ReVeAL

Regulating Vehicle Access for improved Livability

How to regulate vehicle access in urban areas:

Guidance from the EU ReVeAL project for cities putting in place access regulations

31.10.2022

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Responsible Author(s)	Lucy Sadler (Sadler Consultants), corresponding author Julie Schack Møller-Kristensen (WSP) Cosimo Chiffi, Marco Brambilla, Ivan Uccelli, Sofia Pechin (TRT) Daniel Guzman-Vargas, Koos Fransen (University Gent) Maria José Rojo (Polis)
Contributors	Bonnie Fenton (Rupprecht Consult) Luca Coin, Raffaella Michelon, Luisa Rispo (Padova) Nimrod Levy, Yoel Siegel, Tomer Shenhar (Jerusalem) Isabel Garnika Ortiz, Juan Carlos Escudero (Vitoria Gasteiz) Sofia Pechin, Tito Stefanelli, Patrizia Malgieri (TRT) Steven Herskamp (VTRON) Per Solér (WSP) Alessia Giorgiutti, Ivo Cré, Laura Babío (Polis) Rodrigue Al Fahel, Kristina Andersson, Josephine Darlington (CLOSER), Bas Bongers (NL MINIENW), Marcel Otto (NL RWS)
Peer Review	Matthieu Graindorge (Helmond), Heather Allen (Independent Consultant), Samantha Tharme (City of London)
Quality Assurance Committee Review	Bonnie Fenton (Rupprecht Consult)

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Abstract	This guidance document is part of the ReVeAL toolkit, supporting cities developing good practice urban vehicle access regulations (UVARs). The guidance covers aspects that are common to many UVAR building blocks. These cross-cutting themes include governance, stakeholder involvement, complementary measures, user needs, public acceptance, communication, financing, and equity. It also covers monitoring and assessment, and some more detailed aspects in relation to exemptions and permits, camera enforcement, geofencing and intelligent speed assistance. This guidance is also available at: Guidance » Civitas ReVeAL (civitas-reveal.eu).
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1. Introduction

1.1. About the ReVeAL project

Urban Vehicle Access Regulations (UVARs) are one of the tools that can help make cities more liveable, healthier and more attractive for all, and help support the achievements of some of their goals for transport. The goal of the EU Horizon 2020 project ReVeAL is to support cities producing good practice in UVAR and to add UVARs to the standard range of urban mobility approaches across Europe and beyond.

The ReVeAL project supports UVAR implementation in six pilot cities – Bielefeld, Helmond, Jerusalem, Padua, City of London, Vitoria Gasteiz - and has developed a toolkit to help other cities decide what UVARs may be appropriate for them and what to be aware of when implementing, of which this guidance document is part.

To find out more about ReVeAL, please see the ReVeAL website and the ReVeAL UVAR decision support tool.

1.2. What are UVARs?

Urban Vehicle Access Regulations are when motorised traffic access is regulated (or restricted). This can be by banning or charging (certain types of) vehicle or behaviour, by taking space away from motorised vehicles to give to sustainable modes or by changing the road layout to ensure that drivers behave as desired. Common types of UVAR include:

1. low emission zones

2. limited traffic zones

3. congestion charges

4. pedestrian zones

5. parking regulations

6. changes in the road layout such as bus and cycle lanes, or road and parking spaces given for other uses, or to ensure drivers behave as desired (e.g., drive slowly)

More details on UVARs and their different types will be given later in the document, and an overview of Many of the first three types of UVAR can be found on the website www.urbanaccessregulations.eu (see also Figure 1).
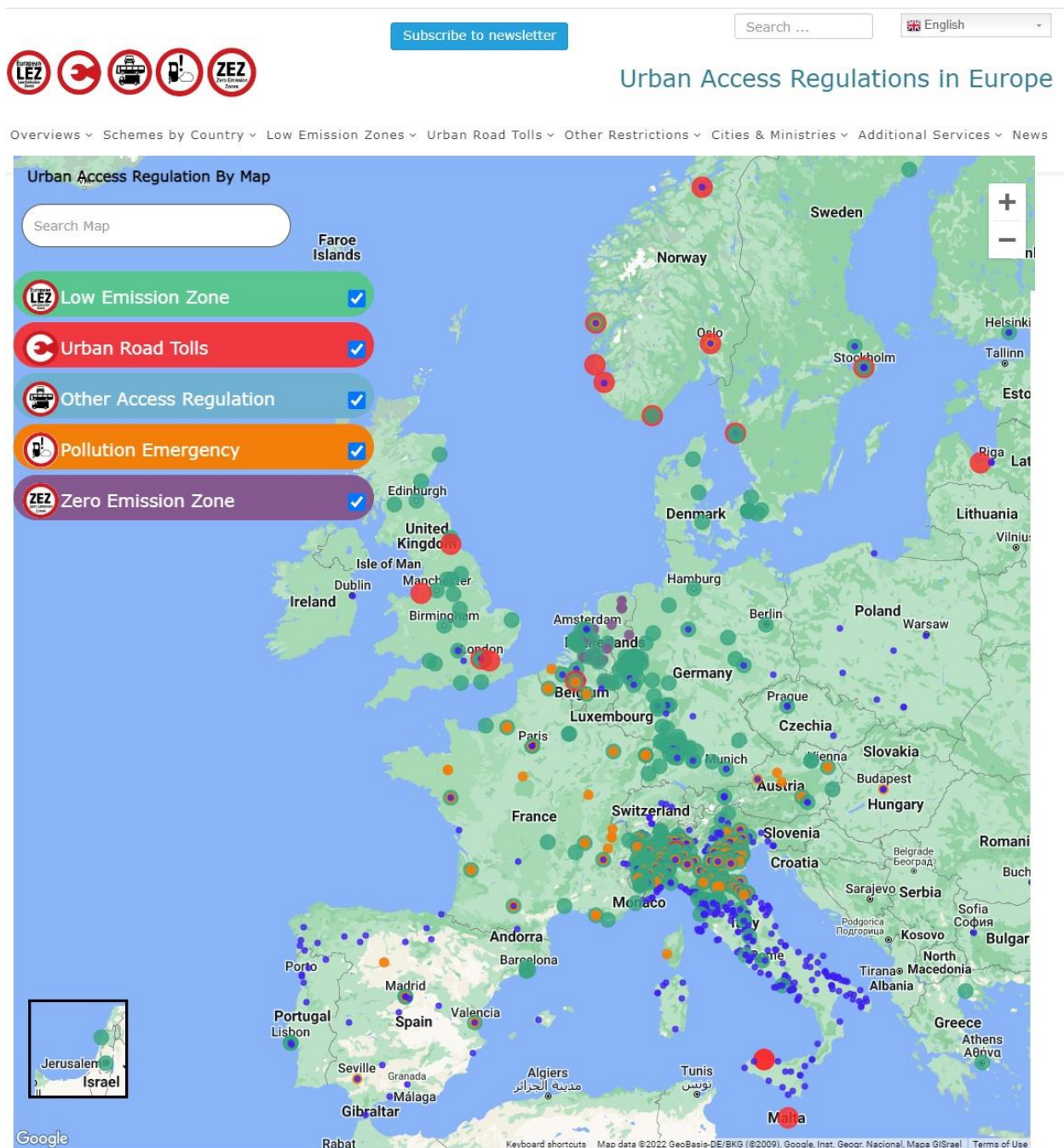
Figure 1: Map of current UVARs across Europe (source: https://urbanaccessregulations.eu)

There are several different definitions of UVAR, some including – or excluding – parking or road layout changes. While the ReVeAL definition includes all of these types, we focus less on parking than on other types as parking is a well-researched field of its own. That said, it could be helpful to consider parking regulations more frequently from a strategic perspective, rather than simply operationally[1].

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[1] See the EU project Park4SUMP: https://park4sump.eu/about/objectives

1.3. Why UVAR?

UVARs focus specifically on regulating motor vehicle road traffic, and all references to, for example, congestion, refer to road traffic congestion (as opposed to congestion on the public transport network). There are many valid reasons to implement UVARs to restrict motor vehicle access to urban areas. These include:

1. **Reducing climate emissions**. Road transport is responsible for 15% of greenhouse gas emissions and is reducing less than other sources. The recent IPPC report[2] calls urgently for stronger measures to reduce transport emissions, stating that "Urban areas can significantly reduce emissions through transition of infrastructure, electrification, sustainable mobility and, e.g., pedestrian zones. Cities can achieve net-zero emissions, only if emissions are reduced inside & outside city through supply chains, that cascade across other sectors".

2. **Reducing pollution**. Pollution kills over seven million people each year[3] – especially the elderly, those with pre-existing health conditions, or even COVID-19 – and causes lung disorders such as asthma in children. It also costs our society 6.1% of global GDP[4].

3. **Reducing urban congestion**. Urban motorised traffic congestion causes delivery companies to send out additional vehicles (which also sit in, and add to, the congestion) and makes journeys and deliveries less reliable. In Europe congestion costs 1% of GDP[5].

4. **Improving the urban quality of life**. Converting road space for motor vehicles into recreational or commercial space results in a much-improved quality of life for residents. In the 1970s, the central squares of many European cities were filled with parked cars. Now much of that space is used for outdoor dining and recreation. The wide consensus is that areas so converted, with outside dining or shoppers as shown later in Ravensburg or Freiburg are far preferable to the town square filled with cars[6], and are more profitable for businesses[7].

5. **Safeguarding urban public space as a valuable resource**. Space is limited in urban areas, particularly in cities, and due to this, the cost per square meter is usually high. At the same time, much space has been given free of cost (or for low cost) for parked and moving personal vehicles. This problem is worsening in many cities with an increase in the number and size of vehicles at the same time as an increase demand for housing in urban areas.

6. **Improve fairness and equity.** People cycling, walking or using public transport travel more sustainably and consume much less urban space. Those who own no car (whether by choice or because they cannot afford one) are effectively subsidising the road space consumption and other costs caused by car drivers. (This issue is discussed in more detail in section 4.7.)

7. **Because sometimes "carrots" simply aren't enough** to achieve a city's goals and the "stick" of an UVAR can be an effective tool to change behaviour. Even if there are good and affordable options available, many people still choose their individual motor vehicle – UVARs can help give a further 'nudge' in the more sustainable direction and make driving less convenient or possible than the sustainable option. Cities cannot always afford to make public transport as cheap as

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[2] https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease/
[3] WHO, https://www.who.int/health-topics/air-pollution
[4] World Bank, https://www.worldbank.org/en/topic/pollution#1
[5] EC, https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_22_559
[6] https://www.sciencedirect.com/science/article/pii/S2352146517309158
[7] https://cleancitiescampaign.org/2021/12/09/why-fewer-polluting-cars-in-cities-are-good-news-for-local-shops-briefing

each as the cost of petrol for the same trip - the cost of the vehicle is often not considered by the user – UVARs can help alter the price.

Most people and companies change their behaviour when the alternative is

1. more convenient or attractive,
2. clearly cheaper, or
3. their current option is not possible or is banned

UVARs can work as one half of an effective pairing of carrots and stick. When the UVAR 'stick' is combined with the 'carrots' of increased public transport, more attractive active mobility and sustainable logistics options, cities have the package they need to invite sustainable behaviour among their citizens.

The need to reduce climate emissions to meet the goals of the Paris Agreement is an increasing driver of UVARs, especially for traffic reducing measures and zero emission zones. While national policies can often improve the general conditions for lower emitting vehicles or fewer individual vehicles through taxes and other incentives, UVARs can help facilitate faster change in urban areas, where sustainable transport and the electrification of vehicles is easier due to generally shorter more predictable journeys and denser networks,

The European Commission outlines UVARs as a way to support many of these goals, in the paper "Reclaiming city streets for people: Chaos or quality of life?[8]", and they support the aims of the European Green Deal[9] and the Urban Mobility Framework[10].

There are ever increasing numbers of regulatory UVARs being implemented in Europe. Over 800 schemes, including around:

- 440 low emission zones (LEZs),
- 450 pollution emergency schemes,
- 18 congestion charge schemes,
- 500 limited traffic zones,
- and increasing numbers of confirmed and planned ZEZs[11].

In addition, most cities, towns and villages have a pedestrian zone, and very many have parking regulations and at least some spatial interventions (road layouts that reduce traffic, speed or parking places). There are also increasing numbers of combined schemes, for example, congestion charging with differential charges for emissions, or traffic limited zones with emissions aspects required for the permits, to enable more flexibility and targeted action where needed.

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[8] https://environment.ec.europa.eu/all-publications_en

[9] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

[10] https://transport.ec.europa.eu/news/efficient-and-green-mobility-2021-12-14_en

[11] Source: www.urbanaccessregulations.eu

1.4. About this document

This document is part of the ReVeAL toolkit, which consists of:

1. This guidance
2. The ReVeAL online UVAR decision support tool (see: www.AccessRegulationsForYourCity.eu)
3. Detailed explanations of the 33 ReVeAL UVAR building blocks (see section 0) and the ReVeAL UVAR building block fact sheets

The different parts of the ReVeAL toolkit are detailed in section 2. The ReVeAL tools offer ideas on the kind of UVAR that might be relevant for a city, and indications of what needs to be considered when thinking about implementing an UVAR. There's no single "recipe" or one-size-fits-all solution, but aspects that are often worth considering. The decisions often need to be taken using judgement while balancing different factors. The guidance is not intended to tell cities which options to use, but rather to help identify the questions to be asked and the factors to be considered in the decision-making process, so they can make the best decisions for their local context.

This purposes of the UVAR guidance are:

- To serve as part of the guidance provided by the ReVeAL UVAR decision support tool, www.AccessRegulationsForYourCity.eu,
- To provide guidance on the process of implementing an UVAR
- To address aspects that are common to all (or at least many) UVARs
- To focus on UVAR-specific aspects (as opposed to broader aspects of sustainable urban mobility) and
- To link out to other valuable resources where they exist.

We work in particular with the following existing documents:

- SUMP Concept
- SUMP Process
- SUMP Guidance UVAR Annex
- SUMP Guidelines themselves, as many of the ways of thinking about the UVAR process development are the same as those described in the SUMP Guidelines.
- C40 LEZ Guidance
- The-7-steps-to-create-effective-low-emission-zones.pdf (cleancitiescampaign.org)
- The Dutch ZEZ Guidance, translated into English here.

This document first explains the ReVeAL project, then looks at the process of UVAR development and finally looks in more detail at the different aspects of designing a good practice UVAR.

2. ReVeAL explained

An UVAR can be a simple or a complex measure. In the ReVeAL project, we break each UVAR down into its component building blocks, to allow an UVAR to be developed that suits your city.

2.1. ReVeAL building blocks and cross-cutting themes

ReVeAL building blocks

In order to understand what a complete UVAR "package" consists of, the ReVeAL project analysed a wide range of UVAR schemes to identify the constituent components of the scheme. 33 UVAR "building blocks" were identified that can be combined to create an UVAR package. The building blocks were categorised into three measure fields: 1) spatial interventions, 2) pricing aspects and 3) regulatory measures, and below that into 12 sub-categories. Building blocks can be combined within or across the three measure fields to create an UVAR package. See Figure 2 for an overview of the ReVeAL building blocks.

For each of the 33 identified building blocks in Figure 2, ReVeAL developed building block fact sheets. Each fact sheet provides a definition, a description of its implementation, which building blocks work well with each other, a case example of its use and other useful information about it. We discuss how to select the appropriate building blocks to create your UVAR in section 3.4.

Spatial interventions

Spatial interventions change the physical space in the city, creating spaces where cars are not able/allowed/easy to pass through. These can include things like roadblocks, parklets or reallocation of road space to walking or cycling or speed limit reductions.

Speed reduction by design

Traffic filter
- Recirculation of traffic (e.g., one-way streets)
- Road block
- Capacity restraint

Reallocating parking space
- Parklet
- Drop-off zone shared mobility
- Logistics bay (mini-hub)
- Kiss&Ride (e.g., school)

Reallocating road space for pedestrian
- Widen pavement
- Pedestrian priority street or zone (e.g., mixed used cycling-pedestrian, residents vs. other groups and temporal pedestrian streets, woonerf or car-free school area)

Reallocating road space for cycling
- Cycle lane
- Cycling street

Reallocating road space for public transport
- Bus/Tram priority lane

Pricing aspects

Pricing aspects are measures that require people to pay for vehicle access to a given area. Pricing can apply to all vehicles in an area (e.g., a congestion charge) or certain categories of vehicles (e.g., a charge based on emissions standards or on vehicle size) and can also include parked vehicles (parking charges). Charging can be flat rate or differential.

Road charges/tolls
- Charge applied to perimeter or area (congestion charge)
- Charge applied to specific points
- Distance-based charge
- Time-based charge
- Permit charge
- Charge based on emission standards (pollution charge)

Parking charge
- Dynamic price (real time)
- Fixed price
- Based on emission standards (pollution charge)
- Workplace levy
- From on-street to off-street parking

Regulatory measures

Regulatory measures restrict the vehicles that have access to a given area using regulations or bans. Regulations may be put in place, for example, to reduce emissions (low-emission zone or zero-emission zone) or the amount of traffic (limited-traffic zone) or to improve safety (regulating by vehicle size or dimension). Non-complying vehicles are not allowed into the regulated area and their owner/users can be punished with a fine if they do enter.

Regulation by emissions
- EURO standard
- Zero-emission vehicles

Regulation by vehicle type/dimension
- Vehicle type (e.g., HDV/LDV, car, van)
- Dimensions (e.g., weight, length, width)

Regulation by trip purpose
- Delivery and logistics
- Through traffic ban (e.g., access to residents and specific users only)

Regulation by permit
- Permit to travel
- Parking permit
- Planning permit conditions (e.g., permit to build car park space)

Figure 2: UVAR building blocks and their categories, as defined in ReVeAL

Cross-cutting themes

ReVeAL has identified four cross-cutting themes – that are relevant to all UVARs (see Figure 3). The cross-cutting themes *user needs and public acceptance*, *governance and finance* and *ensuring compliance* are described in detail in section 4, while *complementary measures* are discussed in this section. Complementary measures are cross-cutting in the sense that all UVARs need them, but the measures themselves are discrete measures that need to be combined with an UVAR, once a draft scheme has been developed.

Complementary Measures
Supporting measure to ease compliance, facilitate adaptation, and minimise equity and undesirable impacts

User Needs and Public Acceptance
Ensuring that the scheme meets user needs and is well accepted by citizens

Governance and Finance
The administrative frameworks and mechanisms

Ensuring Compliance
The tools and methods used to ensure that people can comply with the UVAR scheme

Figure 3: ReVeAL's four cross-cutting themes

The relationship between building blocks and cross-cutting themes can be visualised in **Error! Reference source not found.** below.
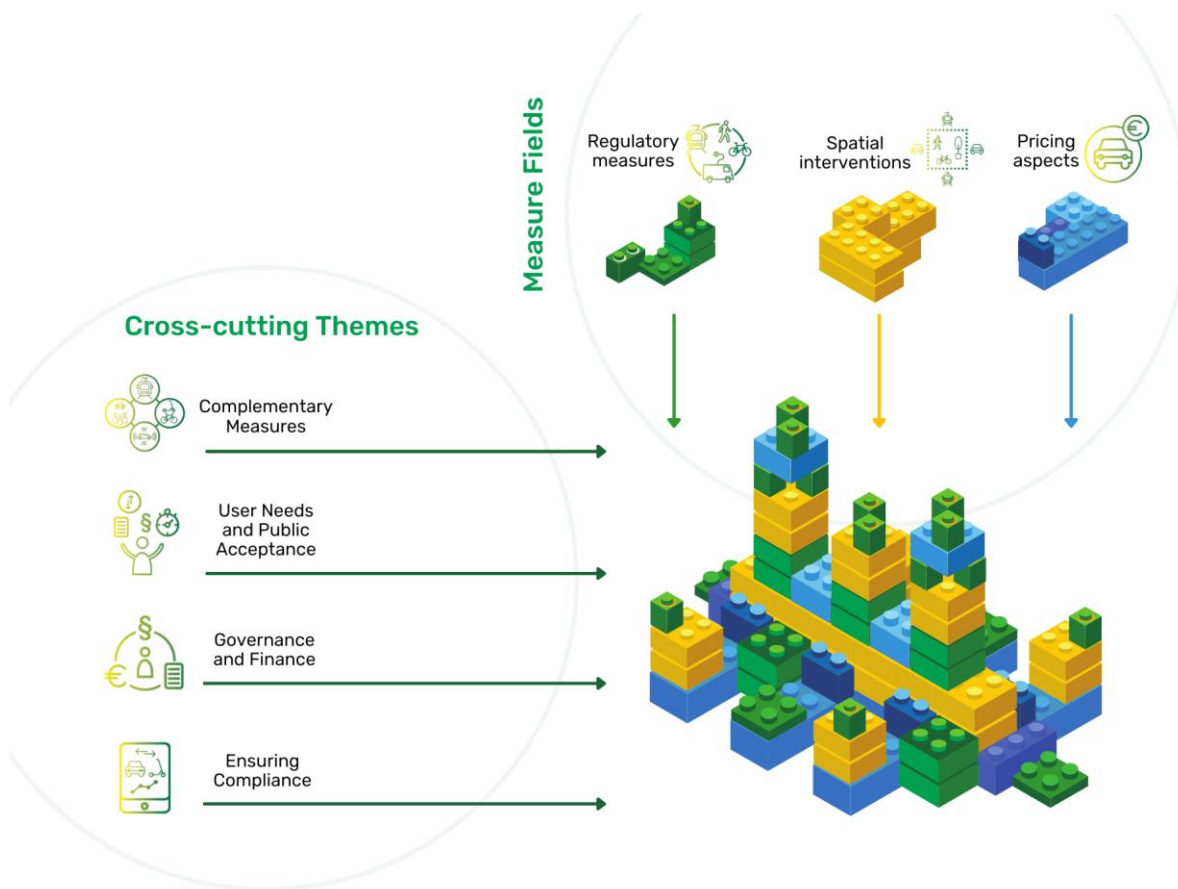
Figure 4: How the components of ReVeAL fit together

2.2. Complementary measures

A supportive complementary measure is an additional measure that complements a planned UVAR to ensure access of people, goods or services into the UVAR area while maintaining the goals of the UVAR, easing compliance and facilitating the best adaptation to the new reality. It can also serve to minimise any equity issues that may result from the measure it complements.

Complementary measures can be crucial to making an UVAR feasible and successful. The planned UVAR should be implemented with an integrated package of supportive complementary measures to improve cost effectiveness and the performance of the UVAR with respect to the declared goal and specific objectives. Complementary measures can, for example, enable trips to be taken by transport modes not affected by the UVAR, facilitate a higher level of compliance or help to avoid a disproportionate impact on disadvantaged groups.

Complementary measures can also increase public acceptance by showing citizens that the UVAR is not just about requiring a change in mobility, but that it is implemented as part of a full package that provides concrete solutions to those who are asked to change their behaviour.

ReVeAL has identified four categories of complementary measures. These are:

1. Complementary sustainable mobility measures

- Examples include additional public transport, increased or improved walking or cycling facilities, a consolidation centre, cycle logistics, micro-mobility, mobility hubs for different forms of shared mobility, a shuttle bus for those with reduced mobility or additional parking outside the zone[12]

2. Financial or in-kind incentives

- Examples include grants for retrofits or exchanging parking/access permits for sustainable mobility vouchers

3. Exemptions

- Examples include vehicles for people with disabilities, emergency vehicles, and – especially during the introductory phase – residents. For further details on exemptions, see section 5.3.

4. Organisational support or other solutions based on the local situation

- Examples include pilot projects to support adaptation to the UVAR, linking service providers to one another, adapting the UVAR operating times or organising joint procurement[13] .

Supportive complementary measures can be added to and selected with the UVAR building blocks and can work as paired carrot and stick measures to encourage more people towards the desired mobility behaviour. The UVAR is the stick while the supportive complementary measures are the corresponding carrot. The overall scheme should include a balance of rules and restrictions together with services and opportunities that accompany them. The main thing to keep in mind is that the accessibility *of people and goods* is enabled, even if it is not with individual vehicles.

2.2.1. Complementary sustainable mobility measures

Complementary sustainable mobility measures refer to the mobility schemes and related services that may be needed to help an UVAR to reach its full potential. Such measures aim to introduce, accelerate or maximise significant changes in mobility patterns or mitigate possible negative impacts of an UVAR implementation. They should make up a coherent package of accompanying or interlinked measures that support the restrictive nature of a specific UVAR scheme by making access to the area by other means easy and attractive. Such mobility measures can be classified into the following categories:

- Improvements in public transport
- Enhancement of cycling and walking
- Changes in parking system
- Enhancement of shared mobility

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[12] There are SUMP topic guides on the implementation of many sustainable mobility measures. Sustainable urban logistics planning, micromobility, active mobility and electrification may be particularly relevant; all have SUMP topic guides. See www.eltis.org/mobility-plans/topic-guides. For logistics measures, there are the Sustainable Urban Logistics Plans (SULP) Guidelines. Additional guidance on parking can be found at Park4SUMP.

[13] examples of complementary measures, including organisational support are given in the Dutch Zero-Emission Zone Support Framework, also translated into English
https://drive.google.com/drive/folders/1rp-fNiBilxPcDf9d-vaIXxcAUqqZhRGH?usp=sharing

- Improvements in urban logistics
- Zero and low emission vehicles
- Ticketing and digital support

Ideally, complementary sustainable mobility measures are put in place at the same time as, or before, the UVAR scheme goes into operation. In addition, you may find after the implementation that some groups of citizens are unintentionally disproportionately affected by the UVAR scheme. In such cases, additional mitigating measures may be needed to compensate for this.

Context is essential when selecting complementary sustainable mobility measures to accompany your UVAR. Even before you have selected a particular UVAR, you should consider things that might affect the additional sustainable mobility services including:

- Main characteristics of the area in question: historic, touristic, industrial, financial, mainly residential, etc.
- The role of the city in the region (e.g., core city of a functional urban area, "feeder" town in a functional urban area, a city without an agglomeration, an independent town)
- Whether there are lots of visitors entering the city, and whether these are regular or occasional visitors
- Urban and demographic structure
- Environmental, economic and social variables (air quality, fleet composition, road safety impacts, population age, etc.)
- Current modal split
- Parking available outside the zone

It's important to keep in mind that the introduction of a UVAR will also impact those who live outside the city but visit it regularly for key activities such as work, health or education.

Example: Area C, Milan

In 2012, Milan introduced the congestion charge scheme, Area C, replacing its previous "Ecopass" pollution charge. The congestion charge is a €5 fee for vehicles entering Milan's city centre between 7:30 and 19:30 (Monday to Friday) and is applied to an 8.2 km² area.

The scheme introduced a number of complementary measures. These included **pricing integration** of the access fee and the on-street parking fee for service vehicles[14] (e.g., maintenance or construction), **urban consolidation centres** for the reorganisation of last-mile delivery, a supply of **reserved bays for the loading and unloading** of goods and **20-minute free parking** on paid parking spaces for loading and unloading[15].

Improved public transport was introduced at the start of the congestion charging scheme, with an increase in capacity of 75,000 passengers daily thanks to better services in metros, buses, and trams. Two more trains were added to the M1 line and one more train to the M3 (5% more capacity), frequencies on bus lines travelling to the city centre were increased and the peak-hour frequency was extended until 10:00. More staff was also temporarily employed to assist passengers.

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[14] https://www.comune.milano.it/servizi/pass-per-la-sosta-gratuita-non-residenziale
[15] https://www.comune.milano.it/servizi/area-per-carico-e-scarico-merci

Thanks to the Area C, and partly using its revenues, in 2013 over €13 million were allocated to the further development of metro lines, trams and buses and for the implementation of the second phase of the Milanese **bike share system**. At the same time, the municipality also financed a **P&R facility**, new **30 km/h zones** and an **upgraded cycle network** to help promote sustainable mobility.

Any income gained from Area C is ringfenced for sustainable mobility measures.

Example: circulation plan, Ghent

The circulation plan of Ghent is part of a larger mobility plan devised in 2012 in response to the rising amount of car traffic inside the inner-city ring. To prevent people from (needlessly) driving through the city centre, the circulation plan divided the central area into six separate zones (separated from one another by traffic filters) plus a car-free zone in the city core that is regulated as a limited traffic zone (with no on-street parking).

The City of Ghent also provides a free shuttle service between the city centre and two **Park and Ride facilities** on the outskirts of the city. The nine-seat minibuses connect to the city centre in less than 15 minutes. The frequency is between 10 and 30 minutes and the minibuses are active Monday to Saturday between 7:00 and 22:00 (midnight on Friday and Saturday) plus on shopping Sundays.

Other complementary measures include **on-street parking** immediately outside the car-free area **exclusively reserved for residents** (resident parking zones), **cycle streets** where cars may not overtake bicycles and about 7,000 **bicycles available for rent** at several bicycle points (some also served by the shuttle bus).

2.2.2. Financial or in-kind incentives

Financial incentives are intended to make compliance easier, facilitate the most beneficial compliance method and address possible inequities. Incentives can be either cash or, preferably, vouchers for sustainable mobility provision. Examples include:

- Financial subsidies for fleet renewal (e.g., purchase, rental or leasing of greener vehicles, including tax exemptions or grants),
- Membership or vouchers for sustainable mobility options (e.g., discount cards, free rides or annual passes for public transport, shared mobility or consolidation centres)
- Monetary incentives for cycling (e.g., incentives for cycling to work or for the purchase of an (e-)cycle or (e)-cargo bike),
- Grants towards retrofits (e.g., diesel particulate filters[16], a new engine or fuel conversion) or
- Compensation (either financial or through a voucher) for the scrappage of an old vehicle – often differentiated by emission standards, vehicle type or owner income.

Many national, regional and local authorities have grant programmes to help fund the purchase or lease of electric vehicles, or the retrofitting of diesel particulate filters which can serve as complementary measures to the city's UVAR. Private companies, such as car dealers or micromobility operators, sometimes use the UVAR to trigger their own incentives, for example targeting new fleets with specific marketing and prices for UVAR-compatible vehicles.

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[16] This can also have the advantage of reducing emissions more significantly than a later Euro standard.

Example: mobility vouchers to mitigate adverse effects in Bologna

To accompany and support the addition of an LEZ to its existing LTZ, the municipality of Bologna introduced a tailored **mobility bonus**. Residents who opt for public transport, taxi, ride hailing, car sharing and bike sharing and who turn in an LTZ access permit, will receive a yearly financial voucher of:

- €1,000 per family if they turn in 2 permits associated to EURO 0 vehicles
- €700 per family if they turn in a sole permit associated to a EURO 0 (not if a Blue Badge)
- €500 per family if they turn in 1 permit associated to a EURO 0

The voucher can only be used for other sustainable mobility options. Via a dedicated website, residents can choose which amount of the voucher they want to use on which mobility option(s). The maximum duration is two years. Residents over age 70 can choose between the voucher and a 10-year free pass for the urban public transport network.

Bologna has also launched a funding scheme addressed to all residents and local companies who decide to buy a new e-bike (€500) or cargo bike (€1000), covering up to 50% of the total purchase cost.

Example: London's guidance documents

Many supportive mobility measures are focused on awareness raising, guidance and improving alternatives to the private car to encourage the phasing out of the most polluting vehicles. Measures include improvements to public transport and walking and cycling networks and the ultra-low emission zone scrappage scheme, which allowed those on low incomes to scrap their vehicle for a one-off payment. Drivers also had the option to access a range of special discounts and deals such as a year's free membership for the city's popular Santander bike hire scheme. Another example is the City of London's guidance for managing deliveries and servicing.

2.2.3. Exemptions

Exemptions can be used to make compliance easier and, when used carefully, they can help mitigate the impact on certain disadvantaged groups (e.g., people with a disability) or for emergency vehicles. Exemptions should be as few as possible and clear and transparent. Introductory time-limited 'sunset' exemptions can be useful.

Examples include:

- key exemptions (e.g., police, fire department, waste collection, etc.)
- user needs exemptions (e.g., taxis, residents, deliveries, people with a disability with forced car dependence)
- exemptions for adapted vehicles (e.g., retrofitted, converted or re-engined electric or hybrid vehicles)
- a limited numbers of purchased exemptions (e.g., a given number of entries per day/month/year, access to a specific zone, a quota of allowed kilometres to drive in the zone or "credits" allocated to individuals or businesses)

The types of exemptions will be different depending on the scheme type. For more details on exemptions see section 5.3.

2.2.4. Organisational support or other solutions based on the local situation

Such specific complementary measures can be logistical, administrative, promotional or other types of support that the city is in a position to provide. They might include supporting an alternative business model, for example, for a car park that will have no / fewer customers because of the city's choice of

UVAR measure. A city could also undertake projects to support the changeover to sustainable mobility, such as free trials of cargo bikes or shared electric vans, promoting a new e-scooter operation, or individual solutions to resolve specific local issues. It might also include promotional activities to encourage the take-up of people-friendly mobility option, or to make people aware of the problem the UVAR is addressing (see the example of Jerusalem in see section 4.4.2). Support could also entail changing the operating hours of the UVAR to enable certain groups access by car. For example, London moved the end time of its congestion charge from 19:00 to 18:00 so as not to affect the evening entertainment sector. Examples of organisational support used as complementary measures in the run-up to the Dutch ZEZs can be found on their website[17].

3. Getting started with your UVAR

3.1. Assessing the current situation to identify the problem

The first action of any UVAR development is to assess the 'business-as-usual' situation (i.e., what will happen if we continue on the same path). This helps identify the problem, what needs changing and which vehicles will be affected. For example: is the problem caused by commuters to the area or through traffic? Is it caused by light or heavy-duty vehicles? What sustainable mobility options are available for access to the potential UVAR area(s)?

Many different sources and expertise on assessment are available; if it is lacking in the authority, it should be acquired. The SUMP guidelines can give a good start, and you may find the ReVeAL process evaluation and impact assessment framework useful.[18]

The amount of assessment needed will vary; a large controversial scheme in a large city will need more extensive analysis than a small more consensual UVAR. Usually in these assessments existing data is assessed, including, but not limited to:

- Motorised traffic flows, speeds, congestion, origins, destinations (possibly including the amount of through traffic or the number of commuters)
- Data on sustainable mobility, including cyclists, pedestrians and sustainable logistics
- Traffic composition (including data from automatic number plate recognition or manual counts)
- Air quality, climate or noise emissions inventories to assess the most significant sources
- Road safety data
- Demography of the area and its surroundings
- Land use of the area and its surroundings

The collection and analysis of data at the level of the functional urban area (FUA)[19] can be relevant, as many towns and cities receive significant amounts of traffic from outside their jurisdiction, where there may be fewer sustainable transport options into the city.

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[17] Or https://drive.google.com/drive/folders/1rp-fNiBilxPcDf9d-vaIXxcAUqqZhRGH?usp=sharing translated into English

[18] It can be downloaded from the ReVeAL website here: https://civitas-reveal.eu/wp-content/uploads/2020/08/D4.1_Evaluation-framework_191129.pdf

[19] A functional urban area consists of a city and its commuting zone. Functional urban areas therefore consist of a densely inhabited city and a less densely populated commuting zone whose labour market is

Questions relevant to the assessment include:

- What kind of change is expected to be triggered by the UVAR?
- What types of vehicles or users will be affected by the UVAR (long/short distance commuters, students, access to residential or commercial areas, large or small deliveries, residential or commercial delivery, etc.)?
- Which mobility / accessibility (or other) issue(s) may arise from the implementation of the UVAR? What unintended impacts are possible?
- How can the desirable changes be facilitated?
- How can undesirable consequences be minimised, especially for those on low incomes, those coming from outside the city area and the FUA, people with disabilities or with health needs?

Travel from outside the city can make up a significant proportion of car trips, as sustainable mobility options are often less available.

3.1.1. Assessing the impact of different options

Assessing the different scenarios can help in selecting between them. It is also needed as part of the consultation process. The most common way to do this is to model the situation both before and after the UVAR has been implemented, under the same conditions. The "before" situation can be validated by data; assumptions will be needed for the "after" situation, which should be based as much as possible on data. In early stages of choosing among different options, an indication of the scale of the impact may be useful (for example from +++ to --- for different parameters or indicators.

Neighbouring areas or authorities may be concerned that the UVAR could negatively impact them, however the UVAR may also improve the situation in the areas around the UVAR. For example, the positive impact of any journey that changes to cycling or public transport or to a lower emission vehicle will also be felt in the surrounding area. Modelling and assessments help estimate the impact; these can either reassure stakeholders or highlight areas where complementary measures are needed to minimise negative impacts that the UVAR might cause.

Examples of pre-assessments include from the Dutch ZEZs[20], Oxford's ZEZ[21], and London's LEZ and ULEZ[22] might be useful as illustrations.

3.2. Your goal

The second step in developing an UVAR is to clarify the goal(s) that you aim to achieve by implementing it. An UVAR may help with many aspects of the city's strategies, and it is useful to clarify which *main goals* the UVAR should achieve. For example, reducing traffic volume will likely also improve air quality and reduce noise, climate emissions and congestion. It may also increase walking,

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highly integrated with the city (OECD, 2012). https://www.interreg-central.eu/Content.Node/Dynaxibility4CE/UVAR-Topic-Guide.pdf gives guidance on UVARs in the FUA context.

[20] https://drive.google.com/drive/folders/1EvyCYqk723Q5nYi7JHhmzmAqEs30GmxR?usp=sharing

[21] https://www.oxford.gov.uk/download/downloads/id/4019/zero_emission_zone_feasibility_study_october_2017.pdf

[22] Assessments of the LEZ: https://tfl.gov.uk/corporate/publications-and-reports/low-emission-zone and ULEZ: https://tfl.gov.uk/corporate/publications-and-reports/ultra-low-emission-zone

cycling and public transport use, improve safety and enable more liveable space, all of which may be city goals.

There are several factors that might affect the goal of the UVAR, including:

- the main mobility-related problem in the city,
- how the scheme is perceived and communicated, and therefore accepted (see section 4.4),
- the national law under which the UVAR is implemented
- an UVAR often requires a clear legal justification in the form of an identified goal that can be measured as having been met. If this is not the case, the UVAR may be vulnerable to legal challenges

It is therefore wise to have one main goal for which the new UVAR is being implemented and acknowledge that it will support other aims as well.

3.3. UVAR development phases

UVAR development can be seen in four phases, which are described below (see also Figure 5).

1. Idea development

Here, the clarification of the goal the UVAR should be achieved. This stage should consider the type of UVAR, possible building blocks, an assessment of the existing situation and feasibility studies. The idea development phase ends when a political decision is made in principle to implement the scheme, a shortlist of options is created from a wider selection and a design, and any complementary measures, have been outlined.

2. Design

Once the outline of the scheme has been created, the details need to be worked out. It may be that two options need to be assessed in more detail and a decision made between them. The designing of the required complementary measures would be included here. The design step ends with a political decision to implement a specific set of UVAR building blocks and complementary measures

3. Implementation

The implementation phase prepares to put the plan into action. This will include making detailed plans, putting in place necessary legal changes, making the physical changes to the street, setting up any back-office systems, training staff, communicating the final scheme widely so that affected people can comply. If a pilot is considered, this could be implemented in this phase – or in the next phase if it requires more planning. The implementation phase ends the day the scheme starts.

4. Operation

The operation phase includes enforcing and monitoring the scheme, as well as periodically reviewing it, to ensure that it is still fit for purpose. This phase ends only if the scheme is removed or there is a decision to update or change the scheme. An update or change would mean returning to step two.
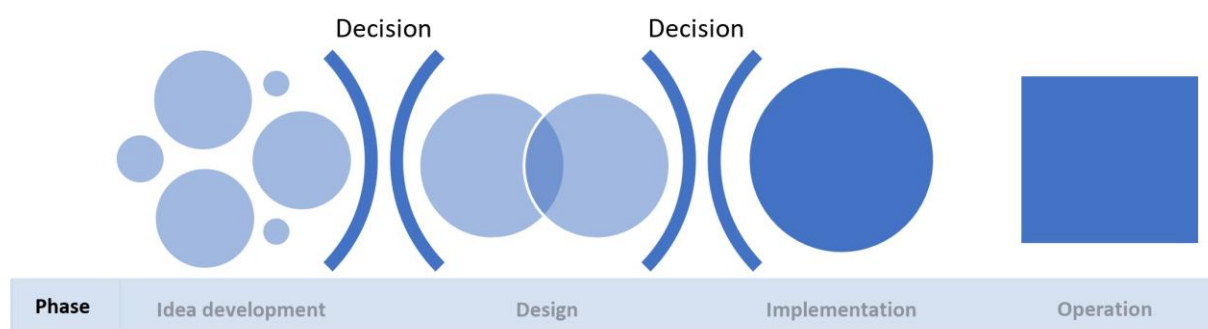
Figure 5: Four steps in the UVAR development process

The different phases described above can be useful to gain a clear picture of the process. At the idea development stage, many options are still open. In the design stage, the most promising ideas are developed further. In the implementation stage, a clear single UVAR "package" emerges, and the many details are worked out. In terms of what is done in each phase, there is no simple answer, as many of the activities in the UVAR development process are relevant in more than one – if not most – phases. And of course, an UVAR package is not developed and implemented in a vacuum. It needs to be incorporated and aligned with the many ongoing processes and existing plans in a city. That's to say, the process is a fluid and iterative one, and decisions are often not clear cut.

Many of the issues detailed in this guidance arise in several different UVAR development phases. For example, assessment and monitoring are needed in idea development (to understand the problem and therefore what needs to be changed), in the design stage (to estimate the impact), in the implementation stage (to get a more detailed assessment of the impact of the chosen scheme) and during the operation stage (to assess success and identify if/when changes are needed).

3.4. Selecting building blocks

Developing an UVAR is best done using a participatory process. One way to approach the process is through a series of workshops with selected stakeholders to select the building blocks (and then complementary measures) that are most appropriate for the city's UVAR.

Different stakeholders will need to be engaged in the process, both to ensure that all aspects are considered, as well as to gain buy-in for the scheme. Stakeholders range from colleagues from different departments in the city authority, politicians, different layers of government and many different aspects of society, (see further details in the Stakeholder involvement section 4.2). As with many things, a balance needs to be struck; you and your colleagues know your city, its stakeholders, and the context of the UVAR development best. Even if there is no or little history of participatory development in the authority, it is worthwhile trying it.

Involving stakeholders early in UVAR discussions will likely be better received than presenting them with a completed scheme; early involvement enables them to understand the purpose, offer constructive comments and help inform the development of the scheme, rather than being faced with a finished scheme to criticise. An UVAR development process that is and, importantly, is also *seen as*, transparent, open and fair can help increase public acceptance and ensure that legitimate (see section 4.3) are appropriately accommodated. Ensuring an inclusive UVAR development process helps achieve this.

Carefully considering the groups that you gather feedback from will ensure that your scheme is equitable and reflects the needs of the people who will be affected by it. This includes representatives

of groups that may have particular needs, such as people with disabilities, the elderly or parents with children.

Workshop participants need to be informed about the process and the building blocks, as well as the current assessments that have been undertaken of the city/area, so they are in a position to make decisions. The REVEAL building block fact sheets clearly explain the building blocks and provide concrete examples to ease this process. Making the materials available in advance is useful to achieve this, as well as introducing them in the first workshop.

During the workshop, each participant ranks each building block in terms of how relevant they feel it is for the area under consideration for an UVAR. After this, a discussion among the participants of their choices, and the reasons for them, is useful. The different perspectives and opinions expressed may impact a participant's initial choices and they may want to modify the rank given. Another round of workshop(s) might be done after making a shortlist of options, after combining different views and assessments, and / or with different workshop attendees.

The ReVeAL project also created an online decision support tool, which is intended to help users identify which UVAR building blocks might be appropriate for their local context. The online tool can help by steering the user to a combination of different UVAR building blocks that may become the basis of an UVAR package that suits the city. The ReVeAL decision support tool can be used to help participants identify the building blocks with the highest potential for success in their situation. One way to use the tool: in a first workshop, participants discuss building block options and comes to a general agreement on some that may be valuable. In a second workshop, the participants use the ReVeAL tool to see if it offers any new options. The differences and similarities can be compared and discussed.

Whatever format is used, the highest ranked building blocks would be selected, the aim being combined to create a coherent UVAR package. When deciding between different options, an estimate of the impacts of the options may be needed – with indicative impacts at early stages and later rounds of assessment being more detailed. The selection may need to be reviewed, and steps repeated depending on the combinations selected, or assessments undertaken.

Ideally, these processes will lead to two or more different "packages" of building blocks for the project area or different areas, where different building block combinations, geographic scales, timing or implementation conditions are considered. These scenarios can then be assessed in more detail during the design phase in order to choose between them.

3.5. Selecting complementary measures

A complementary measure is an additional measure that complements a planned UVAR to ensure access of people, goods or services into the UVAR area while maintaining the goals of the UVAR, easing compliance and facilitating the best adaptation to the new reality. It can also serve to minimise

any equity issues that may result from the measure it complements. It is useful to keep these in mind even at early stages of UVAR development; as they may make a building block possible or acceptable that otherwise would not be. They can also facilitate a more sustainable adaptation to the UVAR, reduce any undesired negative impacts on certain sectors of society or enable essential transportation needs. The need for complementary measures may arise from the project inception, in assessments, stakeholder workshops or through an understanding of the cultural, social and political situation in the city.

The UVAR should ideally be integrated into the city's SUMP, which helps combine the planned mobility measures to maximise the impact of an UVAR. When deciding which complementary measures will accompany the UVAR scheme, it is also useful to consider any relevant measures that are foreseen for the future to determine if these could be brought forward to support the UVAR.

Questions that were relevant during the assessment (see section 5.1.2) are likely to be relevant in considering which complementary measures are needed.

As with selecting building blocks, selecting complementary measures should be done in using participatory processes and consultation with different communities. When selecting a specific complementary measure (or a package of measures), it is important to consider:

- How will the complementary measures respond to the issue(s) arising from the implementation of the UVAR measure?
- Does the implementation of the planned complementary measure (or package of measures) address the actual user needs? (see user needs in section 4.3)
- Is the timing appropriate? (i.e., before the UVAR is implemented, or at the time it is implemented)
- Has the planned supporting measure been used in the past elsewhere in this or similar cities? Was it successful?
- Does the city have the competence and resources to implement the measure? If not, who else needs to be involved?

"IT'S A CLEAR EXAMPLE OF PUSH AND PULL. THE NEW [THREE TIMES HIGHER] PARKING PRICES STARTED ON THE SAME DAY AS THE NEW BUS NETWORK WAS IMPLEMENTED."

Juan Carlos Escudero, City of Vitoria Gasteiz

There will also be the question whether, and how, to accommodate which groups – as many of those affected may call for special treatment. Decisions on legitimate concerns vs. self-interested desire to avoid change need to be made based on evidence and moral, political and operational concerns informed through stakeholder engagement[23]. In the London congestion charge, no concession was made for the Smithfield meat market workers, for example. However, the end time for the daily charge was brought forward from 7 pm to 6 pm to avoid the evening shifts of theatre and restaurant staff and address wider concerns about the evening economy[24].

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[23] The issue of who to give special treatment is also discussed in the stakeholder engagement section 4.2
[24] https://www.c40knowledgehub.org/s/article/How-road-pricing-is-transforming-London-and-what-your-city-can-learn

4. ReVeAL cross-cutting themes

As described in section **Error! Reference source not found.**, ReVeAL has identified four cross-cutting themes that are relevant to all UVARs (see Figure 3 and**Error! Reference source not found.**). The cross-cutting theme *complementary measures* is described above. The themes *user needs and public acceptance*, *governance and finance* and *ensuring compliance* are described in this section.

4.1. Governance

For ReVeAL, good governance implies transparent procedures for policy and project design, project management, procurement, financial management and allocation of revenues at the local level. In many cases, policy and operational coordination is needed between different levels of government affected by the UVAR.

At its best, effective governance translates into professional project management of the UVAR scheme, with accompanying measures (short and long term) institutionally anchored by means of a specific agency/authority, different agencies working together or through the establishment of public-private partnerships.

Key aspects include:

- Decision-making context
- Legal frameworks (national and local)
- UVAR-specific EU legal issues
- Institutional setting and organisational arrangements
- Policy frameworks and planning instruments
- Political instruments
- Enabling sufficient resources (human and financial)
- Integration and interaction of cross-cutting themes (including champions; see below)
- Communications

Each of these is discussed in more detail below.

4.1.1. The decision-making context

Understanding the decision-making context is a key step to understanding the governance opportunities and challenges behind an UVAR. When assessing this, some of the questions that need to be answered are:

- *Who makes UVAR-related decisions?* Identify the leading councils, elected leaders, civil servants, etc. in the UVAR process, at the local level as well as the regional and national levels.
- *Who formulates technical solutions?* Identify the leading technical employees within the city, including planners, engineers, transport designers, and the leading external or contracted technical experts in the UVAR project.
- *What is the approval process and who is involved?* This could be horizontal within the local government or vertical among the different levels of government.
- *Which are the leading voices and organisations that affect the UVAR project (both supportive and opposing)?* This could include civil society, citizen-led groups or residents, business associations, opposing political parties, etc.

- *Is there a champion[25] leading the process from within the authority or pushing it from outside?* This can significantly increase the success of the scheme, especially if it is a leading politician. When introducing a new policy to the public, this can be a critical factor in success.
- *What is the estimated level of participation /opposition from the public and are they any particular groups that are particularly relevant?* Such groups should be identified, and communication established.
- *How is the UVAR process to be managed across different government departments within a municipality and regarding the interface with other government agencies?* It is important to have one body that is clearly seen as the "lead" and communications core.

When implementing UVARs, it is important to have the electoral cycle in mind (including elections, the beginning of a campaign, decision-making standstills before and after elections, etc.) and how it could impact the UVARs. It helps to try to foresee if the UVAR will be implemented within the electoral period of those deciding the scheme. The greatest resistance to a scheme generally arises around the time of implementation (see the public acceptance section 4.3), so there is a significant advantage of the scheme being implemented at least a year before the end of the legislative period so that the changes can be accepted and the improvements acknowledged before the next election. If the scheme cannot be implemented within the electoral period, will the scheme have sufficient cross-party support to be implemented over more than one electoral period? Another (riskier) option is to complete detailed preparation in one electoral period and for the politicians to seek re-election on the basis of its implementation in the next period.

Different organisations can influence decisions related to the UVAR lifecycle. These include both public administrations (e.g., city council, regional government, national government), as well as expert commissions, political parties, interest groups or other stakeholders. The interests, concerns and needs of different groups must be considered from the early stages to make an UVAR a success. As discussed in the stakeholder involvement section (4.2), it is important for involvement to be with a full cross-section of society, including women, youth, the elderly and people with disabilities, who may otherwise be under-represented in discussions.

4.1.2. Legal frameworks

It is crucial to determine from an early stage whether national legal frameworks or guidance[26] exist for the implementation and efficient enforcement of the selected UVAR. Some of the possible issues include the right to ban certain vehicles from an area or charge them to be there, the use of automatic number-plate recognition for camera enforcement, sending fines, identifying complying vehicles or the use of transponders. The requirements for its financial management, personal data protection, tendering and procurement must also be established.

It is also important to know if new local regulations are needed to implement the UVAR, or whether new or altered national legislation is needed. Sometimes mechanisms can be (legally) used for purposes for

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[25] Champions are people willing to invest their resources in return for future policies they favour. Their motivation may be a concern about certain problems, the promotion of policy values, professionalism, or simply the satisfaction of participating. Champions can be elected officials, civil servants, activists or journalists, groups or individuals. The presence of an appropriate and skilful champion can improve a measure's chances of moving up on the agenda if this figure makes the critical 'couplings' when policy windows open, as well as being publicly acceptable by setting the tone of the discussion. A city staff member plus a politician or political group, can make a good champion team.
[26] For example, the Dutch logistic ZEZ Roadmap

which they were not designed; for example, the Italian limited traffic zone legislation allows cities to add conditions to gain access. This makes it possible to turn those LTZs into other schemes or combined schemes. For example, an LTZ can become:

- an LEZ, where the only access conditions is meeting the emissions standard
- a congestion charge, when entry is upon payment,
- a combined LTZ-LEZ, where vehicles are limited by the LEZ and those vehicles that are permitted must meet emissions standards
- a toll-LEZ as in Milan's Area C[27].

Another example in London is the existing congestion charging legislation was also used to implement London's LEZ and ULEZ, with high "charges" for non-compliant vehicles (which could also be seen as a fine and daily exemption permits).

There are often different ways to implement an UVAR (and complementary measures), so it is important to identify the most appropriate one for your local context. For example, Berlin's low emission zone bans non-compliant vehicles – and then charge a fine for non-compliance. On the other hand, Oslo uses a road toll for its LEZ[28] that varies with emissions and removes road space for vehicles in its ZEZ[29]. A large car-free area with spatial interventions can be used instead to create a (nearly) zero emission zone if the legal framework for a zone that bans combustion engines is not available. It may then be possible to put conditions on, for example, delivery and other vehicles entering the area, requiring them to be zero emission.

It might be difficult to put a new UVAR in place within an existing legal framework, and creativity might be needed. Examples of non-standard processes include using existing legislation for a slightly different (but still allowed) purpose, the use of a trial or experimental traffic regulation orders or the use of voluntary compliance – or a combination of these. Within ReVeAL, both Bielefeld and the City of London used experimental traffic orders to test an UVAR in real life, before committing to it. It should be noted that further traffic order processes would be needed to continue the scheme beyond the experimental period, and the monitoring and assessment requirements of the different options can be different.

As a different approach, Jerusalem worked with local and national legislators to update the local and national legal frameworks to allow it to use camera enforcement for its LEZ. Changing the law is possible, but not easy and therefore not the first choice. All other avenues should be pursued before choosing the route of changing the legislation. Voluntary schemes should be used with caution, due to their low compliance rates.

When there is more than one scheme of a certain type in a country or region, there is significant advantage to having as much commonality as possible among them. This leads to greater acceptance and avoids the confusion and annoyance to drivers of slightly different schemes. Regional authorities in German and northern Italy harmonised their LEZs. In Germany, common emissions standards were set for all cities with an LEZ in their region. In northern Italy, there are LEZs in all cities with more than

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[27] See further information in section 2.2 or https://urbanaccessregulations.eu/countries-mainmenu-147/italy-mainmenu-81/milan-area-c-charging-scheme
[28] https://urbanaccessregulations.eu/countries-mainmenu-147/norway-mainmenu-197/oslo-charging-scheme
[29] https://urbanaccessregulations.eu/countries-mainmenu-147/norway-mainmenu-197/oslo-zero-emission-zone

30,000 inhabitants. This was done to ease communication and understanding, and to avoid concern from the retail sector that shoppers would go to the neighbouring (non-restricted) city.

Cities new to UVARs would be well advised to first identify whether there are models elsewhere that might be suitable for their city, and to work with the national level of government, and/or with neighbouring cities or countries to reduce the number of different schemes. New UVARs should be as similar as possible to existing schemes, differing only when needed. Road user or congestion charges usually need their own specific legislation. All schemes need appropriate legislation, but there can sometimes be flexibility on which legislation is used.

EU legal issues

The aspect of EU law that most affects UVARs is the EU Freedom of Movement Principle, one of the key aspects of the EU treaty. In terms of EU law, an UVAR is a potential barrier to trade, but depending on how it is implemented, it can be justified under Article 30 of the EC Treaty, which provides an exhaustive list of grounds for exemptions from the Freedom of Movement Principle, one of which is the "protection of the health and life of humans, animals and plants".

The other two aspects of EU law that affect UVARs are the *proportionality and non-discriminatory principles* – so schemes must be proportional to the problem, and not discriminatory. This means in practice that:

- UVARs should not be any harder for foreign vehicles to comply with than for vehicles of the home country. Information on the UVAR should be spread EU-wide if foreign vehicles are affected (this is often necessary for public acceptance).
- The freedom of movement principle also means that the emissions or other standards and retrofit certification should be able to be met EU-wide. For LEZs this means that the standard should be in line with the EU vehicle Euro standards, age of first registration or for retrofitting UNECE REC[30] for heavy duty or construction vehicles or related to the Euro standards for light duty vehicles. This may also have implications, for example, for C-ITS options such as ISA (see section 5.4.1), which need to be carefully considered.
- Motorways and the Trans-European Transport Network (TEN-T)[31] key roads need to be exempted from LEZs and other UVARs, or have an appropriate diversionary route (which in practice is difficult for motorways).
- Most of the time "non-discriminatory" is interpreted at national level as within the scope of application of the Treaty that established the European Community and the Treaty on European Union, and under which any discrimination on grounds of nationality is prohibited. This right is enshrined in article 21 of the Charter of Fundamental Rights. This includes any discrimination based on sex, race, colour, ethnic or social origin, genetic features, language, religion or belief, political or any other opinion, membership of a national minority, property, birth, disability, age or sexual orientation. Thus, attention is needed to ensure that there are no unforeseen exclusions due to income, gender, age or ability with the introduction of an UVAR.

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[30] https://eur-lex.europa.eu/EN/legal-content/summary/uniform-rules-concerning-the-approval-of-retrofit-emission-control-devices-rec.html ,
https://unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2015/R132e.pdf,
https://wiki.unece.org/pages/viewpage.action?pageId=2523175
[31] https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

4.1.3. Institutional setting and organisational arrangements

When assessing the context, and in the initial idea development and design phases, a city must ensure that it has competence, not only for planning and deploying the selected UVAR, but also for operating and enforcing it. If the city does not have full competence for any of these aspects, it should identify what other institutional actors need to be involved (e.g., national government, national police, regional government, etc.). Some aspects of the UVAR might be outsourced, and these should be identified.

Different political processes and events may have an important impact on the UVAR process (e.g., local elections, political party agreements). At the same time, there are a variety of political instruments which can be used in different moments of the UVAR lifetime to support the UVAR process (e.g., consultation and participation processes). Periodic monitoring reports are key for the necessary assessment of, and support for, UVAR measures and confirming support for their implementation (or changing them if needed to gain support). These are also key to successful communication with the general public. Aspects related to equity, equality and fairness should be considered within the monitoring process of the UVAR.

It is worth cooperating with other cities and stakeholders for the resource-efficient implementation of easy-to-communicate UVARs.

4.1.4. Policy frameworks and planning instruments

It is helpful to identify policies that will be relevant to the planned UVAR. These can address topics such as air quality, congestion, accessibility and climate, but also land use, public transport, parking, cycling, innovation, equality, equity or economics amongst others. Many cities have policies covering these areas. It is important to ensure that the objectives of the UVAR align with the city's existing policy objectives, and that there is a process to align the implementation of the UVAR with these policies.

Especially for a high-impact or controversial UVAR, it helps to work within the framework of an integrated, long-term plan, such as a SUMP. The integration of the UVAR in a SUMP ensures that the UVAR is integrated in, and supported by, a comprehensive mobility strategy. It can offer a structure of existing stakeholder groups or communication processes which can support the UVAR implementation process, and also address sustainable modes of accessing the areas concerned that may benefit specific communities. The SUMP topic guides, including one on UVARs in SUMP, might be useful here.

Different UVARs and different situations in the city might call for different approaches with respect to SUMPs. For example, neighbourhood level UVAR schemes may not be appropriate to reference in the city's SUMP, but they should fit in with the SUMP aims. An urgent problem may need to be addressed outside the SUMP framework, but again, ideally aligned to the SUMP aims.

A SUMP might need an update – for example to enable a new mayor to implement an UVAR within the first half of their electoral period so benefits are seen before the next election (see the public acceptance section 4.3 and governance section 4.1). An UVAR may be a key or supporting component when a city develops its first SUMP, and it should certainly be considered by any city undertaking a SUMP. Ideally, the planning of an UVAR measure is undertaken together with urban planning process right from the beginning – but in reality, this is not always be possible.

An example of good practice in the integration of UVAR and SUMPs is provided by the Spanish ReVeAL city of Vitoria-Gasteiz. The superblock scheme[32] was used in their SUMP[33] as the main tool to achieve the objectives of the city.

The Belgian city of Ghent's circulation plan is another good example: the circulation plan was developed as a chapter of the mobility plan to highlight it as an integrated measure that was part of the overall strategic vision of the city.[34]

4.2. Error! Reference source not found.Stakeholder involvement

As with the SUMP process, stakeholder involvement is an essential part of implementing an UVAR. This is because it is likely to make a better, more accepted and adapted scheme. Taking the extra time and resources to engage with different users can seem to make the planning process expensive and risks making the outputs inconclusive. However, these efforts can uncover issues not previously considered by experts. They can also be a source of innovative solutions.

Stakeholder involvement needs to be designed so that it hears more than the voices of those resisting any change that will inconvenience them. A judgement will need to be taken as to which concerns are legitimate, and which simply want to resist change. Care needs to be taken to ensure that voices such as those of youth, women, minorities and those with disabilities are heard as clearly as those who may otherwise have undue influence over the process.

"WE SPENT NEARLY A YEAR IN STAKEHOLDER ENGAGEMENT, BUT IT WAS WORTH IT."

Juan Carlos Escudero, City of Vitoria Gasteiz
(when asked about how the city gained public support for
the removal of hundreds of car parking spaces to use for sustainable mobility)

The city of Bielefeld, Germany, was very open about what could be done in its Old Town and had good (and plentiful) experience with stakeholder involvement. They developed an interactive website to gather input on their planned UVAR measures, held online meetings during the pandemic and maintained working groups to ensure the scheme could be discussed and suggestions included.

"GENERALLY, STAKEHOLDER RELATIONS IS QUITE SIMPLE, IT IS JUST ABOUT TAKING PEOPLE ON A JOURNEY, MAKING THEM FEEL INVOLVED, AND ALLOWING THEM TO REPRESENT THE CITY THEY SERVE!"

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[32] https://www.interregeurope.eu/sites/default/files/inline/14._Superblocks_streets_designed_for_sustainable_mobility_in_Vitoria-Gasteiz.pdf

[33] Superblocks in Vitoria Gasteiz's SUMP https://civitas-reveal.eu/wp-content/uploads/2021/06/Incorporating-UVARs-into-the-Vitoria-Gasteiz-SUMP-red.pdf

[34] For further information on the Ghent Circulation Plan you can visit ReVeAL's webinar ReVeALing Space for People: Ghent's UVAR ReVeALed.

4.2.1. Stakeholder engagement strategy

A stakeholder engagement strategy should be developed at an early stage of your process to define how to engage with stakeholders during the UVAR development process. Aspects to include in your strategy are:

- Identifying and understanding your stakeholders
- Forms and methods of engagement to be used
- Level of engagement (inform, consult, collaborate or empower[35]) and decisions about which stakeholders to involve at which levels
- Timing of engagement activities (also what information to provide when)
- Required resources (skills, budget, time)
- Ensuring the voices of all socio-demographic user groups are reached through appropriate channels (e.g., the elderly, the youth, residents and commuters, etc)

4.2.2. Identifying and understanding your stakeholders

It is important to include stakeholders from both inside and outside the local authority, from both inside and outside of the UVAR area and from the city's entire functional urban area (FUA)[36]; those who currently travel into or through the potential UVAR area will likely have different access needs from those who live within it[37]. Grouping stakeholders can help ensure that all are identified, but it is important to ensure that all voices are heard.

Generally, it is valuable to involve as many stakeholders as is relevant and practicable. Figure 1 gives an outline of possible stakeholder groups to identify. It may help to try to reach out to specific organisations that both bundle the concerns of a given group and have direct access to members of the group.

Table 1: Possible stakeholder groups to engage

Public authorities	• Authority colleagues in relevant departments • Neighbouring authorities • Other levels of government • Transport authority(s) • Transport operators	*Other*	• Representative associations (e.g., people with disabilities, older people's forums, tourism, car drivers, cyclists…) • Special groups (e.g., women, elderly, youth, migrants) • Those who contract or hire drivers/vehicles • Interest groups (e.g., NGOs, community groups) • Universities, research institutes
Business	• Chamber of commerce • Business and trade associations • Freight associations		

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[35] http://intosaijournal.org/inform-consult-involve-collaborate-empower/
[36] The functional urban area (FUA) is a city and its commuting zone, see
https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Functional_urban_area
[37] https://www.interreg-central.eu/Content.Node/Dynaxibility4CE/UVAR-Topic-Guide.pdf gives guidance on UVARs in the FUA context

• Shopkeepers	• Building occupants
• Individual businesses (if significantly affected)	• Local, regional, national media
	• Schools and children
• Transport operators	• Emergency and security services
	• Local and (if relevant) national politicians
	• General public

It is also important to ensure that you reach different cultural and socio-economic groups among your stakeholders and that you achieve a gender balance so that as many voices as possible are heard (see also Equity section 4.7). In some cities there will also be different languages to consider. By doing this, you will hear the needs to be addressed in the planning and implementation from those who stand to be affected. It also enables people to be involved in the process; they may be less likely to oppose it afterwards if they have an understanding of the issues at stake. Thorough work here will help you avoid costly mistakes at a later stage if you inadvertently neglect important stakeholder groups.

Some people will stand to benefit from the proposed UVAR, while others will feel they are being (unjustly) "punished" by it. In some cases, the perceived punishment is rather the removal of a privilege (such as eliminating long-standing cost-free car parking). It may also mean that there will be an extra cost (in time or money) to those who are already disadvantaged but who have no choice but to rely on a car. UVARs need to account for the needs of people with mobility challenges to ensure that they are still able to access the city. The art is to decide whose needs or potential disadvantages may warrant an exemption or complementary measures. It is worth the effort to understand where stakeholders are coming from and what their agendas are – hidden or otherwise. For example:

- Whom do they represent?
- What are their objectives?
- What do they have to lose or gain?
- How much influence do they have?

It may require extra effort to gather input from those with much to lose, but who have (perceived or actual) little influence, or those who will benefit from the UVAR (and are therefore less likely to feel the need to express their views about the scheme). These groups are typically more difficult to engage with, but they are also those at greatest risk of being excluded by the implementation of the scheme if their needs are not understood.

Where relevant, providing information on your UVAR plans in relevant local languages may be helpful for building trust and understanding and gaining valuable input. Likewise, meeting people at a time and place that works well for them (as opposed to being most convenient for you) will also provide you with insights that you would not otherwise get. You also need to be sure that the voices of those with significant influence, but little to lose, do not drown out others.

It is useful to have a balance of those (likely to) support and to oppose the plans in the same room. It also helps to include some strong supporters and allies, so that you are not the only one talking about the benefits of the proposed scheme. A fluid and transparent conversation needs to be created where every group's arguments, as well as real and perceived concerns are heard, considered and included. At the same time, the goals and opportunities of the UVAR(s) upon which the authority will not compromise need to be transparently presented. Complementary measures, such as case-by-case exemptions or the ability to buy a limited number of day passes, can prevent marginalised groups from being disproportionally impacted.

It is important to clearly set the limits of influence of stakeholders so as not to raise false expectations. Where and when decisions are expected from them, and there should be sufficient information on

which to make informed decisions. The REVEAL building blocks and fact sheets can be a helpful resource to inform stakeholders.

People and goods will need to move around and into the area, meaning it is important a) to get buy-in from those living and working there and b) that they can still access the UVAR area. Neighbouring authorities may fear the UVAR will shift traffic and worsen the situation in their jurisdictions, whereas in fact, it is more likely to improve their situation. This is because people who change mode may well switch farther away, meaning they are on a bicycle or bus through the areas neighbouring the UVAR. And a low emission zone leads to more low emission vehicles in all parts of the city and its surroundings – as those in the surrounding areas will often want to access the LEZ itself. Indeed, the London low emission zone led to more journeys with cleaner vehicles – also in the neighbouring authorities – as more people were encouraged to switch to compliant vehicles. Sharing impact assessments with neighbouring authorities can help overcome their concerns.

Diversity of users and stakeholders

The socio-economic situation of residents and mobility users can range widely, as can their cultural background and mobility needs (among others). It is particularly important to include those with special needs into any discussions; this might include those on low incomes, people with disabilities or who do not work, especially those who are responsible for caring for dependents.

Age and life stage are also key determinants for mobility needs and behaviours. Combining the mobility needs with age (life stage) and income across the different groups can provide important insights into the needs of these groups, who may not be the most vocal in stakeholder engagement outreach but may end up being the most affected by an UVAR. Another example is migrant communities who may live within or very close to the proposed zone, whose needs may be slightly different from other citizen groups due to language, faith or social norms. Extra effort may be required to reach some hard-to-get-to groups. There are many different categories of user and these need to be set out in the project.

This diversity is one of the key reasons why UVARs will never become a one-size-fits-all solution; what shows great results in one city might show limited or no success in a city with different demographic patterns. This diversity needs to be reflected in the stakeholder outreach. Careful training of the facilitators is also required so that everyone feels able to and encouraged to share their views and perspectives.

While some UVARs only affect some users (e.g., low emission zone for commercial heavy goods vehicles), others (e.g., car-free neighbourhoods or limited-traffic city centres) affect a wider variety of users. The difference in UVARs must therefore also be taken into account when working with a broad range of user groups.

4.2.3. Timing of engagement activities

Choosing who to involve and when to do so is important and will depend on your specific situation. It may be different if you are planning an UVAR based on a number of studies or on a national framework or if you have a specific direction in mind than if you are fairly open to suggestions for an area where early brainstorming with interested stakeholders may be useful. Other factors may include the size or strategic importance of the area or the land use type within the area, as well as how controversial the scheme is likely to be. A common step near the end of the process – even required by law in some cases – is a public consultation on a concrete proposal.

Generally, one would start engagement with different departments inside the authority. When approaching those outside the authorities, approaching those who have expressed interest may be a good place to start – always balanced with the need to get a broad and representative range of

stakeholders. In all cases, those involved need to have enough information to be able to make informed decisions and participate.

4.2.4. Engagement tools and tips

There are many ways of interacting with stakeholders, each with its own advantages and disadvantages. Smaller meetings enable discussion, while larger ones enable (often one-way) explanations to larger groups; online consultations can be useful for gathering information from large numbers of people, to brainstorm at the beginning, to collect views throughout the process, or for public consultations once the final scheme has been decided and assessed.

Strategies should be developed to include communities that may not be able to attend in-person meetings (especially if they are held in the evening) such as single parents, mothers, people with disabilities and migrant communities. It is important for equity and inclusiveness to ensure that these groups are given suitable opportunities to learn about and understand the project as well as share any views and/or concerns they may have.

Some UVARs only affect some users (e.g., a low emission zone for commercial heavy goods vehicles), while others (car-free neighbourhoods or limited-traffic city centres) affect a wider variety of users. This will affect how the stakeholder engagement process is undertaken.

The ReVeAL project took place during the Covid-19 pandemic, meaning "live" meetings in the partner cities were limited and creativity was needed with online tools and methods for engaging people. This was not all bad. Being forced to rethink old ways can lead to some new and better ones. The expanded use of online participation tools enabled larger numbers of responses and participation by some who otherwise would not have been involved. However, this does not entirely replace face-to-face meetings and discussion and care is needed to ensure that groups who have more difficulty with online options are included in other ways.

There are several different resources on stakeholder engagement, including from CIVITAS[38], C40 and Dynaxibility, as well as tips from Dutch ZEZS on working with the city's own fleets and working cooperatively at a regional level[39].

4.3. User needs and public acceptance

Stakeholder involvement is a key part of meeting user needs and achieving public acceptance, as discussed above. If user needs are not taken into account when designing an UVAR scheme, a city may end up with a system that does not work as anticipated. It is important here to distinguish between user *needs* and user *desires*. The need may be to access the area, the desire may be to access the area by private car; ensuring the perceived access *need* is appropriate and an issue that the UVAR should address, but this may not always be in the *desired mode*.

The stakeholder (section 4.2) and equity (section 4.7) sections address the important issue of making sure the needs of all groups are heard, and the diversity of different needs in a city is one of the reasons why UVARs are not a one-size-fits-all solution. There is a risk that essential transport needs

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[38] e.g. https://civitas.eu/thematic-areas/public-participation-co-creation,
https://www.eltis.org/sites/default/files/trainingmaterials/civitas_brochure_stakeholder_consultation_web.pdf,
https://www.eltis.org/sites/default/files/trainingmaterials/qf-brochure_participation_en_0.pdf ,
https://www.eltis.org/sites/default/files/trainingmaterials/guidemaps_volume_1_colour.pdf,
[39] https://drive.google.com/drive/folders/1tfcedg2QvayNhh0X-1sarXeUUz0_jixg?usp=sharing

cannot be met or that certain groups will be unintentionally disproportionately affected if stakeholders are not involved. Some user concerns can be addressed, but the supposed automatic "right" to drive everywhere may not.

4.3.1. Public acceptance

Public opinion and acceptance will almost certainly vary across user groups. While it is unreasonable to expect the scheme to please everyone, overall, it is important for any UVAR scheme to have a high level of general local support for it to work well. A scheme that is well designed with stakeholder involvement, tackling a known and agreed-upon problem has good chance of being accepted. Public opinion may vary across societal groups, as will the needs. Furthermore, public acceptance and opposition often fluctuate over time, meaning acceptance should be seen as a continuous process and not a once-and-for-all "for or against" a specific UVAR.

The acceptance curve

Public acceptance will change over the lifetime of a proposed scheme. As an example, the same distinct pattern of acceptance has been observed in the implementation of congestion charges in several cities (see Figure 6).

Early in the process, when the discussion is general and the effects of charging are discussed as an abstract concept, there is typically limited opposition from the public. As the concept progresses towards implementation, more concrete definitions around the scheme design are developed and presented to the public. The scheme becomes more "real" (and potentially personally relevant) to those who may be affected and a "not in my back yard" (or NIMBY) reaction may occur. The increased clarity around congestion charging typically makes people worry about negative personal consequences and evokes public debate. The level of public acceptance decreases during this phase. On opening day, the level of acceptance will likely be at its lowest.
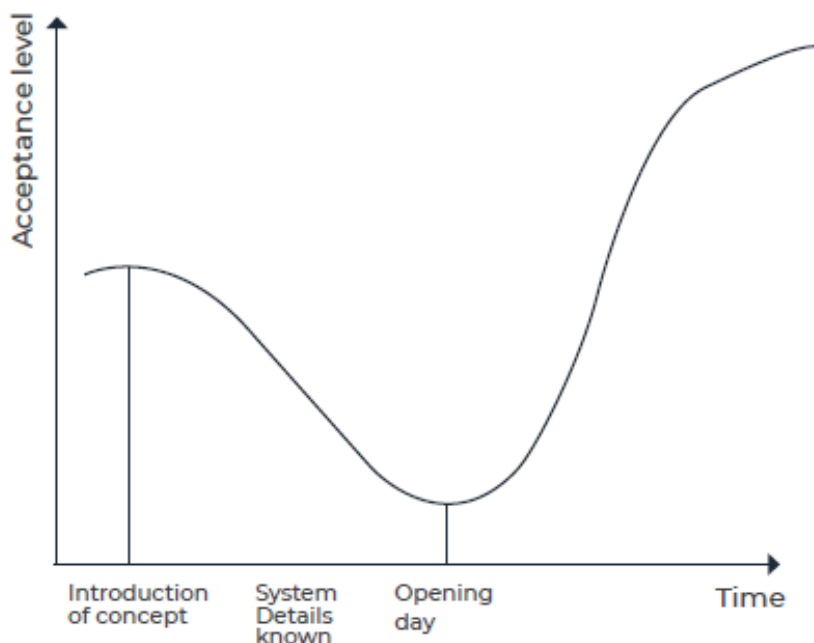
Figure 6:Typical dynamic pattern of acceptance[40]

After implementation, acceptance typically increases again. This increase can be attributed to several factors, primarily as the benefits are observed. But even those who must change their travel habits due to the scheme often find that travel times are not as negatively affected as expected and that negative expectations are not as problematic as anticipated. In addition, people adapt and accept the new status quo, seeing it now as a new normal.

Understanding this helps to explain the reactions to a scheme, and to plan the stakeholder involvement, consultation and communication strategy aspects appropriately.

4.3.2. Transparency

The UVAR development process should be, and be seen as, transparent, open and fair to help increase public acceptance and ensure that user needs are appropriately accommodated.

If an UVAR addresses – and is seen to address – a widely held concern, then support is easier to gain. When Ken Livingstone was re-elected Mayor of London saying he wanted to clean London's air (with a low emission zone), no-one disagreed that there was a pollution problem that needed to be solved. Where an issue *is* a problem, but is not generally *seen as a problem*, information campaigns may be needed at early stages of the UVAR project. For example, while Jerusalem's air is polluted, it was nonetheless perceived by locals as being "as clean as mountain wine" (see Communicating the aim of the scheme section 4.4.2). This meant the Jerusalem LEZ information campaign needed to explain the issue of pollution before it could begin to implement the low emission zone.

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[40] source Schade, J., Seidel. T., Schlag, B., 2004. Cross Site Evaluation of Acceptability Indicators. Working Paper. EUH Project 17 CUPID Funded by the European Commission under the 5th Framework Programme. Dresden, https://www.wsp.com/-/media/Insights/Canada/Documents/doc-Congestion-Charging-Report.pdf?la=en-US&hash=CEF19F5AB861A42C12EBE3651B680758583A71CA.

There also needs to be a transparency from the city about the aspects of the scheme they cannot compromise on. This could include legal requirements of meeting the EU air quality limits for which the scheme is designed, or perhaps the fact that you want vehicles off of school routes during the school run to save children's lives.

4.3.3. Designing a good scheme

Needless to say, a well-designed scheme will be more readily accepted and more effective than a poorly designed one. It will also be more effective in achieving your goals, and less open to legal or political challenges. A well-designed scheme that is not enforced (either by road layout or active enforcement) is also unlikely to be effective – or seen as fair. Many aspects that contribute to a well-designed scheme can be found in this document. **Error! Reference source not found.**

4.4. Communication

Communication is one of critical issues to take into account when planning and implementing an UVAR. Some of the reasons are:

- People cannot comply with an UVAR they are not aware of.
- How an UVAR is communicated will significantly affect how it is perceived (see public acceptance section 4.3.1); timely and appropriate communication can improve the perception.
- Dialogue fosters understanding and can enable a certain shared commitment, which can lead to voluntary compliance.
- Understanding the purpose of the UVAR makes people more willing – or at least less resistant – to adapt their behaviour; in this way, good communication contributes to the achievement of the goals of the UVAR.

Communication is related to how stakeholders are involved (see stakeholder section 4.2), but also goes beyond this to the general public within and outside the authority and even beyond the region and the country.

A European Commission UVAR study indicates that "*effective information and communication can mitigate criticism and lead to successful and smooth implementation of an UVAR scheme, ensuring its long-term effectiveness*".

> *"DON'T UNDERESTIMATE THE VALUE OF COMMUNICATION AS A TOOL, AS WELL AS HARD INFRASTRUCTURE. IF YOU GET YOUR MESSAGING RIGHT, PEOPLE WILL COMPLY."*
>
> Samantha Tharme, City of London

Communication plays a key role in all UVAR phases. The key aspects of communication for UVARs are:

- Two-way communication with stakeholders *while developing the UVAR*
- Dissemination of information about the agreed-upon scheme to enable people to comply; this includes opportunities to ask questions, *from the time the scheme has been confirmed and continuing during its operation*. This is essential and should be as wide ranging and use as many methods as possible – particularly for regulatory or area charging schemes.
- Providing opportunities to ask questions and for penalties to be contested *during operation*.

- Keeping people up to date on evaluation results and developments, and their implications *during operation*

4.4.1. A communication strategy

Once an UVAR scheme has been decided on and confirmed, it is important that it be communicated as widely as possible[41]. A communication strategy helps plan and structure the way stakeholders can be consulted and contacts in different sectors are covered. It enables mechanisms to be prepared and ensures that nothing is forgotten. How wide the communication is dependent on the size and scope of the scheme and city. There should be enough time to communicate to those likely to be affected and for them to be able to adapt. This could, for example, mean a business must acquire a compliant vehicle or secure other transportation modes. The timing for this may affect the overall implementation date.

Part of the strategy is also communication within the authority and with other levels of authority. In the local authority, this includes those responsible for planning, traffic, climate, environment, IT, economy, equality and others. Those outside the local authority will include national, regional or neighbouring governments and government agencies, including, for example, vehicle database authorities. This is important to achieve an integrated scheme that is understandable and works for the entire functional urban area and does not alienate neighbouring cities. Part of the strategy should include sharing data with other governments on how the UVAR might affect them.

Your strategy should also outline how you will monitor any communication campaigns carried out. This helps identify communication gaps with specific user groups that may need to be filled.

Contact information for the authority should also be published on any communications material sent out. This allows people to raise issues and demonstrates that you are open to input and feedback.

4.4.2. Communicating the aim of the scheme

Good communication to present – or "market" – an UVAR is essential in all phases of development and operation. Wide dissemination is needed particularly prior to implementation so vehicle operators are aware of the scheme – and its implications – and during the development stage. The CIVITAS toolkit on marketing communications may be helpful here.

Appropriate messaging is key to achieving a high level of compliance to a new UVAR. It can make the difference between a scheme being well accepted or not[42], or even between a successful scheme and one that fails. The messaging underpinning the solution that the UVAR addresses needs to be appropriate to the local context. This works best if the problem is already recognised as something that affects everyone. This may be pollution, congestion, safety or another issue that is not new to the community where the scheme will be introduced.

Many UVARs support the achievement of several of a city's goals. These can include reducing pollution or climate impacts or improving traffic safety or the quality of the urban space. Choosing which goal to focus on in your communications can influence acceptance. If a congestion scheme is presented as a revenue-raising tool, it is less likely to be accepted than if it is presented as a solution to a recognised congestion problem (even if the scheme does both), as seen in the case of Stockholm and Gothenburg

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[41] Other aspects of communication, of course, start much earlier in the UVAR development process. Communication is also closely linked and interwoven with stakeholder involvement.
[42] See the example from Sweden in the "A tale of two cities" towards the end of section 4.4.3

(see end of section 4.4.3). Indeed, efforts to tackle a problem that is widely recognised will be more readily accepted than addressing something that citizens do not see as a problem.

Schemes that have multiple goals, such as the Dutch logistics zero emission zones, for example, are being "sold" as either air quality measures or as climate measures, depending on the local context. The London ULEZ is also an example where communication helped compliance. The London low emission zone was implemented using congestion charging legislation, but it was communicated, marketed and legally justified as a low emission zone to improve air quality.

The London ULEZ also operates under charging legislation, also affecting private cars. Vehicles not meeting the emissions standards pay £12.50 per day. London successfully used communication messaging that focussed on improving air quality to getting drivers to comply with the emissions standards or use sustainable transport modes. At the same time, access was not banned for anyone; it remains possible for a vehicle to enter the ULEZ – if the driver pays the charge. The intention was to create an incentive to comply, especially for frequent users/polluters. The result was that compliance was indeed higher than would otherwise have been expected.

This implies that preliminary awareness raising of the problem may be needed before possible solutions can be presented. This was the case in Jerusalem. A traditional Hebrew song describes Jerusalem as having "mountain air as clear as wine". While this no longer reflects the reality of the modern city of Jerusalem, it has remained an image carried by most residents of the city. This meant that, unlike in London, many residents of Jerusalem were unaware that air pollution was negatively affecting their health and the health of their children. The fact that air quality was not yet a recognised problem meant that the City of Jerusalem faced a communication challenge before it could begin to address its air quality problem.

Jerusalem ran an extensive information campaign for its low emission zone from May 2019 to June 2020, in Hebrew, Arabic, Russian and English (see Figure 7 for a selection of these)[43]. They used radio, billboards, television, print media and direct letters to all owners of non-compliant vehicles in all of Israel (as the country is small and Jerusalem is central). The campaign helped people become more aware of air pollution – increasing the awareness of the LEZ from 15% to 64%. The analysis of effectiveness and cost effectiveness indicated that the greatest impact in awareness was achieved through billboards (48%), followed by radio (39%). Television was the least effective (16%).

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[43] More details on their information campaign can be found at
http://www.Jerusalem.muni.il/he/residents/environment/environment and https://civitas-reveal.eu/wp-content/uploads/2021/06/2021-06-22-Project-Campaigns-Jerusalem.pdf and https://www.avirnaki-jr.co.il/
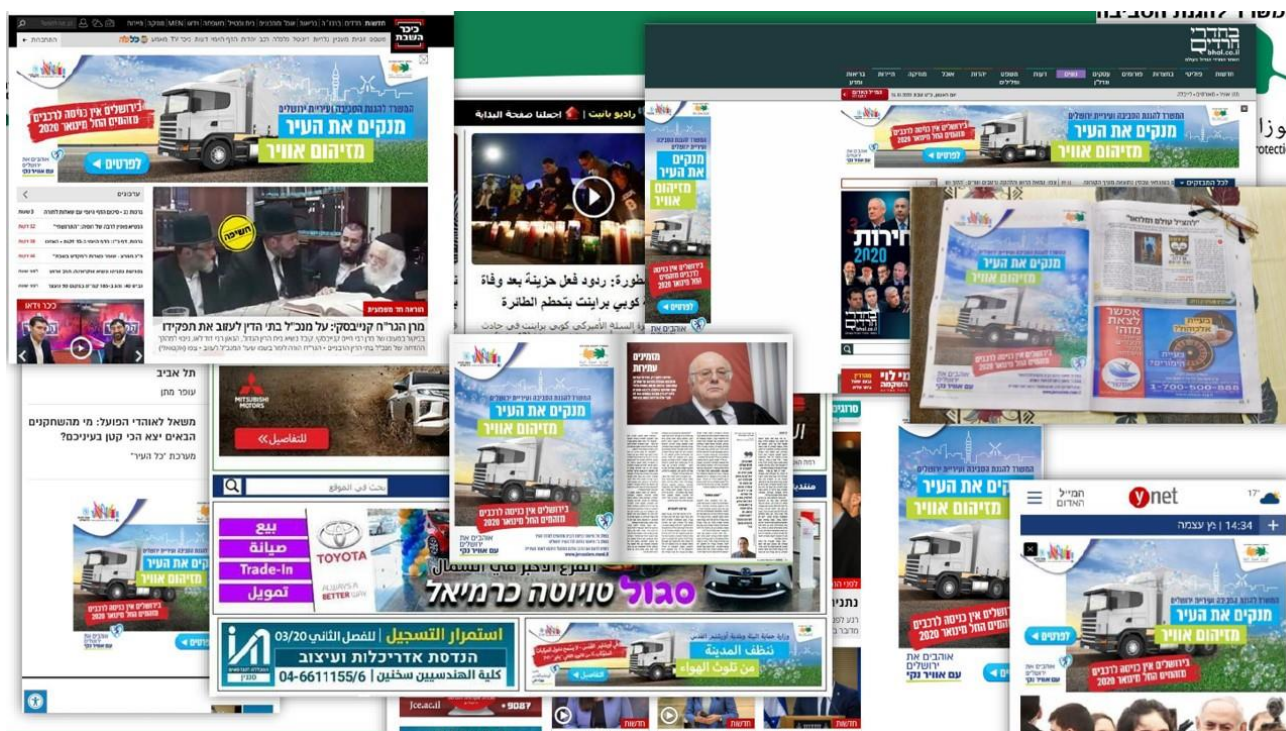
Figure 7 Examples of Jerusalem's advertising campaign for its LEZ

In London, a good deal of planning and research of possible measures to improve air quality has taken place in recent years. Some of the measures that have been put in place include the 2008 LEZ and the congestion charge, which was introduced in 2003.

While London's air quality problem is not new[44], awareness and concern about it have risen and fallen over time. For example, during the 2019 implementation of the ultra-low emission zone – which also affected cars for the first time – public perception of the air quality problem was at a higher level than during the 2008 implementation of the original LEZ (which initially affected only lorries). This meant there was less opposition to the stricter ULEZ than there might otherwise have been.

Contributing factors to the general recognition of the air quality problem in London likely include:

- The regular publication and promotion of air quality data over the years,
- Significant work of advocacy groups like Client Earth to raise the issue,
- The high profile confirmed pollution-related death of a 9-year-old girl,
- The COVID effect – people experienced lower air pollution levels, which they recognised and appreciated,
- The amount of research over the years which highlights both health and the economic cost of air quality in London, as well as studies on potential measures to improve air quality.

Strong leadership also plays a role. Both Ken Livingstone and Sadiq Khan included improving air quality in their manifestos when they ran to become Mayor of London. Mayor Sadiq Khan's office

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[44] London's first air pollution regulation was put in place in 1306 to address coal smoke. See London Air Quality Network Guide.

continues to report on both the problems and on the success of its interventions to keep the issue front a centre for London's citizens and to show them that their efforts are producing results.

Having the planning and research in place made it easier to implement the ULEZ when the political situation allowed it, but it was the successful communication of the problem that led to the generally high level of acceptance of the relatively drastic measures.

Some of the communication lessons learnt in London include early identification of, and engagement with, stakeholders that are likely to be particularly affected by the UVAR and the need to ensure that positions are coordinated internally, and messaging aligned and regularly updated.[45]

4.4.3. How to communicate the scheme

Communication is important in all UVAR phases, and a communication strategy should be an early step. The strategy will depend on many factors and involves – like many aspects of implementing an UVAR – balance and judgement, however there are some general guidelines, covered in this section.

There are different aspects of communication, involving different and overlapping groups:

- Participation (stakeholder events)
- Notification (to publicise the matter to be consulted on)
- Public consultation (large two-way flow of information and feedback)
- Disseminating information on the scheme once it is confirmed (using a range of methods)
- Queries and complaints

In all aspects of communication, it is important to reach interest groups and communities with specific needs (such as women, youth, low-income groups, those not working, the elderly, people with disabilities and minority groups). Considering the views of a wide range of stakeholder groups from the initial stages is key to ensuring the future success of UVARS[46].

An UVAR, like any policy, needs to be presented in a clear, structured, visual way. Communicating it as part of a "story" can be helpful, and it should be concise, self-explanatory and appealing. The reason(s) for implementation should be clearly communicated and make the link to the scheme and the action that the scheme requires. Figure 8 provides an example from the city of Antwerp. Variations on the story can be tailored to different language, demographic or socio-economic groups in your city. Overall, different messages and formats will be required depending on whether you are talking to city engineers, planners or politicians or communicating the information to individuals or businesses. Logos and images can also help messages reach a wide range of target audiences and gain visual recognition, as was done with the superblock scheme "Superguizza" in Padua (see Figure 9Figure 9).

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[45] Catherine Weatherby, TfL, email communication as part of the ReVeAL project
[46] For more information, see these articles on London low-traffic schemes and Brussels low emission zones.

Figure 8: Illustrated explanation of the LEZ in Antwerp (https://www.slimnaarantwerpen.be/en/LEZ)

Figure 9: Superblock logo in Padua's Guizza neighbourhood (source: Padovanet)

It is important in your communications to use language that is clear and easily understood. Focus groups can be valuable to help the city determine how best to talk about the scheme, including how to describe the geographical boundaries, the most compelling reasons for the scheme and the benefits it will bring. This will help make sure the scheme is relevant to local people, is understood, can be related to and ultimately it will increase support for the scheme

Selling the advantages

For those whose regular travel is directly affected by the UVAR, it may be easy to see the disadvantages and inconveniences. For this reason, communication should start from the benefits so that as many people as possible also see the advantages. Images from Ravensburg, Germany and Ghent, Belgium (see Figure 10) show the gains in attractiveness created by past UVARs. While these were highly controversial at the time, few would dispute their value now.

It is helpful to present the advantages to each group that would appeal to its members. For example, messages to local shopkeepers could include:

- People who walk to the high street can spend up to 40% more than people who drive there.[47]
- Pedestrianised and traffic calmed areas attract customers who are likely to spend more time (and money) there than in a shopping street full of car traffic[48].

If key stakeholders such as shopkeepers see the UVAR as positive, this will significantly improve its chances of acceptance (see stakeholder section 4.2). Working with shopkeepers not only in developing the scheme, but also once it is decided can help to ensure that they serve as champions for the scheme rather than hindering it.

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[47] See, for example, pedestrian-pound-2018.pdf (livingstreets.org.uk)
[48] See, for example, section 0

Ravensburg Centre (DE)   Braun Square (Gent, BE)

Picture Sources: Ravensburg Blaserturm um 1970 Copyright Landesmedienzentrum Baden-Württemberg 01 08 1970; Lucy Sadler

Picture sources: Beeldbank from the city of Ghent; Databank Publieke Ruimte (Database Public Space).

Figure 10: Before and after images of UVAR implementations in Ravensburg and Ghent

Nonetheless, a certain amount of opposition is to be expected when implementing most UVARs. Involving people in the development process means they are more aware of the arguments for and against different aspects, and they feel part of the process. It also allows you to receive critical input and address it at an early stage. This is much more constructive and efficient than receiving negative feedback on a finalised scheme because you had overlooked important needs of a stakeholder group.

Open or closed? Language influences perception

Ensure that the general perception remains that the city (or part thereof) is open and accessible, albeit perhaps not by private car. In doing this, consider the language you use; for example, a closed road has only been closed to cars. It has been *opened* to people walking or cycling. See, for example, the additional sign for a neighbourhood traffic street in London in Figure 11 which highlights that the street is only closed for vehicles; it is very much open to people.

This is particularly important for a scheme in the city centre. Shopkeepers and business owners must still see the city as open, otherwise there is a risk that they may share (and therefore promote) the idea that the city is inaccessible, thereby inadvertently harming their own businesses. Of course, language alone is not enough to address this. It may be necessary to improve or increase the sustainable mobility offering to ensure that the city is – and is perceived as – open and easy to access. For more information on this, see the complementary measures section 2.2.

Figure 11: Supportive signage for a low-traffic neighbourhood in London (photo: Alamy)

The right amount of information at the right time to the right people

As with many things, decisions on who, what and when is a question of judgement. Early in the UVAR development there may be less concrete information available, but more ability for those with whom you are talking to influence the direction of the development. Where decisions or views are expected, there should be sufficient information on which to make informed decisions. This is particularly important before a public consultation, or even a referendum (which is high risk and should be well considered before undertaking). UVAR referenda have been used successfully (and unsuccessfully) for large, controversial, schemes such as congestion charging. Some of the successful ones involved trials, which enabled the success to be demonstrated, some of the unsuccessful ones had the referendum at an early stage, when the scheme and its positive impacts were not sufficiently developed.

A tale of two cities: The difference communication makes

The stories of the congestion charges in Stockholm and Gothenburg can give good insight to how different approaches can lead to different levels of public acceptance.

In 2007, Stockholm introduced the first congestion charge in Sweden. In 2013, the Gothenburg congestion charge was introduced.

While the two cities sit on different sides of the Swedish peninsula, they are comparable in many ways and share the same social, cultural and legal context. Although there were many similarities between the two schemes, the acceptance levels turned out to be very different. The different outcomes of the

schemes highlight the importance of the design and communication of a scheme and of the local context to an UVAR.

The Stockholm congestion charge was launched as a half-year trial followed by a public referendum. Prior to the trial, the approval rate was as low as 21%. The referendum resulted in a 53% approval rate from the citizens. Later, the approval rates climbed as high as 70%.

The Gothenburg congestion charge had a public acceptance level of 28% before the implementation (2013). At the time of the 2014 referendum, the public acceptance level had grown to 43%. Although a majority of citizens voted against the scheme, the city's government argued that there was a lack of policy alternatives to put in place to replace the congestion scheme, and therefore kept it in place without the support of the majority of the public. The highest approval rate of the Gothenburg scheme was reached later in 2014 with an acceptance rate of 51%, but has decreased since, never reaching the sustainable approval rate of Stockholm's scheme.

Plenty of factors play a role in the difference of approval ratings between the two cities. Due to the similarities between the two cities, the differences are to be found in the different levels of congestion, political process and public engagement. The main reason for the differences in acceptance lie in the fact that in Stockholm the congestion charge was framed as a green policy (with money raised supporting mobility), while in Gothenburg, it was framed as a measure to raise funds for transport infrastructure.

4.4.4. Communication campaigns

Once the UVAR is confirmed, it is important to disseminate information on it as soon as possible, as widely as possible. Those affected need to be able to plan their adaptation or investments. A business vehicle purchase cycle might range from 3 to 6+ years. New business models of transportation – micro-mobility stations, consolidation centres, or a new bus line all take time to plan and involve different stakeholders in and outside the city authority – and as many of these as possible should be implemented before the UVAR starts, through private or public agencies.

Once the scheme is confirmed, communication campaigns and processes are instrumental to spread the word and efficiently communicate the UVAR requirements to citizens and a wide array of stakeholders. Communication campaigns should use as many different methods as possible, reaching many different types of users, and include strategies to reach a variety of target groups (including those with no/limited access to new technologies).

As examples, Vitoria-Gasteiz and London used – and widely communicated – an introductory phase to their UVARs, sending warning letters to inform drivers rather than fines in the early months of the scheme. Another option is to send a warning for the first infringement (and charge a fine thereafter). In Vitoria-Gasteiz, the warnings were sent until the campaign had finished and the campaign duration was influenced by day-by-day compliance monitoring to see when it had reached an acceptable level.

A good example for a video was used in Jerusalem's communication campaign (see section 4.4.2) where they needed to raise awareness both of the fact that Jerusalem's air quality was not good, and of the LEZ scheme itself.

Letters are often sent to residents as well as to affected bodies such as local, regional and national trade organisations and the other local authorities within in the functional urban area (i.e., the area making up the commuter catchment area of a city) as well as to neighbouring, national, regional authorities, who can help spread the information to all those who will be affected. However, in an increasingly mobile world, communication needs to extend well beyond the borders of an authority. At all stages, relying on the local press or other 'leading voices' alone to convey scheme information may not provide all the information needed to be made available by the authority.

Information dissemination may play an even more crucial role in the case of dynamic/reactive UVAR schemes (e.g., those that are only in force when pollution levels exceed a given level). Here it is important that users know the *current* UVAR status.

It helps to monitor awareness levels and opinions about the UVAR through quantitative research (surveys, etc.) when the scheme is implemented and as time passes. This will help give insight into whether more publicity is required, or a change in approach to how the scheme is publicised.

Once the scheme is in operation, it is advisable to have a transparent query and complaints system, as it operated by Transport for London for the congestion charge. This gives vehicle operators a place to turn if they feel unjustly treated, wish to dispute a fine, or are uncertain if their vehicle complies, etc.

4.4.5. Communication channels and activities

Different communication channels can be used for different purposes (see Table 2 for a list with examples). One-way communication is used for information dissemination and awareness raising, and two-way for stakeholder engagement, questions or complaints. Communication channels are also used to provide road users with UVAR-related real-time information. This is particularly important in dynamic/ reactive UVAR schemes such as those only in force when pollution exceeds a given level.

Table 2 Commonly used channels to raise awareness about an UVAR to enable compliance or engage stakeholders

Channel	1-way	2-way	Real-time	Explanation
Letters	√			Sending letters to all residents, local businesses, associated governments and agencies or stakeholder groups can ensure those most affected are informed; these letters can also be used to distribute appropriate permits.
E-mails	√			E-mails can be sent to specific users and user groups to provide them with UVAR-related information.
Call line	√	√	√	A dedicated telephone line to provide information on the UVAR. This can be used to receive feedback on the measure, or an automated phone message can provide current information on dynamic UVAR schemes.
SMS	√		√	Can be used to provide users with updated information. Especially important for dynamic and reactive UVAR schemes
Smartphone Apps	√		√	Can be used to provide users with updated information. Especially important for dynamic and reactive UVAR schemes
Traditional media (TV, radio, flyer, newspaper, billboard)	√		√	These are (still) important communication channels. They can be used to provide users with updated information on dynamic UVAR schemes. This can happen through paid adds or through press coverage.
Dedicated authority websites /	√	√		A space should be created on municipal websites to inform about the measure and provide answers to common questions (FAQ) about the UVAR. Such sites can serve as

interactive websites				the main information hub for the measure and can also be used to collect feedback/complaints from users or stakeholders both during development and operation. Can be used as a tool to gather feedback, ideas from a wide range of people, (e.g. Bielefeld's website, or Talk-London)
Meetings, online & live	√	√	√	Online or real meetings can help discuss issues in more depth. These can take many forms, including focus groups, deliberative events, 1:1, attending 3rd party events, etc.
Events, live or online	√	√	√	Many different options are possible, including on-street, dedicated or part of other events, or online webinars.
Website Widgets	√		√	These can be created for use by third party websites so that they also have automatic updates). Especially important for dynamic and reactive UVAR schemes
Social media	√	√	√	This can be used to provide users with current information on UVAR schemes, and to request citizen feedback on the scheme. This generally works better for younger audiences than for older populations.
Web ads	√			Web ads can be used to extend the reach of the communication efforts in the development of an UVAR measure. The use of such ads on websites of tourist attractions can increase the awareness of incoming tourists about the measure.
Road signage	√		√	These are a key means of communicating an UVAR – and often a required legal mechanism. These may be traditional signs, or variable-message signs (VMS). VMS can be used to provide users with current information on dynamic UVAR schemes. See section 4.4.6 for details.
Digitising data on UVARs	√		√	Not a channel as such, but it is important that the UVAR area and rules are in a digital format, which enables digital communication with navigation tools, mobility apps. See section 4.4.7 for details.
Navigation systems / tools	√		√	Up-to-date navigation systems can alert users when they enter an UVAR zone. They could also provide users with current information on dynamic UVAR schemes. Digitising data on an UVAR can facilitate the scheme being included in navigation schemes.
C-ITS	√		√	Cooperative Intelligent Transport Systems (C-ITS) are becoming possible and include the city sending information on the UVAR directly to the vehicle, most likely to be relevant for dynamic UVARs. See the UVAR Exchange project for more details.

Most of the communication channels described can be combined, and good practice is to use as many of the channels as possible, particularly for large or controversial schemes. Monitoring the

communication campaign helps to identify communication gaps with specific user groups. Providing stakeholders with a package of information such as maps, flyers, texts or videos enable third party stakeholders to organise their own events to inform their members.

4.4.6. Signage to communicate UVARs[49]

Make sure the signage used for the UVAR is sufficient, clear and understandable. If drivers cannot understand the road signs or find complete information, they will not comply with the scheme. Proper signage includes advance warning signs at different approaching distances from the UVAR boundaries (including static or variable message signs on approaching motorways for larger schemes such as LEZs). It is important to have advance warning signs installed before the last turn-off opportunity to enable drivers to divert before reaching the gate. Entry and exit signs and road markings are needed at gates/boundaries and sometimes also inside the UVAR to, for example, inform drivers about upcoming UVAR restrictions or registration/payment within a certain time after entering.

Error! Reference source not found. shows the most common road signs for UVARs. The "NO ENTRY" sign[50] (and its variants) is the basic sign to be used for limited traffic zones, low emission zones, and sometimes also pedestrian zones. The sign containing a red circle with a polluting vehicle inside is also recommended for low and zero emission zones. Pedestrian zones mostly use a blue sign with a human figure inside, whereas pedestrian priority zones use the blue sign used for residential areas, indicating that pedestrians are allowed to use the entire carriageway and the space is shared by all users, meaning drivers have to pay special attention. The UNECE convention allows for variations for the road signs implemented in different countries so, while they may differ in the details, they will be recognisable as meaning the same thing.

When restrictions are not limited to a single street but rather apply to all streets within a delimited area, a zonal sign is used and installed at all entry and exit roads. The red roundel is displayed on a rectangular panel with a light-coloured ground and the word "ZONE" (or its equivalent in the national language) displayed above or below the sign on the panel. If this does not appear, the sign needs to be repeated after every junction. Zonal exit signs are similar but grey with four thin parallel lines sloping downwards across the sign from right to left. Additional information is usually displayed below the red roundel or better, on supplementary panels.

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[49] The recommendations on road signs in this guidance come from the UVAR Exchange project. Please refer to the project website (https://uvarbox.eu/uvarexchange) for more comprehensive guidelines and examples of harmonised and improved EU-wide UVAR road signs. All photos in this section are from ReVeAL, UVAR Exchange colleagues, or Stefan Egger's Tern symbols with permission.

[50] the red C,2 roundel as designated by the UN Vienna Convention on Road Signs and Signals; see: https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XI-B-20&chapter=11&Temp=mtdsg3&clang=_en. The Vienna Convention is signed by many, but not all EU member states, however it gives good practice that is worth considering by all countries.

Figure 12: Types of zonal entry signs for UVARs

As far as possible, signs should use graphical symbols to convey the information needed by the driver[51]. There is, of course, a balance to be achieved among factors that may pull in different directions, but small or lengthy text is difficult even for nationals to read at speed. For a foreign driver, this would likely be impossible at any speed. The Polish limited traffic zone sign shown in **Error! Reference source not found.**d is such an example. By contrast, the signs in **Error! Reference source not found.**a, b and c show good practice examples. Where text is needed, simple words are likely to be understood by different language speakers (e.g., "permit" or "except"). Brief text also makes larger fonts possible.

Sometimes it may help to combine different standard signs to get across a desired message. The city of Ghent combines a limited traffic zone sign with a pedestrian priority sign to indicate that cars are not allowed in the area (except for permit holders), but bicycles and scooters are – but they must give way to pedestrians (see **Error! Reference source not found.**a).

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[51] See in particular the "Tern symbols" developed by Stefan Egger as part of the SOMS/In-Safety and UVAR-Exchange EU projects and used in this section https://iiidre.weebly.com/symbols.html

a. Limited traffic zone combined with pedestrian priority sign in Ghent, Belgium

b. Low emission zone in Barcelona, Spain

c. Pedestrian zone in the Hague, the Netherlands

d. Limited traffic zone in Poland

Figure 13: Examples of UVAR road signage

Supplementary panels enable other UVAR information to be included in the sign for drivers to understand what they are allowed or required to do, especially if they are used in a logical manner. The supplementary panels relevant for UVARs are shown below, in the order they should be presented under the main panel.

Where an UVAR applies only to certain vehicle types or is differently applicable, their symbols should be displayed first, and using a side view. This is also the case for UVARs where restrictions are not always in effect and time windows must be indicated. Graphical symbol for workdays (crossed hammers) and Sundays and holidays (a cross) are preferable. These are already in use in some countries. Time validity or time windows (e.g., for delivery operations) should use the "hh–hh" format[52]. Examples are shown in **Error! Reference source not found.**.
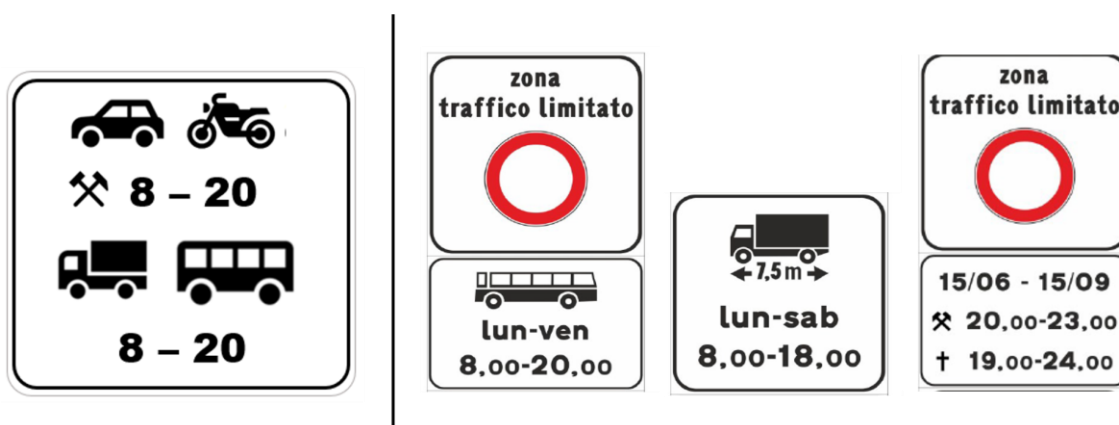

Figure 14: Supplementary panels for time validity, examples from France (optimised - left), and Italy (existing vs. optimised - right).

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[52] Times starting or ending at a quarter or half hour should be avoided.

Exceptions to a general restriction are other relevant information, shown in **Error! Reference source not found.**. The word "except" is preferred because it is recognisable in many language(s). This should be followed by a limited number of graphical symbols.

When several exceptions are available in an UVAR and/or in case pre-registration is needed (particularly with ANPR enforcement), the text "and authorised" after the symbols indicates that there are other categories that are automatically exempted or that can apply for a permit – without specifying them all, which would be too much text for a road sign.

For LEZs that use stickers (e.g., Germany, France, Spain), the message is clearly conveyed to drivers: in order to enter the LEZ, they should register and buy/request the sticker appropriate to their vehicle emission standard.

Figure 15: Supplementary panels for sticker-based ZEZs, using mostly graphical symbols

In case of a non-sticker system, and particularly in complex schemes differentiating by fuel type and vehicle type, the Euro standards permitted by the LEZ should be indicated in text. It's recommended to indicate the most polluting emission standard permitted, followed by the text "and higher standards" or simply "and higher" as in **Error! Reference source not found.**.
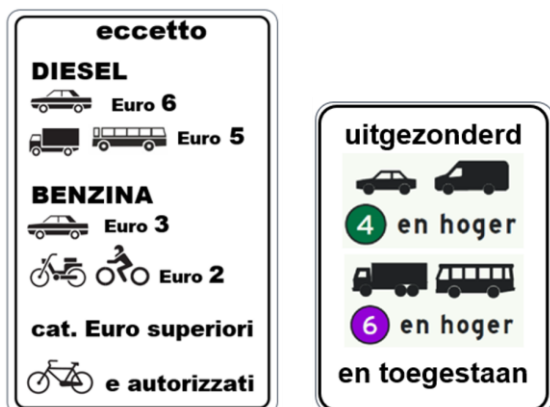

Figure 16: Supplementary panels for non-sticker LEZs, examples that would suit the Italian and Dutch LEZ cases

Where camera enforcement is in place, this should be indicated (see **Error! Reference source not found.**, left). A panel with a short url or a phone number can be provided to offer information and any registration requirements (**Error! Reference source not found.**, right).

Figure 17: Supplementary panels for camera enforcement and further details.

Sometimes, and in some countries, VMS signs are used with UVARs, as in **Error! Reference source not found.**. This may be to indicate whether an LTZ is currently in operation, or whether the pollution emergency scheme[53] has been triggered. The UVAR Exchange project gives the following recommendations when using VMS with UVARs:

- Pictograms should be central to VMS use; text should be minimised
- Information must be easily understandable; standardised pictograms must be as close as possible to the ones used in standard road signs
- Information must be reliable and up to date
- Free text should be kept to a minimum (5-7 words)
- Local abbreviations and acronyms should be avoided
- Bilingual messages should be used when possible (e.g., national language and English)
- Sometimes the use of additional information explaining the UVAR can be valuable to help increase compliance
- To avoid distraction, the VMS can also be switched off when the UVAR is not active
- The VMS location should enable drivers to safely react to the information being displayed and, for example, take a diversionary route

Figure 18: UVAR VMS example from UVAR Exchange

4.4.7. Awareness raising through digitising UVARs

The 'digital transformation', which is often discussed, has a specific relevance for UVARs. Nowadays, most people navigate an area they are not familiar with using a digital navigation tool, such as a satellite navigation device or a smart phone. If an UVAR is saved in a digital, machine-to-machine

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[53] These are UVARs that are in place only when pollution has been, is or is predicted to be high. The restrictions are, for example, to meet a certain emissions standard or to lower speed limits.

(M2M) form, it is significantly more likely to be included in these navigation tools by the service providers. The DATEX II UVAR model[54] provides a single EU-wide format for doing so. If cities save their UVARs in DATEX II, navigation tool providers can use this information to include UVARs in their services. A user-friendly tool, the UVAR Box tool, has also recently been developed to help cities to provide their UVAR in this format.

There are significant benefits to cities for digitising their UVARs.

- Digital UVARs improves the UVAR. As digital UVARs are more likely to be in navigation tools, this raises greater awareness, which in turn creates greater compliance, which in turn means the UVAR has greater impact with less enforcement work and fewer complaints and queries.
- Service providers (e.g., Google) are increasingly contacting cities for UVAR data. If the city provides data to one organisation (in their requested format), the Open Data Directive means that the data needs to be provided similarly for others (in their own, and different format).
- UVAR Box is a single EU-wide M2M DATEX II format for traffic data, meaning data must only be provided once on the National Access Point (NAP) and city / national open data websites
- UVARs in navigation services significantly reduce the resistance to UVARs at an EU and non-local level
- Information on emissions stickers and national traffic rules area required on the Single Digital Gateway (SDG) by the end of 2023 in a specific format; DATEX II can be easily imported into SDG format
- ITS Directive & delegated regulation requires EU Member States to encourage and support cities to digitise UVARs
- Cities often have their own general digitisation processes that UVAR Box can support
- Some countries and cities are working on a "digital mirror" of traffic regulations, meaning that the digital M2M form of the regulation is has equal legal validity as the current paper form (e.g., METR, (Management of Electronic Traffic Regulations).
- Digital UVAR data is also needed for geofencing and for connected and automated vehicle deployment.

Authorities implementing UVARs are therefore strongly advised to digitise their UVAR with UVAR Box, and place the data on their own and national open data websites, as well as their National Access Points.

4.5. Financing

Financing refers to the way UVAR measures are funded and how any resulting revenue streams are generated and used. Within the ReVeAL context, any financial allocation must be fully transparent. Up-front financing of an UVAR scheme might be a challenge for an UVAR implementer, but there are financing instruments and options which can be considered for this purpose (see SUMP Funding and Financing). Sometimes a higher initial investment can reduce operational costs (see section 4.6.2). Clarity about how any revenue streams from UVARs (e.g., from fines or fees collected) are spent (in particular ringfencing any revenue for sustainable mobility), can improve acceptance. That said, UVARs (unless designed as toll schemes) are rarely net money makers. Generally, the city should prioritise compliance over collecting fines.

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[54] Presentation on the DATEX II UVAR model https://www.youtube.com/watch?v=M9pMZs6JhYY&t=2046s. Further information on DATEX II on the DATEX II website https://www.datex2.eu

The financing of complementary measures also needs to be considered; this may take place at a national (e.g., retrofitting grants) or at the regional or city level (e.g., subsidised public transport passes or improvements in walking and cycling facilities).

Key aspects of financing that need to be planned for include:

- Funding the establishment of an UVAR, including ensuring sufficient resources (human and financial) from the idea development stage through to operation and maintenance
- Procurement
- Financing complementary measures
- Ensuring that the UVAR does not engender financial hardship for low income or vulnerable groups, through design or complementary measures.
- Deciding on the purpose and management of any resulting revenue streams

Different aspects might be done in-house or outsourced, depending on internal skills and capacities. Aspects that are often outsourced through procurement include:

- The plan/study
- Installation of the equipment
- Communication of the measure and public involvement
- Implementation
- Enforcement
- Operation and maintenance
- Monitoring and review
- Dissemination of results (regular basis)

The development and implementation of UVARs may entail extra upfront costs, for example for the adaptation of infrastructure assets or the procurement of new technologies. Upfront funds for financing the UVAR scheme investment can be a challenge for an implementing city. Financing for schemes can come from different sources and can include discussions with the national/regional government(s). An alternative to purchasing expensive equipment up front can be hiring it instead of purchasing it. This offers a degree of flexibility, eases financing issues and can ensure continued funding of maintenance and services.

The SUMP topic guides on funding and financing and public procurement may be useful for further advice on funding transport measures more generally. The Smart Procurement for Better Transport (SPICE) project and its best practices are relevant to financing/procuring ITS systems. As a guiding principle, UVAR procurement procedures need to be transparent. The authority may already have guidelines for many of these aspects in place; this helps ensure this transparency.

4.6. Ensuring compliance

It is important that an UVAR achieve high levels of compliance as an UVAR that is not complied with is not worth implementing. Indeed, it should be your goal to make it as easy as possible to comply with your UVAR, as greater compliance will lead to better achievement of the goals behind the UVAR. The main means of achieving compliance is, of course, effective enforcement, which is what this section describes in detail. But it is important to keep in mind that there is more to ensuring compliance than blind enforcement of rules. Spatial interventions are often largely 'self-enforcing' through physical barriers or the alteration of the road layout. Ensuring compliance also includes aspects of communication (see section 4.4) as drivers can't comply with something they are not aware of. Flexibility, as can be achieved by well-focussed complementary measures (see section 2.2), is also necessary, to minimise negative impacts for certain groups of users. Having established these aspects first, effective enforcement will be the "last line of defence" for your UVAR, and it must be planned and considered carefully from the beginning.

There are a wide range of factors to consider when it comes to choosing enforcement mechanism(s). The type of UVAR, the scale, the cultural, political and economic context and the legal framework in which you are working, as well as the attributes of each option are all factors to take into account when these choices are being made.

4.6.1. Enforcement options

The task of the different enforcement options is to distinguish between compliant and non-compliant vehicles, and then process the appropriate information to enable penalties to be issued in case of non-compliance. The choice of enforcement option has a significant impact on the overall UVAR design, and the design also affects the preferred enforcement options – i.e., whether the scheme is self-enforcing or needs to be actively enforced. The two most common options for the enforcement of LEZs are Automatic Number Plate Recognition (ANPR), which uses cameras and databases, and manual enforcement, which uses enforcement officers for stationary traffic together with police officers for moving traffic; ANPR and transponders are the main choices for charging schemes and for limited traffic zones (LTZs) together with physical barriers.

The main enforcement options are given below, with some brief key points. Many of these can – or should – be combined to achieve effective enforcement.

1. **Cameras with automatic number-plate recognition**: This technology uses optical character recognition on images of vehicle registration plates to identify a vehicle and compare it against a vehicle database so that penalties or warning letters can be sent for non-complying vehicles, or bills for tolls, as in the Norwegian congestion charges.
2. **Visual inspection:** Manual enforcement through visual inspection of vehicles by police (for moving traffic) or enforcement officers (e.g., parking wardens for parked traffic). Windscreen stickers or other documentation in the windscreen can help distinguish between complying and non-complying vehicles. Again, penalties can then be sent.
3. **Physical barriers** (automatic or manually operated): Such barriers work in combination with another system to ensure that only compliant vehicles have access. These other systems can be RFID or DSRC transponder (see points 4 and 5), a pay booth, ANPR cameras (see point 1), an intercom, visual inspection (see point 2), etc. A non-complying vehicle does not gain entry.
4. **Radio-frequency identification (RFID)**[55]: This requires the vehicle to have a transponder[56] (typical costs are ~€1) or "tag" (such as a windshield sticker) containing an antenna and is used either for payment or to open physical barriers. The antenna receives and responds to radio frequencies emitted by dedicated roadside equipment (RFID transmitter-receiver devices). RFID is commonly used for toll collection outside of the EU; in the EU, DSRC technology is more common.
5. **Dedicated short-range communication (DSRC)**: This is commonly used for electronic toll payment. The system consists of radio communication between roadside equipment and a dedicated on-board unit[57] (OBU) or in-vehicle transponder[58] (typical costs of the device are ~€8-10).

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[55] Where transponders, geofencing systems or other on-board units are used, cameras are still needed to identify vehicles without such equipment; otherwise, a vehicle could avoid enforcement by simply not having the equipment. For example, the Italian TELEPASS operates through a combination of ANPR and DSRC technologies.

[56] RFID transponders usually operate in the ultra-high frequency range (860-960 MHz)

[57] An on-board unit (OBU) is a device installed on-board the vehicle, communicating with roadside infrastructure or with a back office to communicate exchange relevant data. Note that an OBU is a generic term and may refer to completely different devices, e.g., an OBU in the case of DSRC technology will be very different from an OBU used for ISA or geofencing

[58] DSRC on-board units use microwave technology (5.8 GHz) following CEN standards: CEN/TC 278

The communication can be one or two-way. The system is commonly used for electronic toll collection in the EU, but it also presents potential applications within other ITS and cooperative ITS applications (e.g., parking management, real-time traffic information transmission)[59].

6. **Global Navigation Satellite System (GNSS)-based tolling[4]**: Vehicles are equipped with a GNSS on-board unit[60] (cost ~€200-300) that allows for the vehicle's position, speed and local time to be determined. The trip data[61] is used within a tolling scheme to calculate a bill. Processing can be done by the on-board unit or in a back office (where data is sent by Global System for mobile communications).

7. **Intelligent Speed Assistance** (ISA): The vehicles speed is compared automatically and remotely with the speed limit. The system either does not allow the vehicle to go faster than the set speed or it informs the driver that they are driving too fast. ISA consists of an in-vehicle system that uses information collected by means of image recognition (road signage), interaction with urban infrastructure (C-ITS) and/or geo-location. For more details on this see the ISA section 5.4

8. **Geofencing**: Regulations (e.g., speed, energy source permitted) can be defined for an UVAR digitally for the geofenced area and are communicated digitally either to the driver through an in-vehicle notification or directly to the vehicle, e.g., by lowering its speed once the vehicle is within the UVAR area. While in theory possible to change the energy source from combustion to electric, this option is in practice no longer relevant. For more details on this see the ISA section 5.4.

See Table 3 for pros and cons of each type of enforcement system.

4.6.2. Deciding factors in the selection of enforcement options

There are several factors to consider in deciding which enforcement option to use. These include:

- Legal options available
  - o The selection of enforcement options may be constrained by the availability of legal frameworks
- Political or cultural acceptance
  - o When a specific option is widely used in a country or region, acceptance, interoperability and harmonisation all increase. Familiarity usually also helps to achieve higher acceptance for a system. Conversely, some options may face high levels of resistance by the general population.
  - o Skills and awareness of practitioners about the options may limit (or expand) the set of technology options that will be considered.
  - o How much is external enforcement required? In some countries, UVARs are less likely to be complied with unless strong and visible enforcement (physical or ANPR) is present. In other countries, there is, as a general rule, a culture that is more likely to comply with road signs.
- The level of compliance that can be expected
  - o A physical barrier leads to almost 100% compliance. ANPR also leads to high compliance levels (e.g., the camera-enforced London LEZ achieves around 95% compliance). The compliance for manual enforcement depends very much on the

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[59] Recommendation ITU-R M.1890 (04/2011). Intelligent transport systems – guidelines and objectives. International Telecommunication Union. https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1890-0-201104-S!!PDF-E.pdf

[60] In the future, on-board units could be replaced by smartphone tolling solutions.

[61] See Regulation (EU) 2016/679 (General Data Protection Regulation)

resources invested, as well as other issues including the tightness of the scheme and cultural factors, but even well-resourced manually enforced schemes usually achieve less compliance than ANPR.

- Resources (for set up and operation)
  - o Manual schemes tend to be cheap to set up, but expensive to operate at levels to achieve reasonable compliance levels.
  - o Automatic enforcement (e.g., ANPR) means a higher financial investment at the start, but the automatic system reduces personnel costs during operation, particularly for large schemes.
  - o Hardware, software, maintenance, service and personnel costs should be considered for each option throughout the lifetime of the scheme.
  - o A small scheme affecting few vehicles might be more relevant for manual enforcement than a larger scheme where there are large traffic flows, that might be more relevant for ANPR.
  - o Some technologies require users to pay part of the costs (e.g., to acquire on-board units). If high, such costs may impact the level of acceptance and compliance as well as user acceptance.
  - o Technology providers are increasingly offering the option to hire equipment, which can reduce the up-front costs of the equipment. It can also increase flexibility (if the equipment or method is subsequently changed), enable the renewal of equipment/software and provide additional on-going services or maintenance; the total cost may be higher than purchasing but may be compensated for by the other benefits.
- Matching enforcement option with the type of UVAR
  - o UVARs created through **spatial interventions** generally consist of physical barriers or changes to the road layout that prevent vehicles from entering a given area. However, for some specific interventions (e.g., school streets, cycle streets), other enforcement options may be needed for proper enforcement, e.g., ANPR cameras or manual enforcement, as well as temporary barriers.
  - o **Limited traffic zones** can generally use ANPR, physical barriers with transponders or manual enforcement[62]. If transponders are used without a physical barrier, then ANPR is needed to penalise those entering without the transponders. Note that most LTZs will require a permit management system. The link between the permit options (e.g., "whitelist" database, windscreen stickers) and the selected enforcement option(s) should be carefully considered (see **Error! Reference source not found.** in section 5.3.1 below).
  - o **LEZs** generally use ANPR or manual enforcement, potentially also combined with geofencing in the future. The selection of the enforcement option and its impact on the correct management of proof of compliance and the scheme exemptions should also be considered (for permits and exemptions see section 5.3.1 and for permit systems, see section 5.3.7).
  - o **Tolling schemes** can use ANPR with or without the option for transponders or GNSS. A physical toll booth is also possible for point or single-street or bridge schemes.
- Reliability

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[62] If there are insufficient funds to install all cameras at once, a mixed system can be used whereby there is 100% control through ANPR or physical barriers in a central area, and manual enforcement in an outer area as a phased approach.

- It is important that the enforcement option be robust and reliable, otherwise the system may not be well accepted and/or prevent the city from reaching its goals and ambitions. The same applies to manual enforcement: if the police cannot be reliably (or affordably) available to enforce a scheme, it may not be the most appropriate enforcement option. Non-police enforcement officers are only able to enforce the UVAR on parked vehicles, so can only enforce schemes that are in force 24/7. This is because in a daytime scheme, for example, the vehicle could have travelled to the parking spot legally during a time that was permitted.
    - The use of physical barriers in roads with public transport traffic needs to be carefully studied. Reliability is key in this case, as a malfunctioning bollard could lead to a complete halt of public transport operations in the affected area. Emergency vehicle access must also be enabled, and may also create challenges.
- Interoperability
    - Synchronisation and harmonisation between complementary enforcement systems should be considered. For example, where an ITS enforcement solution (e.g., RFID, DSRC, geofencing) is used, you will still *also* need ANPR to detect vehicles that do not have such a device, as these would otherwise evade detection.
    - Complementary enforcement technologies (e.g., geofencing) could also be integrated with ISA technology to regulate and control speed within the boundary area.
    - Depending on the type of UVAR, the enforcement system would be linked to a database of vehicles for verification purposes (e.g., permit management system for an LTZ) and penalty issue. In such cases, enforcement, verification and any system used for the issuing of exemptions and/or permits should be fully harmonised.
    - For LEZs, the national vehicle database can likely provide most of the information on whether national vehicles comply – or data to enable the estimation of emissions standards[63]. Vehicles for which the information is not available (e.g., foreign[64] or retrofitted vehicles), may need to register, and this registered vehicle database be added to the exemption database.
- Data privacy
    - Some technologies may generate more privacy and data management concerns than others[65] (e.g., ANPR cameras, global navigation satellite systems). A data strategy should be established that defines the conditions and parameters for collection, storage and exploitation of UVAR-related data. See section 0 on camera enforcement for more details on some of these.
    - ANPR can often be justified in terms of UVARs and privacy concerns, in terms of offering effective enforcement while not disrupting traffic flows – as long as sufficient care is taken about data management (see section 0).

The choice also directly impacts the resources needed at a city level, the administrative burden and the level of compliance that can be expected. Each enforcement option has its own characteristics, advantages, and disadvantages. These are summarised in Table 3.

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[63] although the exact data available on each national vehicle database varies, and the situation should be investigated for each new type of LEZ in the country; for example, the emissions of heavy-duty vehicles are harder to estimate with date of first registration

[64] Until, or unless, the EU facilitates EU-wide foreign vehicle enforcement – for updates on this issue, please see the UVAR Exchange project.

[65] Note that these privacy concerns strongly depend on the legal, cultural and political context of the city.

Table 3: Pros and cons of various UVAR enforcement options

Enforcement option	Pros	Cons
Cameras with automatic number plate recognition (ANPR)	• Suitable for both high and low speed traffic • Suitable for high traffic volumes and large areas • No equipment or action is needed on the vehicle side • Non-compliant vehicle identification: 90%+ • Good with high vehicle numbers • Does not impede moving traffic • Required with some other options (e.g., DSRC) to identify vehicles without the required technology fitted	• May raise privacy and data protection issues that need to be addressed • Higher upfront costs than manual enforcement (equipment rental may assist with this issue) • Generally lower running costs per penalty than e.g., manual enforcement • Maintenance costs • Potential aesthetic issues
Manual visual inspection	• Low upfront costs • Less prone to privacy and data protection issues • Easier with low vehicle numbers	• Higher operational costs (personnel) • Requires ongoing control effort by personnel. • Usually results in lower compliance than other options • Often requires a windscreen sticker/permit to facilitate optical check • Relies on third party (e.g., police or traffic wardens) willingness and motivation to enforce • Can require higher training costs (especially with any updates or changes in the UVAR compliance requirements)
Physical barriers	• Enables bike and pedestrian traffic • High compliance rate • No privacy issues	• High maintenance costs if automatic rising bollards used • Malfunctioning bollards can lead to a complete halt in traffic • To allow compliant/exempted vehicles entry, another enforcement option is needed for the identification of permitted vehicles (e.g., transponder, ANPR camera, manual/officer) and to give these vehicles access. • Potential aesthetic and emergency vehicle access issues

		• Has traffic flow implications, so not suitable for e.g., major roads or moderate traffic levels
Radio-frequency identification (RFID) transponders	• Low-cost on-board units (<1€) • No privacy issues • High potential for interoperability • OBU needs no batteries	• Requires outlay for vehicle operators for transponder • Less reliable than DSRC at higher speeds • Requires vehicles to be fitted with an on-board unit (tag or transponder) • Costly roadside equipment (gantries) required (and creates some aesthetic issues) • ANPR cameras or physical barriers are needed to identify vehicles without on-board equipment • Potential aesthetic issues
Dedicated short range communication (DSRC)	• More reliable than RFID for high-speed traffic • Relatively low-cost on-board units (8-10€) • No privacy issues • High potential for interoperability (e.g., with commercial parking)	• Requires vehicles to be fitted with an OBU that is more costly than RFID • ANPR cameras, or other mechanism is needed to identify vehicles without on-board equipment • Costly roadside equipment (gantries) required (and creates some aesthetic issues) • OBU batteries need replacing regularly
Global navigation satellite system-based tolling (GNSS)	• Less roadside equipment required than DSRC or RFID • Higher on-board unit costs than DSRC or RFID • High potential for interoperability	• OBU is more costly than for DSRC or RFID • ANPR cameras, or other mechanism is needed to identify vehicles without on-board equipment • Potentially requires costly roadside equipment (and creates some aesthetic issues) • Precision can be problematic in urban areas (e.g., sufficient signal), which requires roadside equipment to compensate • May raise privacy and data protection issues • Potential aesthetic issues
Smartphone as on-board unit	• May be possible in the future	• Not yet a viable option
Intelligent speed assistance (ISA)	• Does not require roadside infrastructure	• In terms of UVAR, would be used as a permit condition in an LTZ • Vehicles require an on-board unit • Needs an appropriate legal framework • Usually requires of sufficient appropriate quality road signs • ANPR cameras, or other mechanism is needed to identify vehicles without on-board equipment

In practice, if you have a small area and only lorries are affected, it may be more feasible to enforce manually. If you have an LEZ covering a large city and affecting all vehicles, cameras may be the only

effective way to ensure a reasonable level of compliance due to the personnel requirements that manual enforcement would require.

It is important to communicate information on the enforcement methods used and what letters or penalties will be sent. The city's website would be a good place to explain the UVAR, to describe processes for challenging penalties and to receive complaints.

Enforcement options should be carefully considered early in the idea development phase to avoid continuing with the design of an UVAR for which no suitable enforcement options exist (e.g., for lack of legal frameworks or resources). For any methods where a financial outlay is required by the user (e.g., for a sticker or equipment in the vehicle), a decision needs to be taken on who bears (how much of) the cost and how to avoid creating undue hardship.

4.7. Fairness and equity

There are several aspects of fairness and equity related to UVARs. While some are more obvious than others, there are (at least) two important ones. First, there are equity issues that need to be taken into account when implementing UVARs. These can often be compensated for using complementary measures (section 2.2). But another aspect is equity (or justice) issues that serve as *additional reasons for putting UVARs in place*. These address the current imbalance in the allocation of public space in cities. Thus, issues that may appear to argue against an UVAR can actually be reasons for putting one in place.

Understanding whether an UVAR will improve or worsen equity is your city requires appropriate assessments, including of stakeholder needs. It also entails listening to all, rather than just the "usual suspects" (see stakeholder section 4.2). The SUMP Topic Guide on addressing gender equity and vulnerable groups in SUMPs may also be useful.

4.7.1. The difference between equity, equality, inclusivity

Equality entails each individual or group of people be given the same resources and opportunities regardless of individual needs, differences of preferences – and regardless of their starting point. In that sense a road user charge that everyone is required to pay would be considered an example of equality.

Equity recognizes that each person has different circumstances and allocates the resources and opportunities needed for all individuals to reach an equal outcome. Based on need, some would receive more than others. In this example, a complementary measure to a congestion charge could, for example, provide people on a limited income with a discounted public transport pass to ensure their mobility needs are not unduly restricted.

The issue of equity, and what can be done to support it, is illustrated in the images in Figure 19. And while the equity approach provides equal access to both apple pickers in the images, it still requires one person to climb more steps than the other to achieve it.
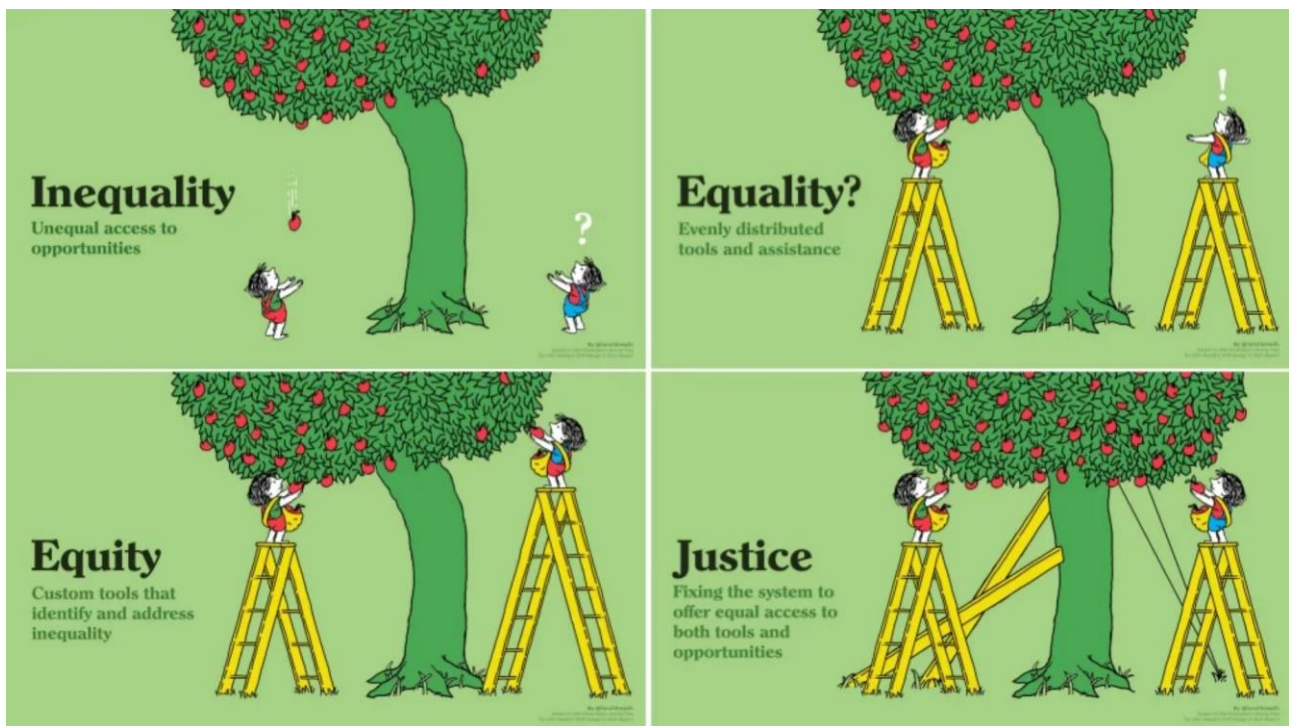
Figure 19 Equality, equity and justice (source: Tony Ruth, created originally for the 2019 Design in Tech Report)

Benefits may not be evenly distributed over the population when an UVAR is put in place; some will experience large improvements, while others might be worse off than before. The uneven distribution is due to factors such as income levels, geography or access to alternative modes of transport. Those who are forced to change their travel habits may feel disadvantaged.

What may be considered fair by some will be considered unfair by others. While this is a human reaction, it can also risk becoming political. Thus, if the aim of an UVAR is to get people out of cars and into other modes, it needs to be – and be seen as – fair. Those who, for legitimate reasons, find it difficult to change or who cannot pay an access fee, need to be accommodated so they are not unduly disadvantaged. These groups, who may already be affected by transport poverty, are likely to be helped by a well-designed UVAR that, for example, makes access to public transport easier. Different measures may be needed for different groups, and good assessments and stakeholder dialogues should help identify where action is needed. In short, people and goods should not be hindered from reaching their destination, but the mode they take may need to be different than it was in the past.

Some countries have legislation specifically working to ensure inclusivity. For example, the UK Equalities Act requires an inclusivity impact assessment be undertaken for certain aspects of their work, including UVARs[66].

4.7.2. Spatial justice

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[66] UK guidance on this can be found at https://www.gov.uk/government/publications/equality-impact-assessments-2010. See example of TfL's ULEZ Integrated Impact Assessment https://content.tfl.gov.uk/ulez-consultation-appendix-j-nov-2017.pdf

Since the post-World War II rise of the automobile as a commodity, it has been taken for granted that urban space should be provided for private cars. As the number of them – and their size – has continued to grow, it is becoming increasingly obvious that this has resulted in spatial injustice; an individual person in a car takes up considerably more space than a person travelling by public transport, cycling or on foot. This may be an argument for limiting car access in some cases and ensuring that public space is accessible to everyone.

The arrogance of space[67] highlights the difference between space given over to cars and to people in many European cities. This applies both to moving and to parked cars and, considering that the average car is parked roughly 96% of the time[68], most cities dedicate astonishing amounts of their precious public space to the storage of private property. The three images in Figure 20 demonstrate the difference in public space consumed by the same number of people when they are travelling alone by car, walking, cycling or using the bus.

Figure 20: Space taken by people when they are travelling by individual cars as compared to by bicycle, on foot or by bus (source: Stadtwerke Münster)

4.7.3. Effects on vulnerable groups

Mobility poverty, or transport-related social exclusion, is when people are prevented from participating in the economic, political and social life of the community, due in whole or in part to insufficient access to mobility options[69]. UVARs can help reduce mobility poverty by improving the transport network either by removing general car traffic to allow improved public transport or cycling routes, through charging schemes that help fund additional transportation lines or by adding bus routes as complementary measures the UVAR. UVARs can also, simply by virtue of reallocating road space or forcing a reduction

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[67] https://colvilleandersen.medium.com/the-arrogance-of-space-93a7419b0278 and
https://www.youtube.com/watch?v=CfXP6KOVBOY
[68] https://www.racfoundation.org/research/mobility/spaced-out-perspectives-on-parking
[69]https://www.researchgate.net/publication/254409601_Transport_and_social_exclusion_Where_are_we_now

in emissions, improve the lives and health of vulnerable groups. But it is important to look at each group carefully to see when it is benefitting and when it is in danger of being further disadvantaged.

Overall, the aim should be to get as much traffic as possible to "disappear" from inside and around an UVAR area, with car journeys changing to other modes. With LEZs, the aim is for journeys to be taken by cleaner vehicles. These cleaner vehicles will also pollute less in the surrounding area, creating a positive impact. For other UVARs, if care is not taken, some traffic may be displaced to neighbouring streets. In some cases, this has led to claims of UVARs reducing traffic in well-off areas at the expense of traffic increases in low-income areas. Some traffic increases may be on major roads, meaning other measures are needed to reduce the impact of any traffic increases.

Some concrete considerations about vulnerable groups when developing your UVAR include:

- Vulnerable groups and those on lower incomes tend to own fewer vehicles and more often travel by public transport, bike or on foot[71]. They will likely *benefit* from UVARs, in terms of pollution and noise reduction and improved road safety.
- Air pollution affects particularly the young, the old and those with pre-existing heart and lung conditions[72] and ambient noise levels negatively affect children's learning[73]. Any measures that reduce traffic or emissions will *benefit* these often-disadvantaged groups.
- Socially disadvantaged groups and those on low incomes tend to live closer to roads and thus be more exposed to pollutants and noise from road transport[74]. They will *benefit* from measures that reduce pollutants.
- People with disabilities and others with restricted mobility, including pregnant women and parents with young children, are more likely to be reliant on motor vehicles – whether private cars or public transport – than to walk or cycle. You may need *complementary measures* to ensure they retain access.
- UVARs could risk having a negative impact on the mobility of women, disabled people, young people, transgender people, LGBT+ people and minority ethnic groups who may be reluctant to use public transport due to the perception of risk to personal safety. You may need *complementary measures* to ensure they are – and feel – safe on public transport.
- There may be an unintended negative impact on refugees, asylum seekers, homeless people or others who rely on services provided by charities and community organisations that carry out their activities using older vans or minibuses which may be excluded from some LEZs. You may need *complementary measures* to ensure that such vehicles can be retrofitted or replaced so that they can continue to support vulnerable groups.

Often, a well-designed UVAR can improve the situation for disadvantaged groups but, in all cases, the impacts should be assessed, both with data and stakeholder engagement, and complementary measures put in place or changes made where negative impacts are likely. They can also help implement the "polluter pays" principle.

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[70] https://www.london.gov.uk/press-releases/mayoral/mayor-announces-bold-plans-for-a-greener-london

[71] https://info.uwe.ac.uk/news/uwenews/news.aspx?id=3978

[72] https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/health-impacts

[73] https://www.eea.europa.eu/publications/health-risks-caused-by-environmental

[74] For example, in London, the average concentrations of pollutants in the most deprived deciles is 24% higher than in the least deprived. Sources include https://www.london.gov.uk/press-releases/mayoral/bame-and-poorer-londoners-face-air-quality-risk and https://www.london.gov.uk/press-releases/mayoral/new-report-highlights-findings

4.7.4. Economic impact of UVARs

Before an UVAR is implemented, business groups often claim that it will lead to significant negative economic impacts, business closures, etc. In practice however, this has generally not been the case, and in fact the fewer cars, the higher shop sales[76]. Figure 21 shows comparative revenues from different types of kerbside uses, illustrating that car parking creates less revenue than UVARs. In the small number of cases where significant UVAR-related economic impacts are foreseen, efforts should be made to find individual solutions. If, for example, a ZEZ will likely create undue hardship on certain groups, complementary measures such as a consolidation logistics centre, good sustainable mobility offerings and ZEV car/van sharing provision may be of particular support for low-income shops or deliverers.

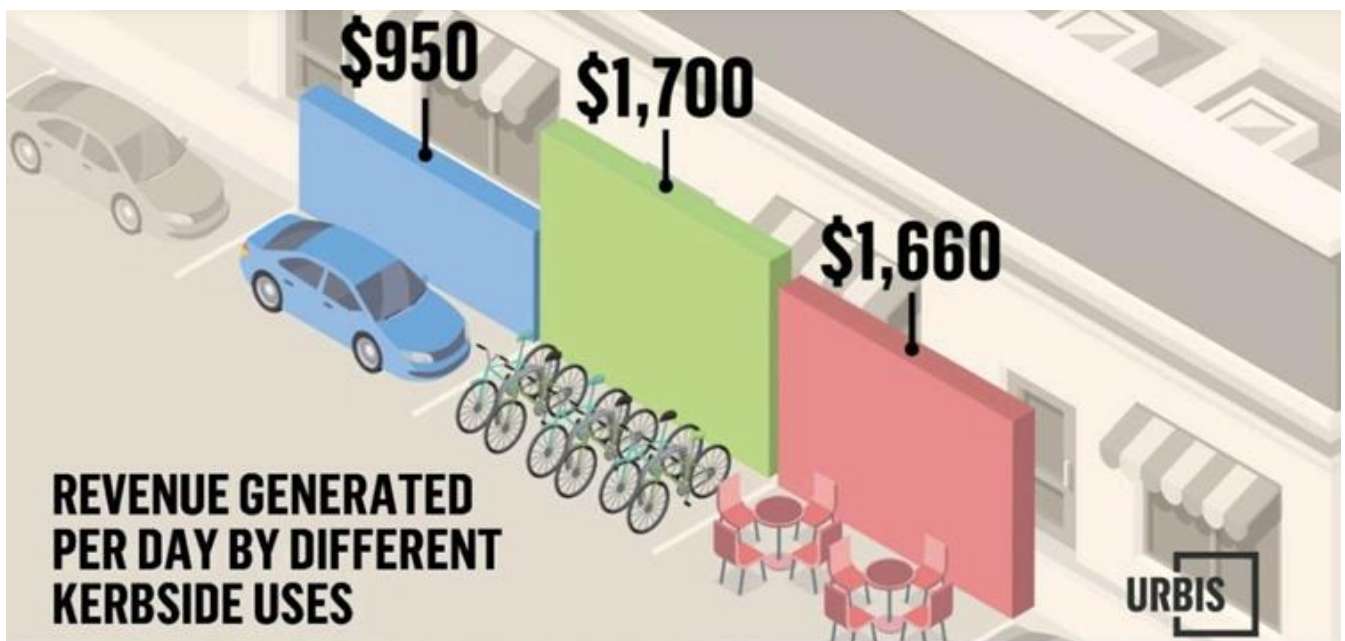*Figure 21 Revenue generated per day by different kerbside uses (source: Urbis)*

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[75] https://www.london.gov.uk/press-releases/mayoral/bame-londoners-bear-brunt-of-climate-emergencyhttps://www.gov.uk/guidance/equality-act-2010-guidance

[76] e.g. https://cleancitiescampaign.org/2021/12/9/fewer-cars-can-boost-christmas-sales/ or https://theicct.org/sites/default/files/publications/congestion_apr10.pdf

It is important to highlight the positive impacts of an UVAR. These can include improved liveability, which often translates into economic benefits as the shopping centre is more attractive and bulky goods can be viewed and tried in the shop, and then delivered directly to the customer – avoiding the need for the delivery to go via the town centre shop.

The indirect economic impact of the externalities of traffic, such as air pollution, noise, climate emissions and congestion – which lead to the need for UVARs – can be useful in making the argument for UVARs. These include:

- Air pollution costs the world $5.7 trillion or 4.8% of global GDP (World Bank)
- Air pollution costs each European €1,276 per year (European Public Health Alliance)
- Congestion in the EU costs nearly EUR 100 billion, or 1% of the EU's GDP, annually (DG MOVE).
- There 9120 urban EU road traffic deaths annually, 70% of which are vulnerable road users (EC)
- Pedestrians have a 90% chance of survival when hit by a car travelling at or below 30 km/h, but less than 50% chance of surviving at 45 km/h (WHO)
- Long-term exposure to environmental noise is estimated to cause 12,000 premature deaths and other impacts such as learning impairment in school (EEA)
- Reducing congestion makes deliveries and journeys more predictable; unpredictability leads to wasted time, and requires more staff

4.7.5. Do charging schemes favour those with high incomes?

The question is often asked – or sometimes it is simply assumed – that charging schemes favour those with high incomes. This is not as straightforward as it might appear at first glance. While only those able or prepared to pay may access a congestion charging zone, one of the purposes of many urban charging schemes is to improve public transport. Especially in urban areas, those on low incomes are much less likely to own a car, so supportive mobility measures are likely to benefit those on low incomes more.

On the other hand, certain unfavourable situations may be created for households with mobility-induced social exclusion or forced car ownership, such as those on low incomes who have no choice other than to use the car. Some of these may warrant special attention through complementary measures such as providing additional sustainable mobility. Two options for those with disabilities are organised (collective or individual) transport or exemptions for their vehicles.

A congestion charge will have different effects on different income groups. While the charge represents a higher proportion of income for low-income households than for high-income ones, those with lower incomes are also less likely to own a car, and more likely to use public transport, walk or cycle. These modes are likely to be improved and subsidised by a congestion charge. The same applies to most UVARs, as their aim is generally to favour sustainable mobility at the cost of private car use.

A similar issue exists for low and zero emission zones, as compliant vehicles are more expensive. For example, My ULEZ car and motorcycle scrappage scheme is available in London to support people on a low income or with disabilities and provides financial support for drivers of non-compliant vehicles to switch to cleaner vehicles or greener forms of transport while expanding the ULEZ scheme to a much larger portion of the city.

Fairness and equity are also important when distributing the revenues from a congestion charging scheme. The distribution of revenues needs to be seen to be making a difference to those who have the fewest options. When distributing revenues from the Stockholm congestion charge, reduced transit fares had the highest effect on equity, and tax rebates the lowest.

4.7.6. Higher price of new technologies

The vehicles that have access to low or zero-emission zones cost more than older vehicles. Some enforcement technologies require a financial outlay for vehicle operators.

For ZEZs, good practice is to first reduce traffic as much as possible (independent of the ability to pay) by making sustainable options more available and attractive. Only then should the focus turn to the emission levels of the "rest"; those vehicles allowed in are zero emission vehicles, which will remain harder for those on low incomes until the cost of electric vehicles drops. Several methods can be used to address this discrimination (see complementary measures section 2.2)

4.7.7. Listening to all

Stakeholder involvement should be planned to gain a broad spectrum of views, rather than the "usual suspects" to ensure that the needs of all are incorporated. Most transport planners are male so it should not be surprising that transport and land use planning policy has tended to be biased in favour of men, with a focus on commuting journeys from the outskirts to the city centre by car.

In general, women have different transport needs than men, but a male planner may forget to take this into account if he bases his decisions on his own experience and travel habits. Concretely, on average, women take more, and shorter, trips, often with dependants. Compared to men, women's trips are more often on public transport or by walking or cycling. Looking at the UVAR through a gender lens can help bring in more users' perspectives to assess whether the UVAR may unintentionally discriminate against any group. Some UVARs will have a larger impact on women than on men. For example, moving parking from on-street to off-street may cause concern for women about entering dark multi-story carparks at night. Lighting, CCTV and reserved spaces next to the exit are all things that can be done to minimise real or perceived danger.

5. Aspects to consider once you have designed your draft UVAR

Once your draft UVAR has been designed and you are beginning to implement, there are still a number of issues to consider and incorporate into your UVAR preparations. *Monitoring and assessment* need to be planned early so that you know how you are progressing toward your goals. *Timing* addresses the possibility of introducing the UVAR in phases and how this can be done most effectively. *Exemptions and permits* looks at some of the decisions that need to be made around which types of vehicles receive special status in an UVAR zone. *Geofencing and intelligent speed assistance* describe some of the technological tools that are becoming available, and which could play a role in supporting enforcement of the regulations in your UVAR zone. *Foreign vehicle enforcement* addresses the need to consider vehicles from other countries – and the related challenges. *Camera enforcement* looks both at how this can be done technically and also at the related privacy issues. *Future proofing* speaks to recent technological developments and how these can change the face of your UVAR and *keeping the UVAR under review* probably speaks for itself. Each of these topics is addressed in more detail below.

5.1. Monitoring and assessments

5.1.1. Monitoring

Monitoring needs to be planned early and should be linked with the UVAR goals, so that impacts – positive as well as any potential negative side effects - can be identified. It is difficult to estimate the impact of a scheme if you have no pre-scheme data, so where there are data gaps, filling them should be a priority.

As with a SUMP, appropriate assessment should take place, and it should be aligned with the UVAR scheme and its goals. Also similar to a SUMP, while the planned measures are mobility related, the potential impacts are much wider than mobility, and these must also be monitored.

You should also have an eye open for any potential unintended consequences. This could include economic impacts on those within the zone and those who enter it or 'rat runs' (a shortcut through an area which is not the driver's destination). Data should include both numbers and the results of questionnaires, public opinion surveys or forum feedback. Expertise and advice on measuring different variables is available in the SUMP Guidelines and the ReVeAL Evaluation Framework.

Monitoring could include parameters from the following categories:

- *Economy:* congestion costs, travel time savings, capital costs, operating costs, operating revenues, managing and maintenance costs, business tax revenues, societal costs, demographics, types and numbers of businesses, ...[77]
- *Energy:* energy use, fuel mix, ...
- *Environment:* estimates of CO_2, NOx, particulate and noise emissions emitted from the vehicles as well as monitored and/or modelled concentrations of particulate, NO_2 and noise in the air …
- *Society:* acceptance level by various social group, numbers of complaints, traffic-related injuries and deaths, equity for all social groups, attractiveness of the urban area, ...
- *Transport:* transport system performance, traffic levels, modal split, available mobility options, average service speed, traffic flow by vehicle type (peak/off-peak), journey origins and destinations, movement of goods vehicles, pedestrian flows, cycle flows, access to shared modes, public space dedicated to transport, traffic measures already implemented or planned, ...

If you do not have in-house expertise in data collection, modelling and monitoring, you would be well worth the effort required to acquire it.

5.1.2. Assessing scheme's impact

Assessing the impact of a specific UVAR can be difficult, as the UVAR is not likely to be the only thing affecting a traffic-related situation. Questionnaires on public acceptance may allow you to gather before and after opinions on a measure, but it will be challenging to monitor the changes in, for example, traffic levels or air quality if you do not have longer-term pre-scheme data.

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[77] The unit values of the external costs of transport can be found in the European Handbook on the external costs of transport

Some general principles in monitoring and assessments can be helpful to guide the monitoring of an UVAR. These include[78]:

- Selected indicators should aim to capture the impacts of the UVAR measure while excluding other influences as much as possible. This is, however, extremely difficult with traffic data, as there are so many factors at play. It helps to have many sources of data, including national trends and those for similar cities without UVARs to better understand what is happening[79].
- Data should be of good quality. There are significant advantages to using data that are already available as they have a longer 'before' history. If additional data is needed, collection should be started as soon as possible.
- The indicators chosen to assess the UVAR should be transparent, and able to be monitored.
- Data needs to be credible, unambiguous and easy to interpret.
- Data should be easy to monitor and robust against manipulation. These are best achieved with simple indicators that link clearly to the data monitored, rather than those requiring formulas to come up with a number.
- Data needs to be credible, unambiguous and easy to interpret.
- Provide answers your questions and those of your stakeholders.

The entire functional urban area[80] should be included in the assessments to understand the full range of possible impacts, so that the impacts can be shared with neighbouring authorities and appropriate UVAR design or complementary measures can be implemented.

Methods for monitoring and assessing the impact of an UVAR scheme include:

- Traffic monitoring, including fleet and vehicle age statistics from ANPR (if legally allowed)
- Modelling: the impact can be estimated with before and after modelling using the same conditions
- Comparing (averaged, long-term) trends before and after implementation
- Comparing trends together with other factors such as wind direction (for air quality) or fleet composition
- Comparing trends with those in similar cities elsewhere
- Changes in the fleet composition: This can be gathered from, for example, anonymised fleet-level data from ANPR cameras (if legally permitted) or from vehicles registered in the area[81]
- Source apportionment, where estimates can be made about the source of e.g., particulates in the air (for air quality)[82]

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[78] See also European Commission Better Regulation Toolbox and CIVITAS 2020 process and impact evaluation framework
[79] Ideas on assessing UVARs for air quality are discussed in monitoring sections of Sadler Consultants' ADEME report, and many of them are transferrable to other transport aspects
[80] A functional urban area consists of a city and its commuting zone. Functional urban areas therefore consist of a densely inhabited city and a less densely populated commuting zone whose labour market is highly integrated with the city, see: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Functional_urban_area
[81] Caveat: vehicles registered at the national headquarters of large organisations can affect this
[82] For example, this study from Berlin

- 'Big data' from external suppliers can offer significant opportunities[83]

That said, each method has its pros and cons and there is a limit to what can be realistically assessed. Long-term trends can provide useful insights on what is going on – if the data exist to recognise them. Charles Buckingham, a Strategic Analysis Manager at Transport for London, notes that TfL's long history of data collection and monitoring is helpful in assessing schemes in a city where there are many different factors. Examples of London's scheme assessments can be found on the TfL website. Importantly, monitoring an UVAR provides a basis for decision making on extending, adapting or tightening of the regulation if it is no longer be doing the job it was put in place to do.

> *"PEOPLE OFTEN SAY THESE DAYS, 'WE NEED ONE SOURCE OF THE TRUTH'. I DISAGREE. I SAY 'GIVE ME AS MANY SOURCES OF THE TRUTH AS POSSIBLE, AND I'LL GIVE YOU MY BEST ASSESSMENT OF WHAT IS GOING ON'"*
>
> Charles Buckingham, Head of Monitoring and Assessment, Transport for London

5.2. Timing of implementation

The implementation of an ambitious scheme will often need to be done in **phases** over a period of months or years as starting directly with the end goal would not be feasible – and would certainly meet with opposition from residents, businesses or others. Phasing in a scheme allows those affected to get used to the scheme and to adapt to the concept as it is gradually extended. There are several ways to phase in a large-scale UVAR. They include:

- *Geographically*: The initial UVAR area is small and is expanded in phases
- *Tightening requirements*: The requirements for entry (e.g., emissions standards) start comparatively loose and are tightened over time
- *Adding requirements*: This entails making an UVAR area accessible to fewer vehicles by adding new requirements to a scheme. For example, emissions or ISA/speed requirements (see section 5.4 for more details on ISA) can be added to an existing LTZ to improve air quality or safety in the area.
- *Removing exemptions*: A starting phase of an UVAR could exempt certain groups (for example residents in the affected area) and then removing that exemption in a later phase.
- *Tightening enforcement*: This may begin with a warning letter for the first infraction (or for a certain number of weeks or months), with fines being enforced in a second phase.
- *Replicating a measure*: The same UVAR scheme can be implemented in another part of the city

The way you choose to phase in your UVAR will likely be determined, at least in part, by the goals of your scheme. For example, if your city decides to implement a ZEZ with the goal of reducing climate emissions, it would be most effective to start directly with a ZEZ in a small geographic area and then *extending the zone*, rather than implementing a new low emission zone and then *tightening its requirements* over time. The existence of even a small zero emission zone encourages people to switch

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[83] See the TMaaS project: https://www.proximus.be/en/id_b_cl_tmaas_in_ghent/companies-and-public-sector/news/news-blog/customer-stories/tmaas-in-ghent.html and https://uia-initiative.eu/en/news/tmaas-final-journal

directly to a zero-emission vehicle or to investigate other mobility options rather than purchasing a lower-emission internal combustion vehicle that would need to be replace or got rid of in a later phase. Another ZEZ phase-in option is delivery restrictions where zero emission vehicles are given longer access windows for delivery, petrol and diesel vehicles shorter times, and these varied until zero emissions are the only permitted delivery option.

Related to this, it is important that as many phases as possible be announced as soon as possible so that those affected understand the end point of the scheme and can make the necessary decisions about how to comply. For example, they can choose whether to buy a vehicle that is compliant with the requirements of the next phase or one that complies for longer. Figure 22 shows the phases of the Bologna LTZ when it added emissions standards to the entry requirements of its LTZ. This created a combined LTZ-LEZ, which will become an LTZ-ZEZ in the future[84].

Figure 22: Phasing out polluting vehicles in the new Environmental LTZ of Bologna, Italy (source: Città Metropolitana di Bologna and PUMS Bologna Metropolitana)

Similarly, spatial intervention can be **upscaled** by adding additional spatial interventions to an existing one to have a larger impact or create a larger scheme. For example, individual actions on a few streets could be upscaled to create a circulation plan, where motor vehicles are no longer able to cross the city centre, but are required to go on an appropriate ring road. Bicycles and public transport, on the other hand, have direct, attractive and safe options to do so.

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[84] Combined schemes are increasingly common. Adding a zero emissions requirement to an existing LTZ is a good way to implement a ZEZ. This means that the number of vehicles allowed is limited, and the vehicles that are permitted are zero emission.

When assessing the situation, you may find that a particular scheme is appropriate but that certain prerequisites may be needed to allow it to function well – this might be sufficient public transport or cycle provision in certain areas. If these do not yet exist in the city, appropriate complementary measures will be needed to allow for effective implementation. While well-considered exemptions can be implemented with the scheme, additional sustainable mobility measures, financial or in-kind incentives and organisational support measures should be in place before the scheme starts.

Technology availability is another factor that may affect the start date. If you want to encourage cleaner vehicles, you need to be sure that enough of such vehicles are available on the market. For example, putting in place a zero-emission zone when there are very few zero emission vehicles in the city will lead to frustration. Similarly, setting up a low emission zone shortly before Euro 7 vehicles are available will likely encourage (unwanted) new purchases of the 'older' Euro 6 standard (the highest emissions standard available at the time).

5.3. Types of exemptions and permit

Many UVARs – particularly regulatory ones such as low emission zones and limited traffic zones – make use of exemptions and permits in different ways. A **low emission zone** (LEZ) requires that all vehicles entering the zone meet a set emission standard (e.g., at least Euro 3), the goal being to reduce pollution emissions. Emissions standards are generally valid for all relevant LEZs, and exemptions are generally either local or national. A **limited traffic zone** (LTZ) aims to restrict the number of vehicles entering a zone to certain user and/or vehicle categories (e.g., residents, public transport). A vehicle may enter the LTZ only if the user has been granted a permit in advance.

Low emission zones and limited traffic zones follow two different approaches and philosophies:

- an LEZ aims to reduce *emissions* by excluding the most polluting vehicles
- an LTZ aims to reduce *traffic* by limiting access only to essential motorised trips and/or to reduce the traffic within the LTZ

While stricter LEZs (e.g., the London ultra-low emission zone) can also contribute to traffic reduction (at least in the early stages when the number of compliant vehicles is still low), basically an LEZ accelerates the shift to cleaner vehicles with no discrimination in terms of user category, and doesn't aim to reduce traffic.

On the other hand, a limited traffic zone builds on the principle that some motor vehicle access is non-essential and can therefore be banned. This forces the shift to sustainable modes such as walking, cycling, public transport or logistics centres or forces the use of the city road infrastructure in a different and more appropriate way (using external streets or car parks).

LTZs can also include emission standards (in addition to user categories), thus incorporating the low emission zone principle to reduce emissions in those vehicles that are permitted access[85], or other requirements.

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[85] This conceptual distinction also exists when we refer to *zero* emission zones (part of the LEZ family) and car-free or pedestrian areas (part of the LTZ family).

A compliant vehicle may enter an *LEZ* if it is visually identified through a sticker or with camera enforcement as being registered in a database[86]. A vehicle may enter an *LTZ* if it has a permit or exception, either as a transponder, sticker or by being on a vehicle database.

In a limited traffic zone, the basic situation is that no vehicle may access the zone. However, certain vehicles, such as postal or refuse vehicles, are essential to the running of the zone; these vehicles are generally identified by the vehicle livery and are given exceptions. For all other vehicles, each individual entry (or vehicle) is given individual permission to enter according to the importance or priority of that vehicle or trip entering the zone. A **permit** therefore serves as proof of compliance to the rules set by the LTZ scheme. Other vehicles such as emergency vehicles, public transport or city authority vehicles that are easily visually identified, are exempted. Both LTZ permits and exemptions should ideally be clearly structured.

In a low emission zone, the term **exemption** is used more broadly to refer also to those categories 1) for which meeting the standard would be a disproportionate effort for limited kilometres, 2) where the user may have difficulty using other transport modes or 3) for emergency vehicles. The number of exemptions in a LEZ should be kept to a minimum, for clarity, fairness and effectiveness of the scheme.

This different approach may cause some confusion, which is why this guidance describes the two UVAR concepts separately. For both LTZs and LEZs, long or complex lists of exemptions with different requirements should be avoided. The fewer exemptions, the more impact and credibility a scheme has.

The general design of the scheme, the needs of users and stakeholder engagement all help identify which exemptions or permits might be needed in the UVAR. The inclusion of different types of exemptions should not be seen as a suggestion that an UVAR should have such an exemption or permit, but as an indication of the types available – perhaps to be seen as a 'maximum' list of exemptions and permits.

5.3.1. Different types of permits

Limited traffic zones require most vehicles or trip types to have a permit to enter, both physical and digital.

Permits options include:

- Manual permits
  - Windscreen sticker (with or without hologram)
  - A letter in the windscreen granting permission
  - A transponder (e.g., RFID, DSRC) in or on the vehicle that opens a barrier
- Digital permits
  - Inclusion in a database whitelist of vehicles allowed entry

Low emission zones sometimes require an active permit be obtained. Others might require an active permit for some vehicles, but not for others, such as most national vehicles (as the needed information is obtained from the national vehicle database).

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[86] This conceptual distinction also exists when we refer to *zero* emission zones (part of the LEZ family) and car-free or pedestrian areas (part of the LTZ family).

The type of permit is linked to the enforcement scheme: generally, a sticker or letter is needed for manual enforcement, a database for ANPR enforcement and a transponder for some of the other options.

As with other enforcement issues, the decision about which method to use is linked to the enforcement method as well as to aspects such as the size of the scheme, type of area it covers, planning permission, resources available, number of permit categories and political, economic and cultural factors.

If a permit request cannot be processed or validated on the day of the application, permits or transponders can be sent by post, or applicants can be asked to pick them up in the issuing office. Sometimes printed and visible permanent permits are preferred to virtual ones for reasons of transparency and for easy check/identification by the local police and the community. In the absence of camera/RFID transponder-based enforcement systems, hologram stickers on permits can help to avoid falsification.

5.3.2. How long a permit or exemption should be valid for

Some permits or exemptions might be permeant, for example those for emergency services. However, there are advantages to permits being time limited, be it 6 months or 5 years, to allow greater flexibility in the requirements over time. For example, a resident who has moved outside the zone and is no longer eligible for a resident permit is unlikely to give up their permit if it is permanent.

5.3.3. Types of exemptions in low emission zones

In principle, in a low emission zone, all vehicles must meet an emission standard to be allowed access. All schemes allow for exemptions to the established rules for certain vehicles and for certain user categories.

Ideally public service vehicles should comply with all requirements and not require exemption; this demonstrates that the municipality is leading by example. On the other hand, complying with LEZs often costs money, so exemptions can be used to lessen the financial impact on particular groups and to avoid disproportionate costs for high-cost vehicles that are rarely needed in the area. Exemptions, if carefully administered, can help increase acceptability and feasibility of the scheme and can allow the implementation date to be brought forward.

A balance must be found between ensuring access to those who really need it but are unable to afford a compliant vehicle, and a long list of exemptions that weakens the LEZ. Exemptions should be (and be seen as) fair, clear and simple, and should not give the appearance that large numbers of vehicles are exempted.

Table 4 gives a list of types of exemptions and their uses. This list should **not** be used as a list of the types of exemptions that an LEZ **should have**; your UVAR may not need all of them. It should be seen more as a 'maximum' list of those that exist elsewhere.

Table 4 Types of exemptions in low emission zones

Type of exemption	Explanation	Further consideration/details
Key roads	Legally required for roads needed for inter-European travel e.g. Trans-European Network (TEN) road network, motorways, harbour access roads due to the EU freedom of movement principle	The Austrian A12 motorway LEZ[87] has a relatively low standard for this reason.
Military vehicles	Usually exempt	Military vehicles are rarely used in urban areas.
Emergency vehicles	Widely used as their entry is essential and vehicles such as ambulances are expensive specialist vehicles.	Good practice is to work with the providers to aim for compliance with the scheme.
Specific expensive low-mileage vehicles	Widely used when such vehicles are needed. These include off-road vehicles which are allowed to drive on the highway, mobile cranes, concrete mixers, mobile suction machines, show/circus vehicles, agricultural vehicles, (non-commercial) historic vehicles.	The aim should be to keep this list short. An alternative would be to allow a certain number of paid exemptions per year.
Hardship	These exemptions are designed to reduce disproportionate impact on low-income drivers/operators and reduce the potential negative socio-economic impact without significantly reducing the positive environmental impact. These are used in the Netherlands and Germany for individuals or companies where compliance would cause significant financial difficulties.	In practice, few were applied for but it increased acceptance by ensuring that compliance didn't endanger businesses. In Germany, one must prove that retrofitting is not possible and that either a) the applicant's income per dependent is below a given level or b) purchasing a compliant vehicle would risk bankruptcy. In the Netherlands applicants are assessed on a case-by-case basis.
Retrofits	These are used to allow more cost-efficient compliance. Sometimes retrofitting to the emissions standards is included as an exemption. Sometimes retrofitting is made part of the standard.	The actual particulate reduction is also increased with diesel particulate filter retrofits, compared with meeting the next Euro standard. A later phase of an LEZ may remove the permission to use retrofitting to comply if the retrofit does not address all pollutants.

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[87] See: https://www.urbanaccessregulations.eu/countries-mainmenu-147/austria-mainmenu-78/a12-motorway-tirol

Type of exemption	Explanation	Further consideration/details
Interim/ sunset clauses on exemptions	Any exemptions can be of limited duration, for example those at the start of a scheme or phase, including: • where residents/businesses had little lead-in time to comply (and the vehicle was owned before the LEZ was announced), • to give some types of drivers (e.g., disabled) additional time to comply due to the (expensive) modifications made to the vehicles.	An alternative is to give sufficient lead time before initiating or to have an interim period (perhaps six months), where notices are given instead of penalties (e.g., a letter saying "if we had enforced, you would have received a €XX fine"). This can also help inform affected parties. Another option is to bring in restrictions of certain categories of vehicles or drivers at a later phase of an LEZ, with standards tightened over time. The period of any exemptions with sunset conditions should be clearly defined and should not be extended. As with any exemptions, they should not be used too widely.
Specific journeys or temporary exemptions	Specific vehicles entering the zone may be able to apply for exemptions in some LEZs. Usually this is limited to certain specialised high-cost vehicles (e.g., crane lorries). In weaker schemes, they may be available for specific or individual trips.	Either individual entries for "the common good" or a certain number of entries can be purchased (see below). These need to be carefully and sparingly given.
Vehicles for registered disabled persons	There are different ways of identifying vehicles for people with disabilities. These can include referring to a specific disabled vehicle tax class, a disabled vehicle entry on the national vehicle database or a Blue Badge. Increasingly, cities look to exempt vehicles that would require expensive adaptations and thus create hardship for vulnerable or disadvantaged communities.	Different to LTZs, affected people with disabilities can still access the area if they comply with the emissions standard (although disabled vehicles are still exempted in some countries). This includes Italy, where LEZs are based on the same legislation as LTZs, and where there are also generally more exemptions than in other countries.
Limited purchased exemptions	These give the potential for wide ranging exemptions that would otherwise cause a high administrative burden. They are a form of exemption where a certain number of entries can be purchased. These avoid the bureaucracy of exemptions while allowing those vehicles that occasionally need/wish to enter the zone the opportunity to do so. These can avoid the need for many of the other category of exemptions.	The premise is that regular visitors will have more impact on air quality (and congestion) than those who rarely enter. The Belgian model allows for a maximum of eight entries per year for an administrative fee of €35. The London model has a high daily charge that works as both a penalty and a charge (€14.50-2330 for a single daily entry depending on vehicle type[88]).

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[88] The London ultra-low emission zone has a daily charge of £12.50 and a penalty charge of £160. The London low emission zone has a daily charge of £100 - £300 and a penalty charge of £500 - £2,000, depending on vehicle type.

Type of exemption	Explanation	Further consideration/details
Electric and hybrid vehicles	Although electric vehicles are often officially exempted in LEZs, in practice this is not necessary (unless perhaps as a political statement), as EVs meet the emissions standards.	Standards for all hybrid vehicles should be based on their Euro standards. Mild hybrid[89] exemptions should be avoided due to their relatively limited benefit in real-world driving. The impact of plug-in hybrids is being downgraded as less beneficial than previously estimated[90], so exemptions of plug-in hybrids should be considered carefully – also with the rapid improvement in 100% zero emission vehicles.
Where and when public transport is not available	Some German and Italian schemes give exemptions to individuals unable to afford a compliant vehicle and whose shift work starts or ends when there is no public transport available.	These exemptions are rarely used any more, and alternatives include other complementary measures.

Increasing numbers of UVARs give the possibility for users to purchase a limited number of exemptions per year to simplify the exemptions and reduce the need for many of the above categories. This also reduces the resources needed on both the driver and the city's side of proving the need to enter and should be particularly considered for new LEZs and LTZs.

5.3.4. Exemptions and permits in limited traffic zones

The purpose of a limited traffic zone is to reduce the number of vehicles in the area, while the aim of a LEZ is to change the vehicles entering to those with lower emissions. An LTZ does this principally by permitting access to a limited set of user or vehicle categories (mostly to guarantee essential access needs). LTZs use both exemptions and permits to function properly.

Again, these lists *should **not** be seen as a list of the types of exemptions that an LTZ **should have***, but can be seen as a guide to the issues to consider – and perhaps conclude that they are not needed. Long or complex lists of exemptions and permits with different requirements should be avoided, as this reduces the transparency as well as comprehensibility of the scheme.

5.3.5. Exemptions in limited traffic zones

Commonly exempted motor vehicles (i.e., those that do not need to request and show a permit to enter an LTZ) are vehicles that are visually identifiable, and include:

- Emergency service vehicles (police, ambulances and emergency doctors, fire service)
- Waste collection and street cleaning
- All forms of public transport including taxi and registered car-hire with driver services

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[89] The two main types of hybrids are a plug-in hybrid, which can typically run on electric-only power, and a mild hybrid vehicle, which cannot run on electric-only mode and does not have a plug-in battery.
[90] See T&E press release and IPPC study

- Postal / parcel services[91]
- Utility vehicles (e.g., electricity, gas, water, sewage or Internet network operators)
- Surveillance vehicles (parking wardens, security firms)
- Funeral vehicles
- Transport of money and valuables

These vehicles are normally – and sometimes automatically – included in the whitelist (if a camera-based enforcement system is in place) or given a transponder (for physical boundaries) or not penalised by the local police if the exemption is indicated in the regulation.

5.3.6. Permits in limited traffic zones

LTZ permits are linked to the categories indicated in the local regulation or ordinance, and are primarily divided into five groups:

- the user's **place of residence** (i.e., people or businesses who live or operate within the zone)
- **health/physical condition** (people with reduced mobility, people who need assistance)
- **regular and ongoing need for access** (e.g., garage owners/tenants, couriers, maintenance workers, caregivers, etc.)
- **occasional access** (e.g., hotel clients)
- **one-off paid-for permit** that anyone can buy, as an hourly or daily permit, limited to a few times a year per number plate; this can significantly reduce the number of temporary permits and categories and the burden of checking the requirements for them.

Especially for the first two categories, the vehicle and/or its owner must demonstrate that they meet the requirements defined above and must formally request (and display) a permit. Different rules indicate whether a vehicle may circulate and load/unload or pick up/drop off or if it may also park in the LTZ. However, this is less so for the short-term permit.

Sometimes **costs** are attached to various types of permits (the building block "Permit Charge". Costs can differ according to the type of vehicle/permit applied for. In Bologna for example, second and third permits for the same household are much more expensive than the first permit, to discourage multi-car households. Permit fees can apply to some, or all, permits to cover the costs of LTZ operation, or if well considered, to raise money for sustainable mobility measures. This is a congestion charge 'by the back door'. Care needs to be taken that large numbers of (income generating) permits do not jeopardise the goal of the UVAR. In any case, raising money through permit fees should be considered carefully, as it can have impacts on how the UVAR is perceived and in terms of equity. It is important to have transparency about the use of any revenue – especially if part of the intent of the LTZ is to raise revenue.

Permits should have a predefined duration e.g., 1 to 5 years (**renewable**), **temporary** (e.g., limited to a defined number of months or days) or **short term**/**occasional** (e.g., a day pass or hourly pass). Permanent permits should be avoided, as they reduce the flexibility to change the scheme in the future.

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[91] These are sometimes exempted and sometimes require a permit. Because of their large number, parcel services may require a permit – sometimes also with conditions for operation; see overlap with freight carriers below.

Main LTZ permit holders

Following is a list of the main user categories generally allowed to hold a permanent or temporary permit for a limited traffic zone:

- **Residents** permanently living in the LTZ (as stated by the municipal registry office as owners/tenants of a property)
- **Owners/tenants of a garage** in the LTZ
- **Freight carriers** (often allowed only in specific time windows), e.g., express couriers, parcel delivery services or logistics companies, or companies delivering goods on an own-account basis (e.g., retailers located in the LTZ, food and beverage producers/distributors, companies transporting heavy or bulky goods, street/public market vendors, pharmacies, catering services, florists, etc.)
- **Maintenance and tradespeople** providing regular and ongoing services in the LTZ (often allowed only in specific time windows), e.g., providers of technical assistance on IT systems, elevators, bar equipment, cleaning companies, electricians, plumbers and other tradespeople
- **People with disabilities** with an EU parking card[92] or disabled vehicle tax class
- **Caregivers**, either professionals or relatives who provide assistance to someone living in the LTZ who is dependent on their help (e.g., elderly or disabled persons, children)
- **Doctors** of the local health service and/or with a clinic in the LTZ
- **Public institutions**, for their official fleet only

Occasional and temporary permit holders

There are many types of occasional or temporary permits to a limited traffic zone, given below. The types of permits that are used include:

- **Tradespeople**
- **Construction companies**
- **Event organisers**
- **Wedding cars**
- **Removal companies** performing house moving operations
- **Visitors** of an LTZ resident (with the resident applying on behalf of visitor, contractor or supplier)
- **Guests of hotels** in the LTZ, usually only for check-in and check-out with hotels applying on behalf of their guests
- **Justified urgent and/or occasional needs** (normally with a maximum number of accesses per month)

However, most of these categories can be replaced by the option to gain or purchase a limited number of single-day permits per number plate.

Other possible (permanent) permit holders

Less restrictive LTZs might also include the following categories as holders of a permanent permit (instead of an occasional one). A good practice LTZ will minimise these permit types and again, the occasional paid-for permit may be an alternative for many of them:

- **Non-permanent residents** – individual citizens or families who live for certain months/ weeks of the year in the LTZ, e.g., university students or owners/tenants of a vacation property)

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[92] This is often abused, so cities are increasingly considering other options for allowing disabled access.

- **Retailers and tradespeople** located in the LTZ
- **Professionals** located in the LTZ
- **Owners of private properties** in the LTZ but not living in the LTZ
- **Minors not living in the LTZ** who need to be accompanied to school or to relatives in the LTZ
- **Private vehicles of people acting in an institutional role or working for a public entity,** e.g., police officers, city council officers, city council members
- **Journalists and media companies**

Further vehicle-related permits

In addition to user-related eligibility categories, LTZ regulations and ordinances may include vehicle-based or other conditions/restrictions. This means that some vehicles might be entirely excluded from the possibility to obtain a permit, even if the user is eligible.

The most common restrictions are **type or size restrictions** (e.g., excluding heavy duty vehicles entirely or limiting their permitted weight or length, or car-free areas where bicycles should be the predominant vehicles).

As noted, emission standards can also be part of the scheme, thus embedding aspects of a low or zero emission zone into the LTZ. This is, in fact, a good way to phase in a zero-emission zone: the overall number of vehicles is limited, and the few vehicles allowed in are zero emission. Another option is delivery restrictions, where zero emission vehicles are given priorities.

Another relevant restriction is **the number of vehicles** allowed per permit household (e.g., maximum 2 or 3 vehicles per resident household). In some LTZs, permit holders may associate more vehicles to the permit but can only access the zone with one vehicle per day/time (i.e., they are fined if two vehicles are inside the LTZ at the same time).

5.3.7. Managing permits (and exemptions)

For every limited-traffic zone, eligible users must complete and submit a permit request. Such requests are processed by a **permit management system.** This system receives the application, performs or facilitates the verification processes necessary to validate the user's request, and finally issues the respective permit.

Depending on the design and impact of the LTZ, the number of permit requests needs to be decided. This might vary with time – perhaps phasing the LTZ in by reducing the number of permits over time. Where the permit system is manual, or the permit requirements need to be checked manually, the city resources available is also a factor in the number of permits.

In the most basic configuration, all tasks associated with the permit management system are done manually. Applicants submit a request in person at the front office of the LTZ manager (a public authority or a mobility/parking company) and personnel receive and process the application. Depending on the type of permit, this request may include supporting documents (e.g., proof of residence, vehicle registration, medical documents) whose validity should be verified. In the case of a positive assessment of the application, the corresponding permit is issued. Although this is the current reality, we recommend digitalising the process. This would help reduce the administrative burden and be easier for those who may have difficulty getting to permit office, including people with disabilities, the elderly, people caring for dependants and people in full-time work, especially if they are already registered in the area. Table 5 outlines the pros and cons of the different permit management systems.

It is crucial to simplify the application and validation processes as much as possible to ensure compliance and reduce the administrative burden for both applicants and for the city. For example, the

application form may include declarations and information that would remove the need to attach official certificates/documents.[93]

Table 5: Pros and cons of various permit management systems

Permit management system	Pros	Cons
Fully manual	• Low upfront costs • Most appropriate for small-scale low-traffic schemes	• Requires all applicants to submit application in person • Cumbersome for occasional applicants (e.g., tourists, unless limited permits are available on street on a paid-for basis) • Administration and personnel costs are high and validation times are comparatively long
Digital (note that digital application systems should also allow for applications to be submitted manually for those unable to do so digitally)	• Can manage a larger number of applications across several permit categories • Some types of permit application can be fully automated • Lower personnel costs and validation times • Reduced burden on applicants, as they do not need to apply in person, and the application can be done on-line 24/7 • Available commercial products may make implementation easier and lower upfront costs • Users increasingly expect an online application process • Costs are likely to be lower in the medium to long term • Easier for many people with disabilities	• Higher upfront costs (which could be lowered by using a service provider with monthly costs rather than having a dedicated software solution provided) • Training of personnel may be required • Service/maintenance costs are incurred

To manage a high number of applications and reduce the burden on personnel, cities increasingly opt for a digital permit management system. It may be possible for a city's internal IT/website service to design and implement an online permit management system (e.g., Pamplona or Siena). Alternately, third parties offer products to support cities with permit management systems; these can be embedded into the city website or use a tailored portal. The LTZ websites of Cortina and Martina Franca in Italy have LTZ websites provided by Parkforfun (Figure 23**Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.Error! Reference source not found.**), and Ghent's permit management system software, *City Permit*, is provided by Sigmax (Figure 24). A digital application

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[93] The process is more rigorous for those applying for a permanent permit, usually requiring at least some documentation to be attached.

system can also be helpful for those who cannot easily get to the permit offices (including parents with small children, the elderly and people with disabilities).
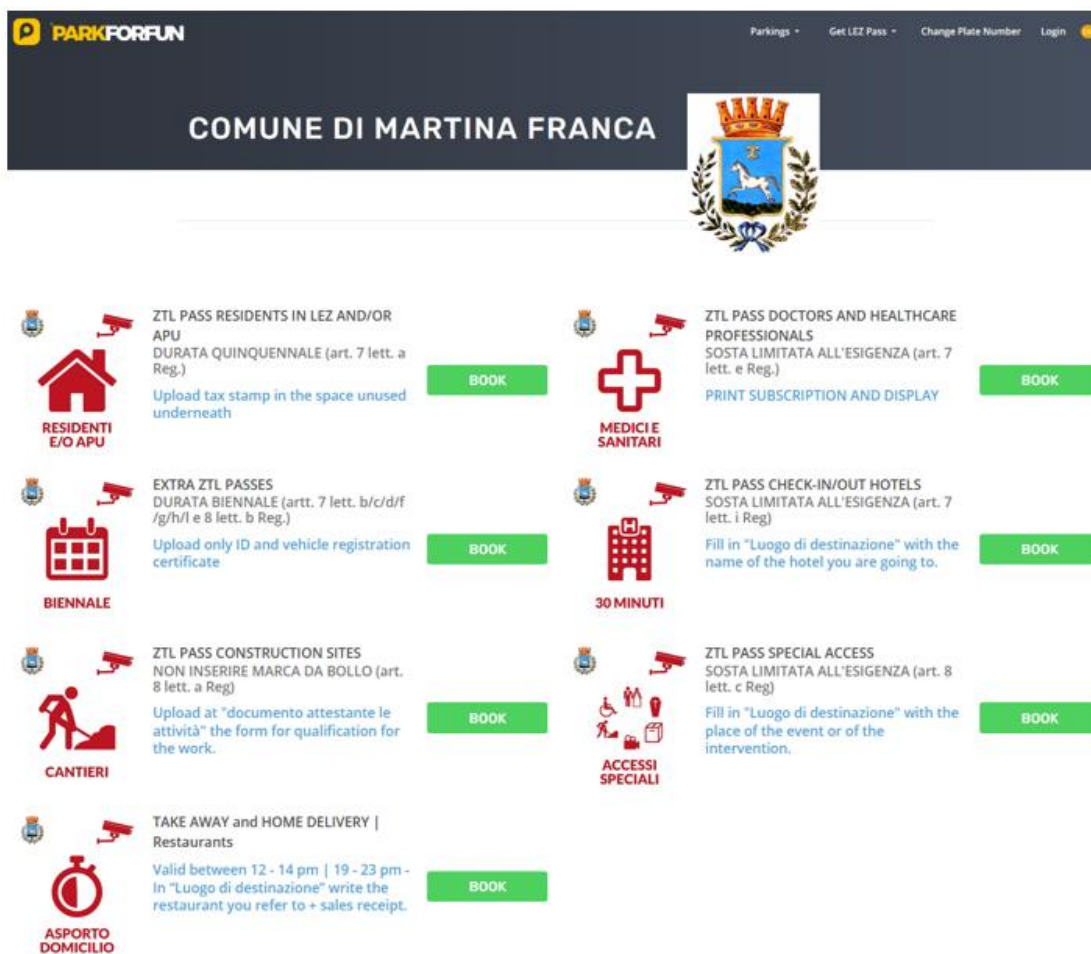

Figure 23: The LTZ information and permit management system of Martina Franca, Italy (source: Parkforfun)

Figure 24: The LTZ information and permit management system of Ghent, Belgium (source: Stad Gent)

Digitalisation and a user-friendly design of the permit management system can make it easier and more convenient for vehicle operators (thereby increasing acceptance) and can significantly reduce the resources needed for permit management. Martina Franca is a small town in Southern Italy with a population of 50,000. The permit management solution provided by Parkforfun accelerated the productivity of front office subscriptions by a factor of five and online requests by a factor of 10 compared with manually processing the requests.

It is important to stress that – except for the paid-for permits that are limited to a few times a year every – all permit requirements must be checked and validated by the issuing authority. There are tools that can reduce the time needed for processing a single permit, such as tablets with cameras, uploading of digital attachments and/or clear application and validation processes. This reduces both personnel costs and the administrative burden (for both the city and the driver).

Where possible, having the same department responsible for granting permits and exemptions and for sending fines can ease the resolution of issues. It is also beneficial in terms of maintaining the privacy of personal data.

Systems can allow applicants to register their application using an electronic ID card or a security code via mobile app (see Figure 24 from Gent), and then apply for a specific permit category and submit the supporting documentation digitally. Payment of any fees, either for permits or one-off exemptions/ permits, can also be carried out within the website application.

The requirements for a permit request vary depending on the permit type. Permanent or temporary permits require applicants to submit supporting documentation. Occasional permits, on the other hand, require little to no documentation and can in some cases be generated immediately. An online process can therefore deal with all applications for occasional permits and also issue permits (doing so automatically for whitelist entries) and notify applicants of the outcome. This enables a city to focus its personnel resources on validating and verifying documentation for permanent and temporary permits.

Exceptions can also be managed through an online system. On the other hand – particularly for low emission zones where few exemptions are desirable – making the process of applying for an exemption too easy may increase the number of applications, which might be counter-productive. However, the same approach for occasional exemptions may be useful. The Antwerp LEZ, for example, offers the online purchase of day passes that can be bought up to eight times a year.

A digital permit management system can facilitate the application of permits by non-local users, as they could apply for a permit online in advance; otherwise permits that need time to grant or issue are difficult for visitors. Hotels, visiting doctors and sometimes residents in an LTZ can usually apply for occasional permits for their guests, visitors or patients. The LTZ schemes in the cities and towns in the Italian region of Veneto use a single digital permit for disabled persons, by connecting to the ZetaTiElle Network, a system that certifies EU blue badges and automatically allows drivers with disabilities access to several LTZs with just one application. This is an attempt to reduce abuse of the blue badge system, which is common in Italy and elsewhere.[94]

Users should always be able to request a permit without the need of an electronic device, i.e., in-person or postal applications should always be available as an option. Providing different means to apply can increase compliance; it also creates a system that is friendly for more user groups (see the user needs section 4.3).

5.4. Geofencing and Intelligent Speed Assistance (ISA)

In geofencing, regulations (e.g., speed or engine used) are defined digitally by the relevant authority for the geofenced area and are communicated digitally either to the driver through an in-vehicle notification or directly to the vehicle. Within the context of UVARs, there are several ways geofencing could be used. It could be used for:

1.   Speed reduction (when combined with Intelligent Speed Assistance; see below),
2.   Emission reduction, by automatically switching plug-in hybrid (PHEV) vehicles to electric mode within the zone, and
3.   Triggering C-ITS messages to vehicles, informing the driver of UVARs, particularly for dynamic UVARs

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[94] The European Commission is working on measures to improve cross-border foreign vehicle enforcement, see https://uvarbox.eu/uvarexchange/ for updates.

Geofencing for **speed reduction** can give the driver a warning about excess speed or prevent a vehicle from being able to exceed the posted speed limit. This appears to be the most valuable use of geofencing: using it as a requirement for limited traffic zone permits to prevent a vehicle from exceeding a set speed.

In terms of **emission reduction**, geofencing can either force a plug-in-hybrid vehicle to switch from a fossil fuel to electric mode or monitor/confirm that a switch has been made. However, plug-in hybrids are an interim technology, allowing vehicles to become zero emission when switched to electric mode. Given the rapid development of 100% ZEVs, and the development and cost of the geofencing equipment, this is now not seen as cost effective or the right way to go. There may be niche uses for it, such as with public transport (as is being trialled in Scandinavia) but this document does not go into this option in further detail.

In terms of **triggering information sent to a vehicle via C-ITS**, in practice, it is the updating of satellite navigation devices with digital data (see the digitising section 4.4.7) that is relevant for most UVARs, as well as status information for dynamic UVARs to save the driver needing to find out if the UVAR is in place at the moment. The UVAR Exchange project demonstrated the sending of information via C-ITS in 2022; more information can be found on the UVAR Exchange website.

5.4.1. Geofencing

Regulations (e.g., speed or engine used) are defined digitally by the relevant authority for the geofenced area and are communicated digitally either to the driver through an in-vehicle notification or directly to the vehicle, e.g., by automatically switching the vehicle from petrol to electric power or lowering its speed. This would be in addition to the usual communication of the UVAR.

On the technical side, in order to work, vehicles need to have a geographic positioning system (GPS) that is linked to a digital map of the relevant zones, so that the system knows when it is in a geofenced zone.

5.4.2. Advanced Driver-Assistance Systems (ADAS)

ADAS is a technology that can have similar uses as geofencing, but instead of using georeferencing, the information is given to the vehicle and to the driver by in-vehicle equipment such as cameras, which capture road signs and actively enforce the regulated behaviour.

On the technical side, ADAS-equipped vehicles would be able to use normal street signs (assuming they are of adequate quality and correctly placed). It also does not essentially require a central system for communicating the regulation digitally.

5.4.3. Intelligent Speed Adaptation (ISA)[95]

ISA is designed to work much like cruise control that can be used a) to prevent a vehicle from travelling over the speed limit, or b) to warn the driver about the speed limit. In terms of UVAR, option a) should be used. Option b) is the minimum that is required for **new** EU light duty vehicles from 2022 and **all**

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[95] ISA is referred to as both intelligent speed assistance, and intelligent speed adaptation – we have also used both here.

vehicle produced from 2024[96]. Where ISA prevents the driver from travelling over a set speed limit, a temporary override may be needed in cases of emergency; this would be logged to find out if its use contributed to an accident. ISA can use both ADAS and geofencing. Within the ReVeAL project, ISA was tested in Helmond as a means of keeping vehicles from exceeding the speed limit[97].

5.4.4. Using geofencing in limited traffic zones (and other UVARs)

ISA could be one of the requirements for gaining a permit to enter a limited-traffic zone or for receiving a taxi licence. Not all vehicles need to be equipped with ISA to reduce the average speed on the road; even if a proportion of vehicles is equipped with ISA, this affects the speed of most of the vehicles, ISA would not even have to apply to all permits.

5.4.5. Geofencing or ADAS?

Each technology has pros and cons; whereas ADAS-based solutions can avoid the need for digital maps of each zone to be present in each vehicle, geofencing allows more control and variation by the UVAR operator. It is likely that ADAS could be effective for new UVARs, as new signs would have to be assessed and placed anyway. For larger schemes, geofencing would also affect trips that are entirely within the area, which may be harder – but with memory of the last sign, not impossible – with ADAS. Combining geofencing with ADAS would mean that one system could operate in places where there were no data for the other. In this case, a hierarchy would have to be established deciding which takes precedence where both exist (and diverge). This would likely be the road signs, as they often have legal force. This hierarchy is also needed if ADAS is to be used with pre-loaded or dynamic digital maps.

Geofencing requires the digitisation of maps and regulations as well as a satellite signal. However, as it is independent of local road signs, geofencing can be more flexible and can incorporate dynamic regulations.

ADAS can use existing road signs (as long as there are clearly visible, unobstructed road signs at every entry and exist to the UVAR area). Signs need to be placed correctly and be readable, including end of restrictions signs, otherwise there will be problems with de-activation of the speed limiter. ADAS is not affected by signal issues and is based on technology that is already used in many vehicles to provide advisory speed information; however, it is not flexible in terms of time or geography. In addition (and importantly), road signs that are understood by the ADAS are needed to warn of the approach of an UVAR zone (i.e., in addition to the signs at the boundary) to enable the driver to divert if necessary.

The overall number of digital maps is increasing due to their use for other purposes, such as navigation or route planning, and they may complement road signs in the future[98]. ISA road signs, in turn, are likely to be needed for more widespread use of ADAS and ISA. Where there are sufficient (appropriate) road signs, ADAS can work without the support of digital maps. It is worth noting that more and more roads will likely be equipped with advanced communication technology (e.g., 4-5G, ITS-G5, 4G and C-V2X) to support C-ITS and communication with vehicles. This will reduce geofencing signal issues.

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[96] See https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=PI_COM:Ares(2021)2243084&rid=1 for further details
[97] see https://civitas-reveal.eu/wp-content/uploads/2022/08/ReVeAL-public-report-on-Intelligent-Speed-Adaptation.pdf for more details or a shorter version at https://drive.google.com/drive/folders/1yBBp9EPY8_hRmci1DqCWc7bgYI91UrCm?usp=sharing

[98] See, for example, this information from TomTom.

5.5. Foreign vehicle enforcement of UVARs

When using ANPR enforcement, the UVAR operator checks the emissions standard with the national vehicle database (for low or zero emission zones), and if a vehicle enters any type of UVAR zone that does not comply with the requirements, the vehicle owner or holder information can be given to the UVAR operator, allowing a fine to be sent. Foreign vehicle enforcement is currently difficult as few national vehicle databases share data with foreign cities[99]. The exception is tolling schemes, which can use the European Electronic (road) Toll Systems EETS[100]. The EU project UVAR Exchange is looking into and piloting solutions to the issue of foreign vehicle enforcement, with a view to making it easier, including through changing EU legislation. See the UVAR Exchange website for updates.

For schemes which require stickers or RFID responders, the sticker will be relevant for foreign as well as national vehicles, making the identification of emissions standard less of an issue. For ANPR schemes where there is no access to the vehicle database, foreign vehicles are often required to pre-register. The exception is for the Netherlands, where the emissions standard and other data of the vehicle is open data[101]. Some UVARs have penalties for not registering in addition to fines for not complying with the scheme.

Where an infringement is identified, the current possibilities to enforce fines for foreign vehicles once non-compliance is identified are bilateral agreements or third-party European Debt Recovery agencies, which is successfully used in many schemes across Europe. Where there are bilateral agreements (check with the national authority), then EUCARIS provides the technical ability to exchange data.

5.5.1. Foreign vehicle enforcement of ZEZs

While the EU UVAR Exchange project is working to identify solutions, in the short term the identification of zero-emission vehicles is made easier by the fact that some countries have number plates or emissions stickers that indicate electric vehicles. As of autumn 2022:

- Austria, Czechia, Hungary, Latvia, Norway, Poland, Romania, Slovakia, the United Kingdom and Ukraine have electric / zero emission number plates, and the Netherlands is planning to do so.
- Swiss electric vehicle number plates have the same number plate as motorcycles.
- In Germany the electric vehicle number plate is joint with plug-in hybrid vehicles.
- The French LEZ sticker 0 is for zero emissions vehicles
- The Spanish LEZ sticker 0 is for zero emissions vehicles and PHEV that have a 40 km electric range.
- Portuguese EVs with a blue identification sticker in the bottom right corner of the windscreen can use electric vehicle advantages.

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[99] This is a longstanding issue with UVARs and LEZs in particular. As vehicle emissions are not available for most foreign vehicles, ANPR schemes must require foreign vehicles to register. While a patchwork of bilateral agreements could help, the only real solution is EU-wide action.
[100] See Directive 2004/52/EC, EC Decision 2009/750/EC and Directive (EU) 2019/520
[101] https://www.government.nl/topics/vehicles/vehicle-registration/viewing-the-vehicle-registration-register

5.6. Camera enforcement and privacy issues

One of the most common UVAR enforcement options is automatic number plate recognition (ANPR), where cameras are used to capture and then digitise vehicle number plates. At an EU level, the General Data Protection Regulation (GDPR) and the Data Protection Law Enforcement Directive are relevant[102], and most countries have specific laws relating to the use of camera enforcement. By taking privacy issues into account in the early stages, serious problems can be prevented at later stages. This means that privacy issues are a crucial part of balancing interests and creating broad support for decisions rather than an impediment to be overcome.

It is important to have the right number of cameras. Insufficient numbers of cameras may lead to drivers taking short cuts to avoid them. On the other hand, large numbers of cameras are expensive. If funds are limited and all entry roads cannot be covered, a combination of static and mobile cameras may help reduce this issue[103].

ANPR system may cause different privacy issues such as:

- unnecessary data mining and risk profiling
- risks regarding the reliability
- interpretation and diffusion of the data of personal vehicles
- citizen concern related to the widespread use of city cameras, leading to private life monitoring

While privacy issues do not need to limit the introduction of ANPR, it is strongly recommended that they are taken into account when discussing, shaping and introducing any such system. In deciding whether you can 'justify' using ANPR, in many cases, it may come down to a judgement, balancing all the factors involved and enforcement options for the UVAR under consideration. The situation can vary between different countries.

There are several problems and challenges that are often raised when planning camera enforcement for UVARs. The following sections discusses these and their solutions. There is also camera enforcement guidance and practical tips from the Dutch LEZs[104] which might be useful.

5.6.1. Privacy issues

Privacy issues are often the most important concern with using enforcement cameras. There are different national sensitivities with regard to camera use: in the UK there is widespread use of cameras in many aspects of life; by contrast, in Germany, using cameras is very controversial and allowed only in certain specific settings.

Privacy is an interest that should be balanced against other interests. It is often incorrectly regarded as an obstacle for achieving practical enforcement results. There should be a balance between the opposing factors - the need to enforce against any privacy issues

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[102] https://ec.europa.eu/info/law/law-topic/data-protection/data-protection-eu_en and
https://ec.europa.eu/info/law/law-topic/data-protection/eu-data-protection-rules_en
[103] The Dutch guidance note, closed cordon or fewer cameras? is useful here
[104] https://opwegnaarzes.nl/kennisbank, or translated into English
https://drive.google.com/drive/folders/1v06ssryuTE4Mtaf5trb54LvBYHeMKoRW?usp=sharing

The issue of identifying the driver has several solutions, including those below, however the different requirements in different countries mean that not all of these will be relevant everywhere:

- The camera only reads the number plate of the vehicle that has entered the area (plus if needed by law, the driver's face)[105]
- Faces of any passers-by can be blurred/pixelated in the photos if it is not possible to focus the camera as described above
- Number plates of passing vehicles also blurred/obscured, as described above
- The photo that proves the offence has been committed is only available online with a QR code to protect the privacy of those in the vehicle.

5.6.2. Data storage

Data storage is a controversial subject in the debates on ANPR, as the storage has a significant impact on the data processing possibilities and the privacy resulting from it. Different storage aspects that affect the level of data protection, security and privacy include:

1. The amounts of data stored (the general rule is to minimise the amount of data stored)
2. Types of data stored (i.e., how sensitive the data is[106]),
3. The duration of storage (as short as possible)
4. The type of storage (e.g., paper / digital, on the camera device itself, stand-alone PC, network or cloud, listed in order of increasing risk)
5. Storage locations (which country the data is stored in – preferably the national country, and certainly not outside the EU)
6. Accessibility rights

Privacy risks increase in a system in which there are large amounts of data, the data is sensitive and/or it is stored for a long time. A camera enforcement system that processes data immediately – including within the camera system itself – and does not store them – is the most desirable. This means that as soon as a registration number has been identified as complying, its record is deleted. If stored at all, the data should be stored for as short a time as possible. This is especially true for the time that the number plate data is linked to the owner's name and address. The data must be used only for the purpose for which they were originally intended and collected – i.e., in this case, for vehicle and traffic enforcement in certain city areas; with the possible exception of police access (see the Dutch guidance tip on this issue).

For an ANPR enforcement system to work, at some point it will need a database (or linked databases) containing vehicle and possibly driver images, number plates and, if the vehicle does not comply, vehicle owner name and address to enforce a fine. This data would need to be held until the fine is paid or the legal process has concluded, which could be a relatively long time. The databases can also contain millions of files on vehicles and persons, each containing hundreds of attributes. All these issues increase the privacy concern.

In big databases, data processing is only possible in automated ways. For this reason, techniques may be used to limit data mining to that which is necessary, such as:

- include the data needed to serve a penalty notice

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[105] A location should allow you to focus the lens on the data needed, while avoiding the recording of passers-by or neighbouring buildings.
[106] data may be assessed with different levels of sensitivity in different countries.

- pseudonymisation[107] and
- data anonymisation.

5.6.3. Public concern

Certain constitutionally protected rights are at stake with extensive video surveillance. The first such right is anonymity, which is closely related to privacy. Many people expect to remain anonymous in public places. The presence of video cameras in public places, even if for traffic surveillance, is sometimes perceived as a way to capture and monitor daily activities of individuals. As noted above, this concern is greater in some countries than in others.

Citizens should be well informed about camera enforcement, in particular about aspects such as:

- Camera-specific purpose and location
- Personal data collection techniques
- How long the data is stored, and under what conditions
- The type of data collected and stored
- Image storage duration

Citizens should be aware that vehicle camera surveillance and enforcement takes place only for purposes related to serving a penalty notice and traffic enforcement. They should also know that video surveillance in public places is permitted only if it is proportionate to pursuing objectives and can only be activated when the other options would result in inadequate enforcement or too much impact on traffic flow. To achieve this, it is mandatory to inform the public about video surveillance through public information and visible signage. See the end of section 4.4.6 on signage.

5.6.4. Proportionality

To use cameras for enforcement, you may need to show that the use of ANPR:

- Is proportionate. It can be justified as the only effective and cost-effective method of enforcement (i.e., it is the 'minimum intervention' to achieve the purpose)
- Is accompanied by sufficient measures to protect data and privacy

5.6.5. Legal issues

Other issues in addition to privacy ones can also be relevant, such as the legal framework to use camera enforcement for the UVAR in question. It helps to have a privacy/GDPR expert in the city legal department who can help resolve any issues that arise.

The legal status of the data is an important aspect. This can vary from country to country, and you should check the status in your country. In France, the number plate is considered personal data and therefore protected; in the Netherlands the number plate and vehicle emissions related to it are shared as open source.

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[107] Pseudonymisation is a de-identification procedure by which personally identifiable information fields within a data record are replaced by one or more artificial identifiers, or pseudonyms

Most countries have strict data protection laws and regulations about **who** can and cannot use cameras to enforce, and **what** they are able to enforce. Some countries have national guidance to help cities[108]. It is worth checking the legal situation early in the planning, and finding out what guidance is available.

The city may be required to obtain approval of the regulators in the national authorities before implementing ANPR, as in the UK or Italy. In addition, UVARs may cover areas where the roads are controlled by different authorities (city, county or national road agency), all with different competences.

In some countries, ANPR cameras need to take photos of the plate from the back to avoid including the drivers face, others *require* it to be taken from the front so that the driver can be linked to the offence. Where there are no such stipulations, front number plates are less likely to be obscured in queuing traffic, but have the disadvantage of not collecting vehicles that have no front number plate, as is the case with motorcycles in many countries and with cars in some.

5.6.6. When is ANPR able to be used for enforcing UVARs?

In some countries, ANPR is allowed for some functions (e.g., speed cameras or parking) but not (yet) for detecting non-compliant vehicles in low emission zones. In such cases, the city may be able to negotiate with the national authority to change the rules to enable the use of ANPR for UVAR. Jerusalem did this within the ReVeAL project, employing temporary solutions during the negotiations, including using the municipal enforcement team to enforce the low emission zone. The enforcement officers use a hand-held device with a camera that is used for enforcing parking violations with a custom-made app that includes a built-in blacklist to determine which vehicles are non-compliant.

5.6.7. Camera enforcement transparency

It is crucial to provide citizens with information about the camera enforcement, including on the city UVAR web page. Many countries require drivers to be informed that camera enforcement is in place by using a road sign (see **Error! Reference source not found.** at the end of the signage section 4.4.6).

Where penalties – camera enforced or otherwise – are to be collected, the scheme signage needs to be lawful and correct, as does the legislation under which the scheme is implemented.

Being able to confirm that the vehicle has been involved in the offence in question is often an important matter. In some countries, the penalty notice includes a photo of the car (sometimes with driver), in other countries the penalty notice includes a link to a URL containing the photo. Using a link to a URL reduces privacy issues as the letter does not contain a photo.

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[108] Some countries have national guidance, some of which is provided in section 0

5.6.8. Practical recommendations on camera enforcement

When measures that may infringe privacy are considered, the following principles should be taken into account:

- **Efficacy**: when enforcing the UVAR is seen as less important than privacy, then infringing on privacy is not necessary. However, an UVAR that is not complied with is not effective. The decision whether to use ANPR is, like many things, a balance; and this balance is different from country to country. If there is an alternative enforcement method that can ensure compliance without disturbing the other traffic, and it is cost effective, then it should be considered.
- **Minimal infringement**: when enforcing the UVAR can be achieved equally well using other means, choose the alternative that infringes the least on privacy.
- **Limiting impact:** when a particular privacy infringement is considered necessary, take care to limit or compensate the infringement as much as possible; for example, by making sure that the camera 'sees' as little area as possible.
- **Balancing of interests and prevention:** privacy is an interest that should be balanced against other interests, such as a sufficiently enforced UVAR, or that the police may not have sufficient resources to enable sufficient manual enforcement. It is often wrongfully regarded as an obstacle for achieving practical results.

5.7. Future proofing

The transport system is in constant transition. As vehicles move people and goods, technological development and general societal trends are shifting the characteristics of mobility. There are many uncertainties associated with the future of mobility, making it important to study the risks and opportunities that may arise, and to mitigate as much as possible the negative effects of the risks on UVAR strategies and measures. For example, the electrification of the vehicle fleet may reduce the effectiveness and relevance of measures such as zero emission zones.

A few of those risks and opportunities have been assessed as part of the ReVeAL project. The following set of future trends possessing features that will likely affect the effectiveness of UVARs has been retained for the analysis. In addition to the future trends that are included in the 'usual' assessments, such as current traffic trends and planned SUMP measures (including electric and shared mobility and ride hailing), others include:

- Autonomous and connected vehicles
- Future pandemics
- The gig economy[109]
- E-commerce
- Technology obsolescence
- Climate change and natural disasters
- Ageing population
- Work anywhere culture
- Internet of Things (IOT)
- Significant unexpected changes in travel demand

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[109] The gig economy involves the exchange of labour for money between individuals or companies via digital platforms that facilitate matching between providers and customers on a short-term and pay-by-task basis.

The UVAR should be monitored using the indicators chosen, and it should be changed or adapted where necessary to ensure it has the desired impact. Some trends have the potential to change conditions dramatically, and the uncertainties in outcomes of different trends are significant. For this reason, it is important to build flexibility into the investments made in UVAR measures. To be resilient, cities must be able to re-design or update their UVAR measures regularly.

Cities may consider which technological systems will likely be needed and which could be used for more than one purpose. Purchasing technologies as a service rather than infrastructure is one way that is increasingly being offered to cities to help them be more flexible and change technology if appropriate – as well as reduce up-front costs.

Some trends could have a large impact on the need for, and effectiveness of, UVARs, with the impact being similar across all UVAR building blocks. For example, if an increase in the use of private autonomous cars leads to a massive increase in car traffic, this would increase the need for (many types of) UVARs. The obvious effects of climate change in a city will increase the general urgency to decrease emissions, which will likely strengthen the acceptance of (many types of) UVARs, etc.

While the future is uncertain and depends on how emerging trends are received in a city's specific context, the future also depends on society's integration of trends. To prepare for a city using UVARs while enhancing its overall liveability, the city needs to be flexible. The future is by no means deterministic; as far as possible having flexible systems for implementing UVARs scheme will increase their benefit and success rates.

5.8. Keeping the UVAR under review

As soon as the scheme has been confirmed, wide-ranging dissemination should make affected vehicle operators aware of the scheme. Once the scheme is in operation, the chosen systems need to be operated, the scheme needs to be monitored in accordance with the goals and indicators established at the outset. An UVAR is not a 'fit and forget' measure, but one that needs to be monitored and kept under review, as to whether it should be altered, extended, tightened.

Details on all of these issues can be found in the appropriate section

6. Further information/links

6.1. Introduction

ReVeAL website: https://civitas-reveal.eu

ReVeAL decision support tool: https://www.AccessRegulationsForYourCity.eu

Information and data on all regulatory and charging UVARs in Europe: www.urbanaccessregulations.eu

IPPC climate change report: https://www.ipcc.ch/2022/04/04/ipcc-ar6-wgiii-pressrelease

WHO air quality health impact: https://www.who.int/health-topics/air-pollution

World Bank pollution impact: https://www.worldbank.org/en/topic/pollution#1

Europe congestion costs 1% of GDP:
https://ec.europa.eu/commission/presscorner/detail/en/SPEECH_22_559

Town squares with shopping or leisure purposes are preferred over car parks: https://www.sciencedirect.com/science/article/pii/S2352146517309158

Town squares are preferred to have shopping or leisure purposes than car parks more profitable for businesses https://cleancitiescampaign.org/2021/12/09/why-fewer-polluting-cars-in-cities-are-good-news-for-local-shops-briefing

Paris Agreement: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

EC presentation "Reclaiming city streets for people; Chaos or quality of life?": https://ec.europa.eu/environment/pubs/pdf/streets_people.pdf

European Green Deal: https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

Urban Mobility Framework: https://transport.ec.europa.eu/news/efficient-and-green-mobility-2021-12-14_en

ReVeAL decision support tool: https://www.AccessRegulationsForYourCity.eu

More information on the ReVeAL building blocks from the building block fact sheets: https://civitas-reveal.eu/about/approach

SUMP concept: https://www.eltis.org/mobility-plans/sump-concept

SUMP process: https://www.eltis.org/mobility-plans/sump-process

SUMP guidance UVAR annex: https://www.eltis.org/sites/default/files/uvar_brochure_2019-09-26_digital_version_v2.pdf

SUMP guidelines: https://www.eltis.org/mobility-plans/sump-guidelines

C40 LEZ guidance: https://www.c40knowledgehub.org/s/article/How-to-design-and-implement-a-clean-air-or-low-emission-zone?language=en_US

The 7 steps to create effective low emission zones: https://cleancitiescampaign.org/wp-content/uploads/2022/07/The-7-steps-to-create-effective-low-emission-zones.pdf

Dutch ZEZ guidance: https://opwegnaarzes.nl/kennisbank

Dutch ZEZ guidance documents translated into English: https://drive.google.com/drive/folders/1IrTs-G4s2qLL4bEybZddWRuF-hwtqXD8

6.2. ReVeAL explained

REVEAL building block fact sheets: https://civitas-reveal.eu/about/approach/

SUMP topic guides https://www.eltis.org/mobility-plans/topic-guides

Dutch zero-emission zone support framework: https://www.opwegnaarzes.nl/kennisbank

Dutch zero-emission zone guidance (English translation): https://drive.google.com/drive/folders/1IrTs-G4s2qLL4bEybZddWRuF-hwtqXD8

SUMP topic guides https://www.eltis.org/mobility-plans/topic-guides

Sustainable Urban Logistics Plan (SULP) guidelines
https://civitas.eu/sites/default/files/documents/sulp_guidlines.pdf

Milan's Area C: http://www.comune.milano.it/aree-tematiche/mobilita/area-c

Milan's pricing integration of the access fee and the on-street parking fee for service vehicles:
https://www.comune.milano.it/servizi/pass-per-la-sosta-gratuita-non-residenziale

Milan's reserved bays for loading and unloading and 20-minute free parking on paid parking spaces for loading and unloading: https://www.comune.milano.it/servizi/area-per-carico-e-scarico-merci

The circulation plan of Ghent: https://stad.gent/en/mobility-ghent/circulation-plan

City of Ghent's free shuttle service: https://visit.gent.be/en/good-know/practical-information/getting-around/shuttle-bus

Bologna funding scheme: https://www.comune.bologna.it/servizi-informazioni/incentivi-bici-cargo-bike-pedalata-assistita

Ultra-low emission zone scrappage scheme: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone/car-and-motorcycle-scrappage-scheme

Santander bike hire scheme: https://tfl.gov.uk/modes/cycling/santander-cycles

Don't wait to start with Freight! guidance: https://www.polisnetwork.eu/wp-content/uploads/2020/12/ZEZ-F_How-to-Guide_low.pdf

C40 15-minute city guidance: https://www.arup.com/perspectives/publications/research/section/green-and-thriving-neighbourhoods

SUMP Topic Guide: Planning for a more resilient and robust urban mobility. https://www.eltis.org/in-brief/news/sump-topic-guide-planning-more-resilient-and-robust-urban-mobility

The SPICE (Smart Procurement for Better Transport) project: https://spice-project.eu/best-practices/

Topic Guide UVAR and SUMPs: Regulating vehicle access to cities as part of integrated mobility policies: www.eltis.org/sites/default/files/uvar_brochure_2019-09-26_digital_version_v2.pdf

CIVITAS Insight N°6, Access regulations to facilitate cleaner and better transport:
https://civitas.eu/content/civitas-insight-06-access-regulations-facilitate-cleaner-and-better-transport

London's walking maps, networks, walking times: https://tfl.gov.uk/modes/walking/

Nottingham's workplace levy: www.nottinghamcity.gov.uk/wpl

Stockholm's night-time delivery facilitation: https://civitas.eu/content/night-delivery-clean-and-silent-vehicles

Energy Savings Trust last mile guides for local authorities
https://energysavingtrust.org.uk/sites/default/files/EST0011%20-%20Last%20mile%20best%20practice%20guide-WEB.pdf and for businesses
https://energysavingtrust.org.uk/sites/default/files/EST007-01-EST%2BDFT-Electrifying%20last%20mile%20deliveries%20guide-WEB.pdf

Polis urban freight topic: www.polisnetwork.eu/topic/urban-freight-2/

London ULEZ and info on scrappage scheme: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone

London ULEZ's "green" standards for public transport buses: https://tfl.gov.uk/modes/buses/improving-buses

Walk to school initiative in Jerusalem (SUNRISE project): https://civitas-sunrise.eu/neighbourhoods/jerusalem-baka

Communication, stimulation and facilitation measures in Amsterdam LEZ/ZEZ: https://amsterdameconomicboard.com/greendeal

Padova Cityporto consolidation centre: http://www.interportopd.it/en/cityporto/

Bicycle use for goods delivery as a quick-win for cities working towards zero emissions logistics: http://two.cyclelogistics.eu/docs/119/D2_1_Guide_to_effective_strategies_for_cyclelogistics.pdf

City of London guidance for managing deliveries and servicing: https://www.cityoflondon.gov.uk/assets/Services-Environment/guidance-for-managing-deliveries-and-servicing.pdf

Transport for London toolkit for efficient deliveries: https://tfl.gov.uk/info-for/deliveries-in-london/delivering-efficiently

Hackney's zero-emissions network programme: An award-winning air quality business liaison initiative https://zeroemissionsnetwork.com/

London TfL's deliveries toolkits: https://tfl.gov.uk/info-for/deliveries-in-london/delivering-efficiently/deliveries-toolkits

Zero-Emissions Network, a multiple award-winning air quality business liaison initiative https://zeroemissionsnetwork.com/zero-emissions-network

Hammersmith & Fulham (London) zero-emission delivery service: https://hammersmithbid.co.uk/our-projects/cleaner-greener-town/parcels-not-pollution/

Transport for London's Healthy Streets Guidance: https://tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets

6.3. Getting Started with your UVAR

ReVeAL process evaluation and impact assessment framework: https://civitas-reveal.eu/wp-content/uploads/2020/08/D4.1_Evaluation-framework_191129.pdf

Functional urban area definition: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Functional_urban_area

Guidance on UVAR in functional urban areas: https://www.interreg-central.eu/Content.Node/Dynaxibility4CE/UVAR-Topic-Guide.pdf

Adapting to stakeholders needs: https://www.c40knowledgehub.org/s/article/How-road-pricing-is-transforming-London-and-what-your-city-can-learn

6.4 Governance

Oslo ZEZ removing road space to ban internal combustion engines:
https://urbanaccessregulations.eu/countries-mainmenu-147/norway-mainmenu-197/oslo-zero-emission-zone

UNECE agreement on Retrofit Emission Control devices (REC): https://eur-lex.europa.eu/EN/legal-content/summary/uniform-rules-concerning-the-approval-of-retrofit-emission-control-devices-rec.html ,
https://unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/2015/R132e.pdf,
https://wiki.unece.org/pages/viewpage.action?pageId=2523175

Trans-European Transport Network (TEN-T) : https://transport.ec.europa.eu/transport-themes/infrastructure-and-investment/trans-european-transport-network-ten-t_en

SUMP guidelines: https://www.eltis.org/mobility-plans/sump-concept

Further information on the Ghent Circulation Plan in the ReVeAL webinar ReVeALing Space for People: Ghent's UVAR ReVeALed: https://civitas-reveal.eu/events/webinar-reveal-uvar-ghent/

Defining governance: https://iog.ca/what-is-governance/

John W. Kingdon, 1984. Agendas, Alternatives, and Public Policies. 2nd ed. Ed. Longman.
https://www.cambridge.org/core/journals/journal-of-public-policy/article/abs/john-w-kingdon-agendas-alternatives-and-public-policies-boston-little-brown-1984-xi-240-pp-995/48BC724C653B27E434357BB2DCEE1599

Future Neighbourhoods: application and funding guidance https://www.london.gov.uk/what-we-do/funding/future-neighbourhoods-2030

Transport for London's healthy streets guidance https://tfl.gov.uk/corporate/about-tfl/how-we-work/planning-for-the-future/healthy-streets

Zero Emissions Network https://zeroemissionsnetwork.com/zero-emissions-network

Transport for London's deliveries toolkits https://tfl.gov.uk/info-for/deliveries-in-london/delivering-efficiently/deliveries-toolkits

How C40 cities are implementing zero emission areas (2020): Outlines international best practice of delivering ZEZs https://www.c40knowledgehub.org/s/article/How-C40-cities-are-implementing-zero-emission-areas?language=en_US

UVAR-specific newsletters for public authorities: https://urbanaccessregulations.eu/public-authorities

6.5 Stakeholder involvement

Bielefeld's interactive UVAR website: https://altstadtraum.de/projektchronik/

Source of: inform, consult, collaborate or empower: http://intosaijournal.org/inform-consult-involve-collaborate-empower/

Functional urban area definition: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Functional_urban_area

UVAR building block fact sheets https://civitas-reveal.eu/about/approach/

CIVITAS co-creation resource: https://civitas.eu/thematic-areas/public-participation-co-creation

CIVITAS Handbooks: Involving Stakeholders: Toolkit on Organising Successful Consultation: https://www.eltis.org/sites/default/files/trainingmaterials/civitas_brochure_stakeholder_consultation_web .pdf,

SUMP quick facts on participation: https://www.eltis.org/sites/default/files/trainingmaterials/qf-brochure_participation_en_0.pdf

CIVITAS successful transport decision-making: https://www.eltis.org/sites/default/files/trainingmaterials/guidemaps_volume_1_colour.pdf,

C40 Inclusive community engagement toolbox: https://resourcecentre.c40.org/resources/stakeholder-engagement

Dynaxibility4CE draft topic guide on UVAR in FUA context: https://www.interreg-central.eu/Content.Node/Dynaxibility4CE/UVAR-Topic-Guide.pdf

Ch4llenge manual on public involvement: https://www.eltis.org/resources/tools/sump-participation-kit

SUNRISE project: Participation strategies: https://civitas-sunrise.eu/wp-content/uploads/2019/07/D2.1_Participation-Handbook.pdf

SOLEZ Action Plan Guide: https://www.interreg-central.eu/Content.Node/Action-Plan-Guide.html

SOLEZ Stakeholder Involvement Guidelines: https://www.interreg-central.eu/Content.Node/D.T1.2.2-Stakeholder-Involvment-Guidelines.pdf

SOLEZ Action Plan Guidelines: https://www.interreg-central.eu/Content.Node/D.T1.2.1-Action-Plans-Guidelines.pdf

Hybrid engagement techniques for citizen-led projects during pandemic: https://www.eltis.org/in-brief/news/hybrid-engagement-techniques-enable-citizen-led-projects-deliver-results-times

Examples of companies specialised in digital participation processes: www.nonconform.at or www.frischerwind.com or www.zebralog.de

6.6   User needs and public acceptance

Typical dynamic pattern of acceptance : https://www.wsp.com/-/media/Insights/Canada/Documents/doc-Congestion-Charging-Report.pdf?la=en-US&hash=CEF19F5AB861A42C12EBE3651B680758583A71CA

6.7   Communication

European Commission UVAR study: https://ec.europa.eu/transport/sites/transport/files/uvar_final_report_august_28.pdf

CIVITAS toolkit on marketing communications: https://www.eltis.org/sites/default/files/trainingmaterials/civitas_toolkit_on_marketing_communications.pdf

Dutch logistics zero-emission zones: https://www.opwegnaarzes.nl/gemeenten

London low-emission zone: https://tfl.gov.uk/modes/driving/low-emission-zone

London ULEZ: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone

Jerusalem's information campaign: http://www.Jerusalem.muni.il/he/residents/environment/environment and https://civitas-reveal.eu/wp-content/uploads/2021/06/2021-06-22-Project-Campaigns-Jerusalem.pdf and "Clean the City of Air Pollution": https://www.avirnaki-jr.co.il/

London's first air pollution regulation was put in place in 1306 to address coal smoke: https://www.londonair.org.uk/londonair/guide/londonhistory.aspx

Client Earth: https://www.clientearth.org/latest/latest-updates/opinions/why-london-s-new-ultra-low-emission-zone-is-vital-for-the-health-of-the-capital/

Pollution-related death of a 9-year-old girl: https://www.bbc.com/news/uk-england-london-56801794

London's air pollution problems raised by the Mayor to ensure support for the measures, including UVARs: https://www.london.gov.uk/WHAT-WE-DO/environment/environment-publications/health-burden-air-pollution-london

The successes of London's UVARs towards their goals that are disseminated to ensure support for the measures: success of its interventions: https://www.london.gov.uk/press-releases/mayoral/ulez-reduces-polluting-cars-by-13500-every-day

Articles on London low-traffic schemes: https://www.theguardian.com/world/ng-interactive/2021/mar/02/low-traffic-schemes-benefit-most-deprived-londoners-study-finds?CMP=share_btn_tw

Articles on Brussels low emission zones: https://www.thebulletin.be/brussels-agrees-new-exemption-disabled-drivers-low-emission-zone?fbclid=IwAR0DLctvsl8kMjlNyc5wyX58jZyBzg2e5zSIc4bnCgOeiJKynd4ZjAuQj_A

Antwerp's dedicated LEZ website: https://www.slimnaarantwerpen.be/en/LEZ

Padova's website article on their school superblock: https://www.padovanet.it/notizia/20211005/comunicato-stampa-arriva-la-superguizza-al-luned%C3%AC-11-ottobre-le-prime-modifiche-la

People who walk to the high street can spend up to 40% more than people who drive there: https://www.livingstreets.org.uk/media/3890/pedestrian-pound-2018.pdf

Source for purchased photo on road closed (to traffic) but open to active mobility modes: https://www.alamy.com/london-uk-30th-nov-2020-a-sign-reminding-the-public-that-school-streets-are-open-for-pedestrian-and-cyclist-only-several-street-around-schools-have-temporarily-become-pedestrian-and-cyclist-only-zones-the-school-led-initiative-is-to-help-improve-road-safety-and-air-quality-around-the-schools-restrictions-apply-monday-to-friday-term-time-only-between-830am-and-915am-and-3pm-and-4pm-credit-sopa-images-limitedalamy-live-news-image387663779.html

Transport for London for the congestion charge https://tfl.gov.uk/modes/driving/congestion-charge/contact-us/complaints-procedure

Bielefeld's dedicated interactive websites to gather feedback: https://altstadtraum.de/

London Mayor's dedicated interactive websites to gather feedback on different matters: https://www.london.gov.uk/talk-london

UVAR Exchange project https://uvarbox.eu/uvarexchange/

UN Vienna Convention on Road Signs and Signals; see: https://treaties.un.org/pages/ViewDetailsIII.aspx?src=TREATY&mtdsg_no=XI-B-20&chapter=11&Temp=mtdsg3&clang=_en

SOMS/In-Safety, EU project on road sign symbols: https://www.iiid.net/soms-in-safety/

Tern symbols: https://iiidre.weebly.com/symbols.html

DATEX II UVAR model, the single EU-wide format for machine-to-machine readable UVAR scheme data: https://uvarbox.eu/wp-content/uploads/2022/10/DeVries_DataModel.pdf

Presentation on the DATEX II UVAR model: https://www.youtube.com/watch?v=M9pMZs6JhYY&t=2046s

Further information on DATEX II: https://www.datex2.eu

UVAR Box tool: https://uvarbox.eu/uvarbox-tool/

UVAR Box full final conference recording: https://youtu.be/M9pMZs6JhYY?t=2046

National Access Point (NAP): the single point for M2M traffic data in each EU member state: https://transport.ec.europa.eu/transport-themes/intelligent-transport-systems/road/action-plan-and-directive/national-access-points_en

Single Digital Gateway (SDG): https://single-market-economy.ec.europa.eu/single-market/single-digital-gateway_en

ITS Directive & delegated regulation: https://transport.ec.europa.eu/transport-themes/intelligent-transport-systems/road/action-plan-and-directive_en

UVAR Box website: https://uvarbox.eu/uvarbox-tool/

METR, an ISO/CEN joint development for the creation of standards for the exchange of digital traffic regulations. METR = Management of Electronic Traffic Regulations: METR, (Management of Electronic Traffic Regulations).

Open Data Directive: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L1024

6.8 Financing

SUMP topic guides (all): https://www.eltis.org/mobility-plans/topic-guides

SUMP topic guide: Funding and Financing
https://www.eltis.org/sites/default/files/funding_and_finance_of_sump_v2.pdf

SUMP topic guide: Public Procurement
https://www.eltis.org/sites/default/files/public_procurement_of_sump_v2.pdf

The Smart Procurement for Better Transport (SPICE) project: https://spice-project.eu/ and its best practices: https://spice-project.eu/best-practices/

6.9 Ensuring compliance

Examples for ANPR usage Norwegian congestion charges:
https://urbanaccessregulations.eu/countries-mainmenu-147/norway-mainmenu-197/oslo-charging-scheme

European Electronic road toll system (EETS) Directive 2004/52/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004L0052

EC Decision 2009/750/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009D0750

Directive (EU) 2019/520 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0520

DSRC on-board units use microwave technology (5.8 GHz) following CEN standards: CEN/TC 278: https://www.itsstandards.eu/25-2/cen-dsrc/

Recommendation ITU-R M.1890 (04/2011). Intelligent transport systems – guidelines and objectives. International Telecommunication Union: https://www.itu.int/dms_pubrec/itu-r/rec/m/R-REC-M.1890-0-201104-S!!PDF-E.pdf

General Data Protection Regulation (EU) 2016/679: https://eur-lex.europa.eu/eli/reg/2016/679/oj

The UVAR Exchange project: https://uvarbox.eu/uvarexchange/

6.10 Fairness and equity

SUMP topic guide on addressing gender equity and vulnerable groups in SUMPs: https://www.eltis.org/sites/default/files/sump_topic-guide_gender-equity_vulnerable-groups_final.pdf

Equality, equity and justice picture source: Tony Ruth, created originally for the 2019 Design in Tech Report: https://designintech.report/wp-content/uploads/2019/03/dit2019_v00.pd

UK guidance on UK Equalities Act requires an inclusivity impact assessment be undertaken for certain aspects of their work, including UVARs: https://www.gov.uk/government/publications/equality-impact-assessments-2010

Example of Transport for London's ULEZ Integrated Impact Assessment https://content.tfl.gov.uk/ulez-consultation-appendix-j-nov-2017.pdf

Arrogance of space: https://colvilleandersen.medium.com/the-arrogance-of-space-93a7419b0278 and https://www.youtube.com/watch?v=CfXP6KOVBOY

Photo of space taken by people travelling by car as compared to by bicycle, on foot or by bus, Stadtwerke Münster: https://www.stadtwerke-muenster.de/blog/verkehr/das-wohl-bekannteste-muenster-foto-der-welt/

Newspaper article claiming UVARs reduce traffic in well-off areas at the expense of traffic increases in low-income areas. https://www.bloomberg.com/news/articles/2021-01-29/lawsuits-challenge-london-s-car-restrictions

Mobility poverty, or transport-related social exclusion: https://www.researchgate.net/publication/254409601_Transport_and_social_exclusion_Where_are_we_now

Quote from London Mayor Sadiq Kahn on social justice: https://www.london.gov.uk/press-releases/mayoral/mayor-announces-bold-plans-for-a-greener-london

Those on lower incomes tend to own fewer vehicles and more often travel by public transport, bike or on foot: https://info.uwe.ac.uk/news/uwenews/news.aspx?id=3978

Air pollution affects particularly the young, the old and those with pre-existing heart and lung conditions: https://www.who.int/teams/environment-climate-change-and-health/air-quality-and-health/health-impacts

ambient noise levels negatively affect children's learning: https://www.eea.europa.eu/publications/health-risks-caused-by-environmental

In London, the average concentrations of pollutants in the most deprived deciles is 24% higher than in the least deprived. Sources include https://www.london.gov.uk/press-releases/mayoral/bame-and-poorer-londoners-face-air-quality-risk and https://www.london.gov.uk/press-releases/mayoral/new-report-highlights-findings

"Polluter pays" principle: https://environment.ec.europa.eu/economy-and-finance/ensuring-polluters-pay_en#:~:text=The%20polluter%20pays%20principle%20is,States%20to%20make%20polluters%20pay

Quote from London Mayor Sadik Kahn: https://www.london.gov.uk/press-releases/mayoral/bame-londoners-bear-brunt-of-climate-emergency

UK Equality Act 2010 Guidance: https://www.gov.uk/guidance/equality-act-2010-guidance

The fewer cars, the higher shop sales: https://cleancitiescampaign.org/2021/12/9/fewer-cars-can-boost-christmas-sales/ or https://theicct.org/sites/default/files/publications/congestion_apr10.pdf

Revenue generated per day by different kerbside uses, Urbis: https://www.linkedin.com/pulse/economic-benefits-dining-parklets-bike-parking-car-alison-lee

Air pollution costs the world $5.7 trillion or 4.8% of global GDP: https://www.worldbank.org/en/topic/pollution

Air pollution costs each European €1,276 per year: https://ec.europa.eu/jrc/communities/en/community/city-science-initiative/document/health-costs-air-pollution-european-cities-and-linkage

Congestion in the EU costs nearly EUR 100 billion, or 1% of the EU's GDP, annually: https://ec.europa.eu/transport/themes/urban/urban_mobility_en

There 9120 urban EU road traffic deaths annually, 70% of which are vulnerable road users: https://ec.europa.eu/commission/presscorner/detail/en/qanda_20_1004

Pedestrians have a 90% chance of survival when hit by a car travelling at or below 30 km/h, but less than 50% chance of surviving at 45 km/h: https://www.who.int/violence_injury_prevention/publications/road_traffic/world_report/speed_en.pdf

Long-term exposure to environmental noise is estimated to cause 12,000 premature deaths and other impacts such as learning impairment in school: https://www.eea.europa.eu/themes/human/noise

Transport for London's ULEZ car and motorcycle scrappage scheme: https://tfl.gov.uk/modes/driving/scrappage-schemes

When distributing revenues from the Stockholm congestion charge, reduced transit fares had the highest effect on equity, and tax rebates the lowest: https://www.sciencedirect.com/science/article/abs/pii/S0967070X17302767

Kristoffersson, I., Engelson, L., Börjesson, M. 2017. "Efficiency vs. Equity: Conflicting Objectives of Congestion Charges." Transport Policy, Volume 60, 2017, Pages 99-107: https://www.sciencedirect.com/science/article/abs/pii/S0967070X17302767

Hysing, E., Isaksson, K., 2015. Building acceptance for congestion charges–the Swedish experiences compared. Journal of Transport Geography. 49, 52–60 https://www.sciencedirect.com/science/article/abs/pii/S0966692315001908

Goodwin, P. 2006. "The Gestation Process for Road Pricing Schemes." Local Transportation Today. Page 444. https://trid.trb.org/view/790777

Schade, J., Seidel. T., Schlag, B. 2004. "Cross-Site-Evaluation of Acceptability Indicators". Working Paper. EU-Project CUPID Funded by the European Commission under the 5th Framework Programme. Dresden: https://www.researchgate.net/profile/Jens_Schade/publication/242462382_Cross-Site-Evaluation_of_Acceptability_indicators/links/0f31752eb83babc8d4000000/Cross-Site-Evaluation-of-Acceptability-indicators.pdf

WSP, 2018. Congestion Charging: Policy and global lessons learned: https://www.wsp.com/-/media/Insights/Canada/Documents/doc-Congestion-Charging-Report.pdf?la=en-GL&hash=ADE02366CDA806EB17ACB7A018E8A6AED624A5A2

Nijmegen light-duty vehicle UVAR (in Dutch): https://www.nijmegen.nl/over-de-gemeente/dossiers/30-maatregelen-voor-schonere-lucht/

Congestion Charging: Policy and Global Lessons Learned, fairness and equity: https://www.wsp.com/-/media/Insights/Canada/Documents/doc-Congestion-Charging-Report.pdf?la=en-US&hash=CEF19F5AB861A42C12EBE3651B680758583A71CA

Report for the Mayor of London on air quality and equities: https://www.london.gov.uk/what-we-do/environment/environment-publications/air-pollution-london-impact-environment-strategy

City of London's Equality, Diversity and Inclusion Action Plan 2021-22: https://www.cityoflondon.gov.uk/things-to-do/history-and-heritage/london-metropolitan-archives/about-lma/equality-diversity-and-inclusion-action-plan-2021-22

Fieldwork activities with different vulnerable groups of people in 6 study areas: https://www.routledge.com/Re-thinking-Mobility-Poverty-Understanding-Users-Geographies-Backgrounds/Kuttler-Moraglio/p/book/9780367333300

6.11 Monitoring

SUMP Guidelines: https://www.eltis.org/mobility-plans/sump-guidelines

ReVeAL Evaluation Framework: https://civitas-reveal.eu/wp-content/uploads/2020/08/D4.1_Evaluation-framework_191129.pdf

Unit values of the external costs of transport can be found in the European Handbook on the external costs of transport: https://op.europa.eu/en/publication-detail/-/publication/9781f65f-8448-11ea-bf12-01aa75ed71a1

European Commission Better Regulation Toolbox: https://ec.europa.eu/info/sites/default/files/better-regulation-toolbox.pdf

CIVITAS 2020 process and impact evaluation framework: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5d9df8da1&appId=PPGMS

Ideas on assessing UVARs for air quality are discussed in monitoring sections of Sadler Consultants' ADEME report, and many of them are transferrable to other transport aspects: https://urbanaccessregulations.eu/images/Reports/SC-Ademe-report-full-report-final-3.pdf

Source apportionment study from Berlin: https://previous.iiasa.ac.at/web/home/research/researchPrograms/air/policy/17_Lutz-TFIAM-Berlin-AQP.pdf

The TMaaS project: https://www.proximus.be/en/id_b_cl_tmaas_in_ghent/companies-and-public-sector/news/news-blog/customer-stories/tmaas-in-ghent.html and https://uia-initiative.eu/en/news/tmaas-final-journal

Examples of London's scheme assessments can be found on the TfL website: https://tfl.gov.uk/corporate/publications-and-reports/ultra-low-emission-zone

A functional urban area definition: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Functional_urban_area

OECD glossary of statistical terms: https://stats.oecd.org/glossary/

CIVITAS 2020 process and impact evaluation framework. CIVITAS SATELLITE: https://ec.europa.eu/research/participants/documents/downloadPublic?documentIds=080166e5d9df8da1&appId=PPGMS

European Commission, 2017. Better regulation Toolbox: https://ec.europa.eu/info/law/law-making-process/planning-and-proposing-law/better-regulation-why-and-how/better-regulation-guidelines-and-toolbox/better-regulation-toolbox-0_en

Handbook on the external costs of transport: https://cedelft.eu/publications/handbook-on-the-external-costs-of-transport-version-2019/

Civitas Initiative, this database allows gaining direct insight on urban mobility issues and specifically on a range (and progress) of measures introduced in the cities contributing towards clean urban mobility: https://civitas.eu/

SUITS: Urban Traffic Monitoring with Crowdsourcing: https://civitas.eu/tool-inventory/suits-urban-traffic-monitoring-with-crowdsourcing

ELTIS database: the database focuses on transfer of knowledge and exchange of experience in the field of urban and regional transport in Europe: https://www.eltis.org/

Eurostat: the statistical office of the European Union, providing high quality statistics and data on Europe: https://ec.europa.eu/eurostat

EU mobility survey: the database is the result of two EU-wide studies on issues related to transport and mobility issues in EU Member States: https://europa.eu/eurobarometer/surveys/detail/2226

European Emission Factor Database: https://www.eea.europa.eu/publications/emep-eea-guidebook-2019/emission-factors-database

Traffic Management as a Service: https://uia-initiative.eu/en/uia-cities/ghent

Citizen Science links: https://cordis.europa.eu/article/id/428542-local-traffic-data-and-how-it-gives-more-power-to-citizens , https://www.bable-smartcities.eu/explore/use-cases/use-case/useCase/citizen-science-for-traffic-and-air-pollution-monitoring.html

Civitas Training for citizen science for traffic data: https://civitas.eu/events/civitas-online-training-citizen-science-and-traffic-counting

EU air quality modelling guidance, in relation to the air quality directive, including air quality planning: https://www.eea.europa.eu/highlights/using-models-for-air-quality

London air quality network: https://www.londonair.org.uk/

6.12 Assessing scheme's impact

London ULEZ traffic impact: https://tfl.gov.uk/info-for/media/press-releases/2019/may/gla---first-month-of-mayor-s-ulez-sees-74-per-cent-of-vehicles-comp

6.13 Timing of implementation

Città Metropolitana di Bologna, LTZ-LEZ information and phases: https://www.cittametropolitana.bo.it/portale/Home/Archivio_news/Bologna_la_svolta_verde_comincia_il_primo_gennaio_2020_con_la_Ztl_ambientale

PUMS (SUMP) Bologna Metropolitana: https://pumsbologna.it/Progetti_in_corso/ZTL-Area_Verde

6.14 Types of exemptions and permits

The London ultra-low emission zone: https://tfl.gov.uk/modes/driving/ultra-low-emission-zone

 The London low emission zone: https://tfl.gov.uk/modes/driving/low-emission-zone

The impact of plug-in hybrids is being downgraded as less beneficial than previously estimated T&E press release: https://www.transportenvironment.org/discover/eu-to-end-undercounting-of-plug-in-hybrid-emissions/ and ICCT study: https://theicct.org/publication/real-world-phev-use-jun22/

Pamplona LTZ: http://www.accesocascoantiguo.com/

Siena LTZ: https://www.comune.siena.it/Servizi-Online/Accesso-ZTL

Permit system provider: Parkforfun https://www.parkforfun.com/en/company/48

 Permit system provider: Sigmax https://www.sigmax.nl/oplossing/citypermit/

The LTZ information and permit management system of Martina Franca, Italy: https://www.parkforfun.com/en/company/48

The LTZ information and permit management system of Ghent, Belgium: https://stad.gent/en/mobility-ghent/restricted-traffic-area

LTZ schemes in the cities and towns in the Italian region of Veneto use a single digital permit for disabled persons, by connecting to the ZetaTiElle Network: https://www.regione.veneto.it/web/informatica-e-e-government/ztl_vivipass

6.15 Geofencing and ISA

The European Commission is working on measures to improve cross-border foreign vehicle enforcement: https://uvarbox.eu/uvarexchange/

ISA is required for new EU light duty vehicles from 2022 and all vehicle produced from 2024: https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=PI_COM:Ares(2021)2243084&rid=1

Helmond's ReVeAL ISA work: https://civitas-reveal.eu/wp-content/uploads/2022/08/ReVeAL-public-report-on-Intelligent-Speed-Adaptation.pdf for more details: A shorter version is available at: https://drive.google.com/drive/folders/1yBBp9EPY8_hRmci1DqCWc7bgYl91UrCm?usp=sharing

The overall number of digital maps is increasing due to their use for other purposes, such as navigation or route planning: https://www.tomtom.com/products/adas-map/

6.16 Foreign vehicle enforcement of UVARs

EUCARIS provides the technical ability to exchange data: https://www.eucaris.net/
The European Commission is working on measures to improve cross-border foreign vehicle enforcement: https://uvarbox.eu/uvarexchange/

European Electronic (road) Toll Systems EETS Directive 2004/52/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32004L0052
EC Decision 2009/750/EC: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009D0750

Directive (EU) 2019/520 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32019L0520

Dutch open vehicle registration data: https://www.government.nl/topics/vehicles/vehicle-registration/viewing-the-vehicle-registration-register

6.17 Camera enforcement

General Data Protection Regulation (GDPR): https://ec.europa.eu/info/law/law-topic/data-protection/data-protection-eu_en

Data Protection Law Enforcement Directive are relevant: https://ec.europa.eu/info/law/law-topic/data-protection/eu-data-protection-rules_en

The Dutch guidance note, closed cordon or fewer cameras? https://drive.google.com/drive/folders/1v06ssryuTE4Mtaf5trb54LvBYHeMKoRW

Dutch ZEZ guidance documents: https://opwegnaarzes.nl/kennisbank,

Dutch ZEZ guidance documents (English translation): https://drive.google.com/drive/folders/1v06ssryuTE4Mtaf5trb54LvBYHeMKoRW?usp=sharing

Dutch guidance tip on police access to ANPR data: https://drive.google.com/drive/folders/1v06ssryuTE4Mtaf5trb54LvBYHeMKoRW