.eu/MediaShell/media/Sep_Cities%20in%20action_Milan_AreaC.pdf http://www.eltis.org/discover/case-studies/area-c-milan-

CC		pollution-charge-congestion-charge-italy
	New York	http://www.komanoff.net/cars_II/Congestion_Pricing_for_New_York_City.pdf
	Singapore	http://www.eltis.org/discover/case-studies/reducing-congestion-road-pricing-and-licensing-singapore
	Stockholm	http://www.sfcta.org/sites/default/files/content/Planning/CongestionPricingFeasibilityStudy/PDFs/MAPS_case_studies_111310.pdf http://www.transportportal.se/swopec/CTS2014-7.pdf

Solution	City	Source
UCC	Bristol	http://trailblazer.eu/files/205850847.pdf
	Copenhagen	http://www.bestfact.net/wp-content/uploads/2014/02/CL1_QuickInfo_CityLogistikCopenhagen-21Jan2014.pdf
	Göteborg	http://www.bestfact.net/wp-content/uploads/2016/01/CL1_137_QuickInfo_Göteborg-16Dec2015.pdf
	L'Hospitalet de Llobregat	http://www.strightsol.eu/demonstration_A.htm
	Lithuania	http://www.bestfact.net/wp-content/uploads/2014/02/CL1_QuickInfo_LP%20EXPRESS_21Jan2014.pdf
		http://www.bestfact.net/wp-content/uploads/2016/01/CL1_060_QuickInfo_4-major-Lithuanian-retailers-16Dec2015.pdf
	Padua	http://www.bestfact.net/wp-content/uploads/2016/01/CL1_014_QuickInfo_Cityporto-16Dec2015.pdf
	Paris	http://www.bestfact.net/wp-content/uploads/2016/01/CL1_135_QuickInfo-Beaugrenelle-16Dec2015.pdf
		http://www.bestfact.net/wp-content/uploads/2016/01/CL1_052_QuickInfo_Distripolis-16Dec2015.pdf
	Parma	http://www.eltis.org/discover/case-studies/ecologistics-parmas-integrated-and-systemic-green-urban-delivery-scheme-italy
	San Sebastian	http://www.bestfact.net/wp-content/uploads/2016/01/CL1_062_QuickInfo_Donostia-16Dec2015.pdf
	Stockholm	https://tfl.gov.uk/cdn/static/cms/documents/stockholm-

		case-study.pdf
	Utrecht	http://www.civitas.eu/sites/default/files/utrecht_experience_of_udc.pdf

Solution	City	Source
OHD	Barcelona	http://www.eltis.org/discover/case-studies/silent-inner-city-overnight-deliveries-barcelona-spain

Solution	City	Source
CB	Amsterdam	http://www.bestfact.net/wp-content/uploads/2016/01/CL1_142_QuickInfo_Marleenkoo kt-16Dec2015.pdf
	Bucharest	http://www.eltis.org/discover/case-studies/socially-responsible-and-sustainable-recycling-bucharest-romania
	France	http://www.eltis.org/discover/case-studies/go-shopping-bike-personalised-support-device-behaviour-change-france
	Germany	http://www.eltis.org/discover/case-studies/emission-free-pizza-delivery-germany
	Ghent	http://www.eltis.org/discover/case-studies/sharing-private-cargo-bikes-ghent-belgium
	Graz	http://www.eltis.org/discover/case-studies/becoming-bicycle-friendly-employer-graz-austria
	Paris	http://www.eltis.org/discover/case-studies/distripolis-new-city-logistics-solution-paris-france
		http://www.bestfact.net/wp-content/uploads/2016/01/CL1_136_QuickInfo_TheGreenLink-16Dec2015.pdf
		http://www.bestfact.net/wp-content/uploads/2016/01/CL1_091_QuickInfo_La-Petite-Reine-16Dec2015.pdf
	UK	http://www.eltis.org/discover/case-studies/encouraging-people-shop-bike-uk
	UK	http://www.eltis.org/discover/case-studies/coventrys-zero-emission-postal-service-uk

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