



TOPIC GUIDE

UVAR and SUMP

Regulating vehicle access to cities as part of
integrated mobility policies

Imprint

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Guide to the reader

This document provides guidance on a specific topic related to *Sustainable Urban Mobility Planning (SUMP)*. It is based on the concept of SUMP, as outlined by the European Commission's Urban Mobility Package¹ and described in detail in the European SUMP Guidelines (second edition)².

Sustainable Urban Mobility Planning is a strategic and integrated approach for dealing with the complexity of urban transport. Its core goal is to improve accessibility and quality of life by achieving a shift towards sustainable mobility. SUMP advocates for fact-based decision making guided by a long-term vision for sustainable mobility. As key components, this requires a thorough assessment of the current situation and future trends, a widely supported common vision with strategic objectives, and an integrated set of regulatory, promotional, financial, technical and infrastructure measures to deliver the objectives – whose implementation should be accompanied by reliable monitoring and evaluation. In contrast to traditional planning approaches, SUMP places particular emphasis on the involvement of citizens and stakeholders, the coordination of policies between sectors (transport, land use, environment, economic development, social policy, health, safety, energy, etc.), and a broad cooperation across different layers of government and with private actors.

This document is part of a *compendium of guides and briefings* that complement the newly updated second edition of the SUMP Guidelines. They elaborate difficult planning aspects in more detail, provide guidance for specific contexts, or focus on important policy fields. Two types of documents exist: While 'Topic Guides' provide comprehensive planning recommendations on established topics, 'Practitioner Briefings' are less elaborate documents addressing emerging topics with a higher level of uncertainty.

Guides and briefings on how to address the following topics in a SUMP process are published together with the second edition of the SUMP Guidelines in 2019:

- *Planning process*: Participation; Monitoring and evaluation; Institutional cooperation; Measure selection; Action planning; Funding and financing; Procurement.
- *Contexts*: Metropolitan regions; Polycentric regions; Smaller cities; National support.
- *Policy fields*: Safety; Health; Energy (SECAPs); Logistics; Walking; Cycling; Parking; Shared mobility; Mobility as a Service; Intelligent Transport Systems; Electrification; Access regulation; Automation.

They are part of a growing knowledge base that will be regularly updated with new guidance. All the latest documents can always be found in the 'Mobility Plans' section of the European Commission's urban mobility portal Eltis (www.eltis.org).

¹ Annex 1 of COM(2013) 91.

² Rupprecht Consult - Forschung & Beratung GmbH (editor), Guidelines for Developing and Implementing a Sustainable Urban Mobility Plan, Second Edition.

1. Introduction

1.1 About this document

This document describes to an audience of urban transport professionals and planners how to relate Urban Vehicle Access Regulations (UVARs) to processes in Sustainable Urban Mobility Plans (SUMPs). It is part of a series of guidance documents that detail the SUMP process and SUMP measure implementation.

The document also relates to the EC's DG MOVE's activities on UVARs.

- In 2017, the EC's DG MOVE published the study Urban Vehicle Access Regulations.³
- During 2018-2019, a co-creation process took place involving road users, industry, NGOs and authorities (national, regional and local) involved in or affected by the deployment of Urban Vehicle Access Regulation schemes throughout Europe. It concluded in February 2019. Five working groups developed conceptual frameworks in five topic areas: information to end-users; UVARs as part of an integrated approach; enforcement; technical implementation (referring to technology options for UVAR management); and the collection of best practices.
- In June 2019, the EU Horizon 2020 project ReVeAL (Regulating Vehicle Access for improved Liveability) started. ReVeAL will look into UVARs and how they are affected by the changing mobility landscape, urban governance, user needs and technology.

The topic guide starts by setting the scene: the UVAR concept is defined and a typology is introduced. The relation between the policy objectives a city wants to achieve and the UVAR type is explained (section 1.2). The close interdependency between UVARs and SUMP is explained in section 1.3.

In chapter 2, the UVAR is put in the context of the eight SUMP principles: planning for the functional city (2.1); developing a long-term vision and clear implementation plan (2.2); assessing current and future performance (2.3); developing all transport modes in an integrated manner (2.4); cooperation across institutional boundaries (2.5); citizen and stakeholder involvement (2.6); monitoring and evaluation (2.7); and quality assurance (2.8).

In chapter 3, the UVAR is related to the SUMP steps, with a phase of set-up and analysis (3.1), strategy and development (3.2), measure planning (3.3), and implementation and monitoring (3.4).

Finally, chapter 4 sees six UVAR-related topics detailed: stakeholder ownership, acceptance and buy-in (4.1); UVAR as part of an integrated package of measures (4.2); UVARs and freight (4.3); UVARs and occasional visitors (4.4); UVARs and SUMP funding (4.5); and how UVARs might evolve (4.6).

The document concludes with case material and a glossary.

³ https://ec.europa.eu/transport/themes/urban/studies_en, authored by ISINNOVA and PWC

1.2 What we mean when we talk about UVARs

UVARs can be broadly defined as ‘measures to regulate motor vehicular access to urban infrastructure’. As such, several techniques and typologies have been adopted across urban areas to regulate vehicles’ access to urban infrastructure⁴.

Next to physical interventions that either prevent vehicles from entering a street or defined zone (e.g. barriers), or slow all traffic within a zone (e.g. 30 km/h zones or woonerfs⁵), UVARs restrict or regulate some or all types of traffic from entering through policy or pricing. They can be placed into five broad categories:

- **Pricing:** Vehicles are charged to enter or travel within a defined area. Variations include urban road tolls, congestion pricing, cordon pricing, area pricing, and urban kilometre charges.
- **Vehicle Emissions:** Regulates vehicles in a defined area based on the vehicle’s pollutant levels (e.g. Euro 3 and above; no diesel vehicles; etc.) Variations include Low-Emission Zones (LEZ), Ultra-Low-Emission Zones (ULEZ), and Zero-Emission Zones (ZEZ).
- **Residential/Historic Centres:** Restricts vehicles in a defined area based on the drivers’ relationship to the area, i.e. residents, shop or business owners, etc. Variations include: Italy’s ZTL (restricted traffic zone) and Spain’s super blocks.

- **Pedestrian Areas.** Prevents all but people on foot from entering a street or zone. Typically, bicycles are permitted and deliveries with a narrow time window. Variations include exceptions for bicycles, deliveries, maintenance vehicles, and for the few residents of the particular block or street in question.

- **Lorry and/or delivery regulations and restrictions.**

It is now widely agreed that UVARs, when implemented, should be integrated into a larger transport and mobility plan. A local or regional SUMP serves as the ideal vehicle for them. UVARs support the promotion of sustainable mobility measures under given circumstances, regulating traffic flows and helping to achieve compliance with air quality legislation. Both are key SUMP goals.

Good practice:

UVARs in Stockholm have made the city more accessible – reducing queueing time by between 30% and 50%, and traffic volumes by between 20% and 25%. In addition, reductions in dangerous emissions such as carbon monoxide (14%), PM10 (13%) and volatile organic compounds (13%) have resulted in air quality improvements across the city (DG MOVE, 2017).

⁴ COMMISSION STAFF WORKING DOCUMENT A call for smarter urban vehicle access regulations Brussels, 17.12.2013 SWD(2013) 526 final

⁵ <https://en.wikipedia.org/wiki/Woonerf>

In the framework of SUMP, the following ways of classifying UVARs can be useful as an example:

Scheme objectives	<ul style="list-style-type: none"> • Air quality improvement • Congestion reduction • Urban landscape preservation/retaining the traditional visual character of a place (historic town centres) • Climate change mitigation • Quality of life and attractiveness • Noise mitigation • Road safety • Redistribution of road space • Raising revenues • ...
Targeted vehicles	<ul style="list-style-type: none"> • Freight and service transport • Passenger transport, either private car use or collective systems • Type of vehicle - pollutant classes • Type of vehicle - dimensions and weight (quads, trucks, +3.5 tons etc.) • Trip purpose (commuter, delivery etc.) • Type of road user (residents, taxis etc.) • ...
Type of access regulation	<ul style="list-style-type: none"> • Ban/limitation • Charging • Limit(s) on the permeability of the area • Advisory⁶ • ...
Scheme design	<ul style="list-style-type: none"> • Toll ring • Distance-based (for charging) • Time-based • Area licence/permit-based • Point-based • Cordon-based • Superblocks: neighbourhood level access scheme • ...
Time period	<ul style="list-style-type: none"> • Permanent (24 hours a day, 7 days a week) • Weekdays vs weekends • Seasonal • Peak times or partial day • Reactive, e.g. during high pollution episodes • Occasional, e.g. during large events • ...
Technological options for implementation and enforcement (often used in combination)	<ul style="list-style-type: none"> • Manual inspection and windscreen stickers/manual toll collection • Automated Number Plate Recognition (ANPR) • Dedicated short range communication (DSRC) • Global Navigation Satellite System/Cellular Networks (GNSS/CN) • ...

⁶ E.g. The Feinstaub alarm scheme in Stuttgart (Germany) invites vehicles to not enter the city. The voluntary aspect of advisory schemes limits their effectiveness.

Measures such as pedestrianisation of neighbourhoods and city districts and traffic circulation and road space arrangements that limit through traffic can also support cities in designing urban mobility policies. UVARs have often been developed in order to preserve historical centres, mitigate traffic emissions, increase liveability and reduce congestion. Looking at the history of UVARs, these have often been the starting point: measures to

preserve historical centres, increase liveability and reduce congestion. Removing (public) road space can be enabled by UVARs (e.g. more space for bus lanes or amenities due to reduced congestion), or it can serve as an alternative to limiting traffic or emissions.

Specific UVAR types can support different policy objectives, as the table below describes.

Policy objective	Type of UVAR
Air quality improvement	Low-Emission Zone Ultra-Low Emission Zone Zero-Emission Zone Pedestrian zone
Congestion reduction	Congestion Charge or Tax Limited Traffic Zone Superblocks, traffic routing Pedestrian Zone
Urban landscape preservation (historic town centres)	Limited Traffic Zone Pedestrian Zone
Climate change mitigation	Zero-Emission Zone Limited Traffic Zone Pedestrian Zone
Noise mitigation	Pedestrian Zone Limited Traffic Zone Superblocks, traffic routing Quiet zones Lorry bans/delivery time windows
Road safety	Pedestrianisation Superblocks, traffic routing Lorry bans/delivery time windows
Redistribution of road space	Congestion charge Pedestrian Zone Limited Traffic Zone
Raising revenues	Urban road toll or kilometre charge
Quality of life	All of the above

Cities are constantly adapting their appreciation of public space. Due to growth in the urban population, economic activity, space required for amenities, the need for mobility and the multiplication of new mobility providers (with new vehicle concepts), urban space has become the city's scarcest resource. Regulatory measures are currently mostly used to address congestion, air quality and noise issues. However, as the need for mobility grows, its energy use increases. In parallel, cities and countries in Europe are seeking to reach climate neutrality in transport, which is leading to an increased focus on modal shift.

Good practice:

Modal shift targets of European cities. By 2041, London (UK) aims at 80% passenger journeys being completed by public transport, walking or cycling. By 2030, the greater Antwerp transport region (Belgium) including one of Europe's largest ports, aims at a modal share of 50% sustainable trips for persons and freight. The Antwerp figures are based upon the projected growth of mobility in view of the available infrastructure: Antwerp is going through a substantial road infrastructure investment programme, but even then, the infrastructure will only cope with demand if a large number of private motorised trips are shifted to more space- and energy-efficient modes.

This transition is bringing with it a new generation of UVARs that are now starting to be seen. They include kerb side management; dynamic space/price management; Ultra-Low-Emission Zones and Zero-Emission Zones; and hybrid schemes that combine measures such as congestion charges with emission requirements.

Temporary or single-street level measures such as cycle streets, living streets, and school streets are not addressed in this document, which is more focused on traffic regulation schemes that target several streets, neighbourhoods or entire city districts. While parking forms part of the tools to regulate access to urban areas, it is not covered in this document, as it is being comprehensively covered in a SUMP Practitioners Guide on Parking⁷. In terms of UVARs, if access is restricted,

then parking place provision, parking policy and the parking control and payment system should be aligned and supportive of the UVAR.

1.3 Discussing UVARs in the framework of SUMP

The central goal of a SUMP is to improve the accessibility of urban areas and provide high-quality and sustainable mobility and transport to, through and within the urban area. It (...) fosters a balanced development of all relevant transport modes, while encouraging a shift towards more sustainable modes. The plan puts forward an integrated set of technical, infrastructure, policy-based, and soft measures to improve performance and cost-effectiveness with regard to the declared goal and specific objectives⁸.

There is a functional interdependency between SUMP and UVARs. For a high-impact and sometimes controversial measure such as an UVAR, it is beneficial to rely on the framework of an integrated, long-term plan. SUMP provides the framework to ensure that the UVAR is integrated and supported by the cities joined-up, comprehensive transport policy. If planned and communicated jointly, it enables the UVAR to be developed with sufficient parking or improved public transport to support it, or to encourage the use of sustainable modes or freight solutions, as well as actions to mitigate any potential negative impact. This can support the overall acceptance and ownership of the UVAR scheme.

On the other hand, SUMP objectives might only be met by introducing a scaled solution that can reduce the number of (certain types of) vehicles within a given area of the city. Integrated solutions consist of pull and push elements: measures that persuade and incentivise sustainable behaviour are combined with measures that actively prevent undesired behaviour. Although UVARs might originate from other policy fields, for instance environment and climate, their implementation and the effects are situated in the mobility sector.

⁷ SUMP Practitioners Guide on Parking

⁸ COM 2013 (913) FIN

These are some of the objectives that can be achieved by implementing UVARs:

- space reallocation for public transport, cycling, walking and other urban functions (e.g. green and public spaces, retail, businesses, and restaurants and bars);
- road safety improvements, e.g. by means of time windows or zonal regulations for Heavy Goods Vehicles (HGVs) or through reduced traffic volumes or speeds which result in fewer crashes and fewer severe injuries;
- air quality improvements through Low-Emission, Ultra-Low-Emission, Zero-Emission or Traffic Limited Zones, which help reach stipulated EU air quality standards or limits advised by the World Health Organisation (WHO) on emissions;
- quality of life improvements through maintaining access to but reducing the ability to drive through a district (reduced permeability), e.g. the superblocks approach;
- reducing congestion, also resulting in several secondary benefits, such as better air quality, lower energy use and less noise;
- economic development by means of congestion relief, market creation for new freight operational models, etc.;
- noise reduction, such as through HGV restrictions at night or reducing traffic volumes;
- city image and improvement through an overall reduction of car dependency and use;
- progress in working towards climate goals;

- positive overall effects on public transport use, fleet characteristics, sustainable mobility and freight operations.

Indeed, UVARs often serve a combination of these objectives.

Good practice:

Vitoria Gasteiz's (Spain) 'Superblocks' scheme aims at enhancing mobility as well as citizens' quality of life by reducing the negative impacts caused by the extensive use of private cars and through better use of public space. A Superblock is a delimited city area designed and regulated to ensure the safe co-existence of pedestrians, cyclists and private car traffic. The Superblocks scenario allocates up to 70 per cent of public space to pedestrians and cyclists. It has demonstrated great potential to reduce levels of harmful emissions, as well as noise.

Good practice:

Groningen (the Netherlands) is an interesting example. Its traffic scheme, first introduced in 1976, saw it becoming one of the first cities on the continent to implement the Buchanan principles – introducing the concept of road hierarchy and its link to acceptable motorised traffic volumes and street design: this leads to the restriction of through traffic in the city centre and the creation a more bike-friendly environment. The traffic scheme can be seen as the starting point for Groningen's evolution into (one of) the most bike-oriented cities in Europe – cycling has a modal share around 60%.

2. The eight SUMP principles in the context of UVAR

2.1 Plan for sustainable mobility in the 'functional city'⁹

Cities normally apply UVARs in their most dense, congested and polluted areas – this is often the city centre. In some cases, measures can be 'nested' at neighbourhood level because severe problems appear. Superblocks are a measure that can be implemented in such circumstances, or a tighter LEZ within a less strict LEZ. The UVAR is often best applied to a 'recognised area': a territory with clear, historical or infrastructural boundaries. This facilitates the communication, routing, signage and digital mapping of the zone.

However, while the actual UVAR is usually applied in only a part of the Functional Urban Area (FUA), the impacts for travellers and hauliers extend far beyond it. Measures need to be designed for the full FUA (or even beyond) that help to maintain the level of mobility and access (so-called 'accompanying or supporting measures'), alongside information schemes.

The fact that certain vehicles cannot enter a designated zone can have positive and negative boundary effects: e.g. parking pressure or detouring traffic just outside the zone can cause additional burden to inhabitants of that zone. On the other hand, the modal choice is made at the trip's point of origin, and the selection of a mode aside from a private car could relieve the problematic traffic situation for the whole FUA. In this sense, the access regulation scheme, regardless of its size, will impact on modal split beyond the areas of high pollution or 'hot spots' where it is located. This is of course dependent on the alternatives provided for private car use in the measures accompanying the UVAR. Choosing a different mode might not be an option for all affected travellers. The attractiveness and appropriateness of the alternatives provided will have a positive impact on the modal split.

With the competence to manage local roads comes great responsibility. Cities indeed hold the competence to manage local roads, regulate traffic and local taxes. They have the responsibility to safeguard the quality of life and health of their citizens. When implementing UVARs, they should be aware of the broader impact the measures have outside of their territories, particularly on road users from outside the city's administrative boundaries. Some city centres serve as a regional centre for employment and public services. Other cities, such as cultural centres or tourist destinations, attract travellers from far beyond their borders.

The impact of UVARs on the peri-urban and rural hinterland should be carefully considered. An understanding of the actual origin and destination of trips in the FUA should be present, as well as an appreciation of trip purposes. This can help to design a better optimised and fairer UVAR scheme. This also means that in the preparation of the UVAR, simulations and air quality/traffic models should (if possible) forecast impacts beyond the central UVAR zone – particularly for larger urban areas. These models can also help provide an evidence base for determining the size of the zone where the UVAR should apply, as well as its impacts. Needless to say, any other impact assessments done would also benefit from including the larger area. Specific guidance on SUMP in metropolitan areas is available; this contains recommendations that can be used in this context.¹⁰

⁹ EUROSTAT/OECD: 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 (OECD, 2012).

¹⁰ <https://www.eltis.org/guidelines/second-edition-sump-guidelines>

2.2 Develop a long-term vision and a clear implementation plan

UVARs are implemented to solve immediate and urgent problems relating to aspects such as road safety, air quality, congestion, damage to historic buildings, and retaining the visual appeal of historic centres. The acceptance of UVARs by road users is dependent on understanding and experiencing the need and urgency. So where do UVARs fit in within a long-term vision?

Such a long-term vision will not only look at air quality, but also modal shift, quality of life and use of urban space. In addition, it provides the perspective to offer multimodal access to city dwellers in a context of demographic growth. Cities face an increased demand for mobility of people and goods, but usually without the possibility or desire to expand the road network.

Early adopters of traffic limitations for through traffic reductions and pedestrianisation schemes have over 20 years of experience. Those who have implemented LEZ schemes and a congestion charge have over 10 years of experience. These schemes show long-term positive effects. The documented change that is experienced by these frontrunners can serve as an example to those cities now looking into UVARs. The implementation timeline for the first phase of UVAR deployment should ideally not go beyond a local legislative period; doing so helps create a coherence between the local policy vision and actual measure implementation.

With regards to the implementation plan, this should be concise and simple. This aids understanding among decision makers, institutional stakeholders, implementers and end users. In turn, this leads to better compliance.

The long-term vision for UVARs relating to air quality

The broader framework in which many air quality-focused UVARs are set is the EU vision on changing urban fleets as described in the EU's White Paper on transport (COM/2011/0144 final). This includes the aims to halve the use of 'conventionally fuelled' cars in urban transport by 2030 and to phase them out in cities by 2050; and achieve essentially CO₂-free city logistics in major urban centres by 2030. UVARs addressing specific vehicle categories in view of air quality can be seen as first steps to accomplish this vision. The UVAR equipment and procedures can be used to address other goals.

UVARs are often best designed in a phased approach. Firstly, depending on the extent of the air pollution issue, older diesel vehicles (potentially starting with heavier or delivery vehicles) are banned from entering the zone, which itself is applied to a smaller area. As time goes on, more recent vehicles or higher EURO/Euro Class vehicles (including petrol) are banned. The geographical coverage of the area can also be extended over time. Phasing also gives vehicle operators time to adapt, and tackles the worst offending vehicles first. A longer vision (2030 and beyond) could include a total phase out of vehicles with internal combustion engines. This phased approach should be communicated early on in the process of UVAR planning, so that all stakeholders can prepare and comply, and enable them to make the choice that complies the longest (and thus provides the most benefits). The accompanying measures should be tailored to accommodate the phased schemes. Tighter standards can be implemented in smaller areas (in nested schemes) where they suit the purpose. The timing of the phases should be carefully matched with the availability of vehicles, retrofit options or alternative transportation offerings, in order to encourage that optimal compliance decisions are taken.

Although the overall and average fleet characteristics will evolve positively over time, air quality-related UVARs can accelerate this, and are crucial in keeping local air quality at an acceptable level.

2.3 Assess current and future performance

As access regulations can be very politically sensitive, require up-front investment, and have high potential impacts, the appraisal of future schemes has been well studied and documented. Cities can definitely look at practices in other cities, in publicly available documents to help gain support and confidence in such schemes, as well as learn from best practice to enable 'learning shortcuts' and avoid potential pitfalls.

The assessment of potential impacts before a mobility measure is implemented is a complex matter. Impact should be assessed quantitatively as well as qualitatively. Distinguishing between factors influencing impacts can be difficult. Often, local issues and traffic measures – such as LEZs, road works, freight restrictions, and incentive schemes – coincide, whilst society as a whole is changing in parallel, e.g. the rise of e-commerce and changing employment rates, demographics and national policy.

Parameters related to issues which the UVAR aims to tackle should be monitored over time both inside and outside the zone in question – and ideally be in place as long as possible before the scheme starts. Beyond official monitoring data, appropriate and trustworthy measurements carried out by third parties (e.g. citizens measuring air quality), could be taken into account where available to identify possible inconsistencies and needs for additional official measurements.

Cities have access to a variety of methods to conduct a pre-assessment of the implications of an UVAR. These include an impact assessment (determining what the effects will be), a feasibility study (determining the financial and practical issues relating to UVAR implementation), a cost-benefit assessment (mapping societal costs against societal benefits), and a cost-effectiveness assessment (mapping at what cost the UVAR's goals can be met).

The 'paralysis of analysis' should be avoided. The duration and detail of the studies should neither overly delay the making of decisions nor hamper actual implementation. This constitutes the postponement of a solution to urgent problems. The assessment should be

appropriate and proportional to the size of the scheme and city, to its expected implementation cost and impacts, and take into account potential resistance. A large complex scheme in a major city would require more assessment than a fairly minor scheme covering a few streets in a smaller town.

Future performance can also be shown by means of trial periods or experiments. Possibilities include temporary zonal access management, alternative use of street space, events impacting on motorised traffic circulation, and car free days. These can all give an impression of how a city changes when there is less motorised traffic on its streets. Experimental schemes should be carefully planned, documented and monitored according to the expected impacts, targets chosen and indicators selected.

It is clear that performance should be assessed against policy goals like EU air quality directive targets). Yet there is more. UVARs are criticised for their adverse negative impacts, such as reduced mobility or access, for damaging local economies etc. Where possible, these issues should also be captured in measurable indicators. Once schemes are in place, their evaluation should continue against the objectives set for them to ensure that they deliver.

2.4 Develop all transport modes in an integrated manner

UVARs are excellent measures to promote multimodality. UVARs are put in place to enable behavioural change, be that modal shift, rerouting, or using other vehicle types. While access to the zone might be regulated and limited for (specific) motorised vehicles, it typically remains open to non-motorised modes and public transport. In the process, they gain more space and become an alternative way of accessing the zone. Not all UVARs necessarily induce modal shift, however. Although LEZs target the exclusion of certain polluting vehicles and a shift to cleaner vehicles can be expected, their impact on modal choice has not yet been documented.

Most UVARs include packages of accompanying mobility measures to compensate those who would need to significantly alter behaviour. This is done both directly,

for example with grants for retrofitting), and more importantly 'indirectly' by offering and improving alternative modes, facilities or options. Planners should be aware that these measures, despite creating societal and individual benefits, can also cause direct or indirect financial disadvantages, which particularly affect those with low incomes. Support mechanisms should be considered, especially to help the financially weak.

The measures packages should include solutions for this issue and should utilise modes other than those affected by the UVAR. In this way, UVARs can also be enablers for new mobility services and new operational models for moving goods and people. Single ticketing and simple payment solutions for public transport and shared mobility services (or Mobility as a Service) can encourage multimodality and offer viable mobility alternatives in urban areas with access restrictions. If presented in an appropriate way, the UVAR can provide the additional push that can make new mobility services attractive to use.

Modal integration applies to the movement of goods as well as the movement of people. Although 'goods don't vote', the overall traffic and economic performance of cities (and city centres' in particular) depends on how first-/last-mile, local freight and logistics flows are organised, and UVARs can provide help improve this if carefully planned. Inspiration on this can be found in the topic guide on urban freight/Sustainable Urban Logistics Plans¹¹.

2.5 Cooperate across institutional boundaries

The most important inter-institutional cooperation with regards to UVARs is that UVAR implementers comply with European, national and regional legal requirements regarding road network management. In this way, UVAR measures need to be compliant and coherent with national and EU law¹².

¹¹ <https://www.eltis.org/guidelines/second-edition-sump-guidelines>

¹² EU legal issues: Freedom of Movement, Proportionality, and non-discriminatory. UVARs can affect the TEN Network (e.g Austrian motorway LEZ), but there are significant restrictions to this, and it must be done carefully, and in consultation with the Commission.

Cooperation between different governance layers at national and European level is key, and should be fostered to ensure that UVARs can succeed, especially with regards to enforcement. Informing drivers not from the UVAR area will often need cooperation with the national level, as well as with other Member States. Scheme compliance relies on effective communication on the UVAR to the right audiences, including those hailing from beyond the city's own boundaries. Enforcement of foreign vehicles is also tightly linked to good cooperation with authorities outside the city or country. National frameworks can support the implementation of UVARs, and potentially restrict the variation within a country – with the advantages and disadvantages that brings. National laws – or the absence of them – can hinder some schemes.

Cities are also dependent on other institutions with regards to accompanying measures. Does a city implementing UVARs have the actual powers, competence or leverage to implement all the alternatives? If a city is part of a broader Public Transport Authority, the additional public transport offer will need to be negotiated. The same applies to park and ride (P&R), which although it might be situated outside the municipal boundaries could determine the success of the FUA's access policy. In case of commercial services, such as those operating new or shared mobility services or freight facilities, there might be a need to first generate the demand for the new services or facilities being offered.

Institutional cooperation should happen also within city authorities. UVAR planning and implementation requires cooperation between departments dealing with spatial, mobility and air quality. This coordination should be carefully crafted and can be part of a bigger interdepartmental and inter-agency/authority coordination within the framework of the SUMP.

Data management and sharing is an essential part of the institutional cooperation. Information on UVARs needs to be disseminated to all stakeholders that may be affected, be they near or far, regular or irregular. Those who do not know about the scheme cannot comply with it. Under the ITS Directive, countries are establishing National Access Points (NAP)¹³ for traffic data, that will in time also carry UVAR-related information to help disseminate the information more widely. Yet local data also needs to be shared openly. It is essential to properly inform users

inside and outside of the UVAR zone. UVAR systems have the potential to generate interesting mobility data that can be drawn on by third parties. This can help increase knowledge of and compliance with schemes, while reducing complaints.

Finally, the city will also have to cooperate beyond the public sphere, and create partnerships with the private sector in its role as a generator of trips, handler of goods or provider of mobility solutions. These partnerships can help to take the UVAR into a solution-oriented environment by facilitating improved mobility options.

Good practice:

London (UK). The Mayor of London's Environment Strategy was published in 2018. It ensures that London is 'greener, cleaner and ready for the future' and looks at every aspect of London's environment, including air quality, the impact of climate change, and noise. The document complements the Mayor's Transport Strategy 2018, also finalised in 2018, which sets out policy on development of the London Congestion Charge, Low Emission Zone and Ultra-Low Emission Zone.

2.6 Involve citizens and relevant stakeholders

The general rule in policymaking applies to UVARs in particular: Communicate well!

The UVAR scheme should include a thorough, well-developed and well-resourced (in budget, skills and mandate) public involvement strategy that covers the planning phase and continues after implementation. There is a simple reason why citizen and stakeholder involvement is important: it makes better schemes! Well-designed and widely communicated schemes also lead to higher acceptance, compliance, and thus higher impact and less resistance.

Here as well the scale of the UVAR will shape the participation process. It should be proportional to the size and scope of the UVAR scheme. It is generally recommended

¹³ https://ec.europa.eu/transport/themes/its/road/action_plan/nap_en

not to design specific procedures for UVAR planning and implementation, but to follow existing procedures. In this way, legal certainty is assured, and UVARs are treated as any other planning or traffic measure.

The strategy should cover (in consecutive order):

- A stakeholder map, establishing a full picture of who is affected by or involved in the UVAR implementation. These stakeholders should cover all modes and trip purposes, and include professional as well as private road users, alongside those who will benefit from the scheme – even those that may not need to change their behaviour. Stakeholders can be situated within and outside the UVAR zone and the city. Here, the FUA can be seen as a logical outreach area (see section 2.1).
- For some of these stakeholders, there may be existing communication channels. These might be neighbourhood committees, committees that bring together local business and retailers with the public sector, communication channels with the freight sector, motoring clubs, trade bodies etc. Such channels can be utilised to support the dialogue on UVARs. A specific and important group are priority vehicle users, i.e. the fire brigade, the police, and the ambulance service. These vehicles should keep access at all times and to all places. Similarly, access is needed for street sweeping and rubbish collection vehicles.
- A user needs/concerns assessment can be conducted, to gather views of road users, citizens, stakeholders.
- The public involvement process should be phased and follow the sequence below.
 - It should start with gathering representatives from key stakeholder groups at the earlier planning stages to raise key concerns;
 - This should be followed by a formal consultation at a later stage – including transparent availability of relevant data. In the formal consultation, it is recommended to focus on the detailed design of the scheme, not on the overall need for access regulations.

- Once the scheme is confirmed, communication should focus on informing drivers about the scheme. This should occur as soon as possible prior to implementation in order to give them time to adapt.

- An approach should be developed to provide drivers and citizens with up-to-date information once the UVAR is up and running. This is key to compliance with UVAR schemes.

- The communication strategy should ensure a good mix of communication channels. Providing information relating to trends in the key indicators that track UVAR performance can help increase support. Stakeholders should receive a sufficiently developed framework to provide informed input, but this framework should not also not create the impression that everything has already been decided.

- A challenge for local authorities is to provide proper information to non-residents, especially if penalties and fines are linked to UVAR enforcement. To raise acceptance of the schemes, any communication directed at both residents and non-residents must consider the particularities and the needs of different groups of road users.

- Where schemes are reactive (e.g. emergency pollution schemes), a special focus is needed on disseminating daily information and keeping drivers informed of the changing situation.

- Communication and dissemination of information should also include the visibility of UVARs in the digital sphere. Integration of information in route planners and navigation devices should be explored. The National Access Points for digital transport data mentioned above will enable machine-readable, standardised information on UVARs to be made available to other service providers, such as Satellite Navigation Devices, route planners, apps or websites. The UVAR requirements of the Single Digital Gateway (SDG)¹⁴, which are to provide UVAR information on national and city websites linked to and searchable through MyEurope, will help to coordinate the information available EU-wide. For this to work, each city needs to provide good quality UVAR information on their website, as well as national UVAR

websites. Until complete UVAR data is available on the SDG and NAP, the European UVARs Portal is helping to disseminate information around Europe¹⁵.

2.7 Arrange for monitoring and evaluation

Monitoring and evaluation is closely linked to the ex-ante assessment of the UVAR (the cost-benefit analysis, feasibility or cost-effectiveness assessment). Policy objectives, targets and indicators that are selected there should be maintained in the monitoring and evaluation and planned from the onset of the UVAR planning and design. UVARs should be carefully considered and weighed up with other policy options. The principle that core indicators as well as circumstantial indicators – for example ones relating to economic performance, tourism, and retail – should be tracked also applies to this SUMP principle. Indicators relating to perception and opinions can also be collected, e.g. through surveys or focus groups.

This raises an important question: When can a UVAR be called a success? Is it demonstrated by compliance – shown by low number of infringements? Is it evidenced by high acceptance – when the measure is liked and appreciated? Is it shown by impacts linked to the UVAR's goals? In general, the advice is to consider the UVAR as a mainstream measure, without the need to invent a new monitoring and evaluation system. It should be part and parcel of the overall SUMP evaluation approach and process. To monitor and evaluate only the UVAR whilst ignoring the rest of the SUMP measures would be counterproductive to say the least.

The integration of the UVAR's evaluation and monitoring into the overall SUMP evaluation and monitoring approach can also help to understand different effects of coinciding measures, and the relation between the UVAR and its accompanying measures. Identifying the impact of a single SUMP measure such as an UVAR can be difficult. There are different methods that have been used¹⁶, and guidance for assessment may be available at national level.

¹⁵ <http://urbanaccessregulations.eu/>

If applicable, an independent evaluation should be considered, e.g. by a representative panel of stakeholders and experts, or by a specialised university or a laboratory to measure air quality. This will help to understand whether the UVAR schemes are appropriate and delivering the expected results. The applicability of such an independent panel depends on how controversial the measure in operation is, and, again, about the proportionality of the whole evaluation effort.

Evaluation results of schemes should be transparent, understandable and publicly available. They should also be useful. In coordination with the communication team, a realistic pace of reporting should be established: What is a reasonable timeline to see the evolution of indicators? When is it too early to draw conclusions?

Good practice:

In Antwerp (Belgium) 100% of the vehicles are controlled and checked. This means that we monitor the access to our LEZ on a daily basis.

<https://www.slimnaarantwerpen.be/en/LEZ/control>.

Smart cameras (ANPR) have been installed along the boundary of the LEZ and in the city centre. These zoom in on every number plate. Once you drive past the signs, your number plate is automatically recorded. This is checked against a list of all the admitted vehicles (whitelist).

The admitted vehicles are automatically filtered from the list of recorded number plates during this check. Vehicles that are not on the whitelist but which do enter the LEZ all the same will be added to a list of potential offenders. An LEZ-supervisor checks this list after ten days and establishes the report. The official in charge of fines will then establish the administrative fine to be paid for every offender. The fine is sent to the holder of the number plate by registered mail. On average, offenders receive a fine for this offence between 20 to 30 days after entering the low emission zone.

An annual evaluation of the Low-Emission Zone in Antwerp (Belgium) is conducted by comparing the vehicles entering the LEZ with the composition of the Flemish regional fleet (fuel and euro-norm). This provides information on the transition that the implementation of the LEZ is driving. The city has also extended its network of air quality measurement stations in cooperation with the VMM - the Flemish Regional Environmental Agency. VMM conducts the air quality measurements required under EU law.

Good practice: Krakow (Poland)

A study was conducted by Krakow University that assessed the results of traffic and parking restriction measures implemented over the last decade in several city centre locations. The available information shows that the transformation of car parks into city squares attracted new entrepreneurs who wanted to invest in these areas. The greater number of shops, bars and restaurants and the presence of other attractions resulted in an increase in the number of visitors to these areas, who also stayed there for longer than previously.

Based on the results of research looking into changes in the revenue received by owners of car parking facilities, it can be concluded that generally the regulations did not cause significant changes in the amount of income, and that any changes were not linked to the restrictions. Whilst the restrictions did not produce a significant increase in income, they also had no real negative impact on owners' revenue – the factor they are always most concerned about. In the case of the parking facilities located on Grodzka Street, this conclusion has been confirmed by the data obtained from the tax office. What is more, the increase in income coincides with the highest pedestrian activity in the city centre.

A very high percentage of owners (75% within the relevant area) would not want to return to the times before the vehicle access regulation. Customers of the facilities located in the analysed areas also reported a very high degree of satisfaction (on average 83%). They are primarily happy with the absence of cars in these areas, whilst also enjoying the presence of structural landscaping, historic buildings, and the general atmosphere. Moreover, only a small share of respondents referred to problems in accessing the facilities. Currently, respondents reach them mainly on foot or by public transport. They visit facilities less than once a week, or occasionally when carrying out other activities in this area of the city.

2.8 Assure quality

The quality of the UVAR has many dimensions: Does it help to accomplish policy goals beyond its current objective? Can it solve urgent, current problems, whilst also creating longer-term benefits, such as modal shift, a better quality of life, and increased city attractiveness?

¹⁴ https://ec.europa.eu/growth/single-market/single-digital-gateway_en

An element of quality is the ability to change the scheme on the basis of monitoring and evaluation results. This means there should be sufficient political, regulatory, operational and technological room for manoeuvre to adapt and improve the scheme as required. This might apply to the UVAR itself, the way it is communicated, or how accompanying measures are shaped and scaled.

The level of compliance and number of appeals and complaints can be a good indicator for the quality of design, communication and handling of the enforcement process. Overall, it is clear that a transparent, understandable and swift process for handling appeals against fines is a vital part of any high-quality scheme.

External input can also be of great value to assure quality. Panels made up of external experts help to avoid tunnel vision and bring facts and methodologies to the table that are not always known within city authorities.

3. SUMP steps for UVARs

3.1 Set up and analysis

In this phase, the measures that will be part of the SUMP are not yet on the table. To ensure that a UVAR can be part of the eventual (SUMP) action plan requires an open attitude towards UVARs as being a building block for local mobility policies.

The following should be considered:

- Conduct a broad scoping of problematic areas relating to urban mobility. Other policy departments might encounter problems that find their solution in regulating access. The LEZ has been mentioned as a tool to solve air quality issues, but access to culture and heritage sites in the city centre could also benefit from a well-designed pedestrianisation, coach routing, or parking/access scheme. Safe travel to school might also be a factor to take into consideration. To develop and implement such schemes as those mentioned above, closer and deeper cooperation between different departments might be required.
- When brainstorming and compiling the set of all potential measures and solution trajectories for the SUMP, make sure it contains solutions that integrate so-called push and pull measures. Incentivising pull measures such as an increased availability of transport services and infrastructure should be accompanied by push measures that regulate and limit motorised transport.
- Collect data relevant for problems that can be solved by UVARs and relates back to the policy objectives mentioned in section 1.2.
- Check to what degree the city is ready for UVAR planning and deployment. This should be done in several areas:
 - Governance: Are the policy priorities clearly defined? Is the legal context in place for UVARs? How can the UVAR be financed?
 - User needs: What is the current/desired mobility behaviour? What is the vehicle ownership rate, and what types of vehicles are owned by citizens,

businesses and visitors? What is the attitude to and availability and current uptake of alternatives to private vehicle use? How is this affected by the demography and socio-economic situation of the travellers?

- Mobility solutions: What is the current modal split and allocation of road space between modes? What is the availability and cost of providing alternatives? What is planned over the coming years in terms of improvements in this regard?
- System design/technologies: What data is available for the city to take informed decisions? How connected are the users and the vehicles using the urban road network? Are there technology or ITS systems in place (owned by the city) that can be used to deploy the UVAR?

3.2 Strategy and development

This will be the phase where the planner should consider if the UVAR is needed, or if there are other measures that may be implemented at a similar cost and are more or as effective. Citizen and stakeholder involvement is key for this phase, as the basis for future buy-in and acceptance will be created here. This is the phase where the planner needs to ensure that push and pull elements of the SUMP are well balanced and that an UVAR is incorporated and integrated within the SUMP, as opposed to standing alone.

It may be challenging to make the relationship between the vision and the access regulation explicit. The planner will have to explain that the positive, aspirational image that exists of a city's future mobility system can only be achieved when certain vehicles types and numbers are rerouted or excluded from certain areas in the city. This relationship can be made explicit by introducing UVAR aspects into the scenario building this phase encompasses, including the modelling of policy measures packages.

3.3 Measure planning

The following actions should be taken into account in the measure planning phase of the SUMP if a UVAR will be in the SUMP action plan. Based on the strategy and other implementation factors, a time plan should be developed to implement the different phases of the UVAR. This supports the process of reaching more ambitious goals with the UVAR as time progresses.

- The boundaries/zone in which the UVAR will apply should be set out (see section 2.1).
- The access characteristics should be defined and tested for effectiveness.
- The action plan should include the necessary accompanying measures (see section 2.4 and 4.2).
- The legal basis and enforcement mechanisms should be clarified and published.
- Institutional stakeholders outside of the city authorities should be involved in the coordination of communication and accompanying measures to make the UVAR a success (see section 2.5).
- It can be very beneficial, particularly for large and more complex schemes, to model different UVAR scenarios to identify the scheme to adopt. The chosen scheme (which may be a combination of different scenarios) then needs to be modelled to assess its impact.
- The technologies used to manage and enforce the UVAR should be selected. In terms of enforcement mechanisms, automated enforcement may be more expensive to implement but more effective and cheaper for good compliance. Manual enforcement can be cheaper and quicker to implement, but expensive and difficult to implement in an effective way.
- A data strategy should be established that defines the conditions and parameters for collection, storage and exploitation of UVAR-related data.
- A communication, consultation and stakeholder involvement strategy should be devised.

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

3.4 Implementation and monitoring

When starting the UVAR's actual rollout, a trial period can be considered. This can be useful for testing systems and procedures and measuring initial impacts. The trial needs to be very carefully planned and sufficiently funded, as a poorly implemented trial could backfire. The implementation should be preceded by appropriate awareness raising to inform users of the urban road network which access conditions will change. This is best combined with the provision of sufficient alternatives before implementation. That way road users can experience the alternatives and start to change behaviour before the UVAR comes into effect.

The implementation needs to be considered in the planning phase in terms of its feasibility. Timescales also play a role here. It needs to be ensured that either it is possible to implement the planned measures within the electoral period of those deciding on the scheme or that sufficient cross-party support exists for it to be implemented over several electoral cycles.

The evaluation and monitoring aspects of the UVAR have been described in section 2.7. It is important that the evaluation is appropriate and proportional to the measure's scale and level of sensitivity. Authorities should be clear about the indicators that will be tracked and present them in a reasonable timeline of outputs. Given the fact that UVARS are part of integrated packages of measures, it might be difficult to assign specific impacts to specific measures in the overall package of mobility measures. The important thing is to deliver an efficient and effective system.

Monitoring media coverage and social media feedback on the scheme could be pursued, as well as direct dialogue with a selected user panel to collect feedback about implementation.

Most importantly, in the case of LEZs, pollutant concentration (mainly NO₂ and PM) within and outside the LEZ should be monitored and evaluated against the limit values set out in the Ambient Air Quality Directive.¹⁷ Primarily, this should be done using data collected by official monitoring stations. However, measurements conducted by citizens using private air quality sensors (although obviously not as accurate) can indicate wider trends related to the evolution of pollution in specific areas.¹⁸ For instance, the Netherlands is exploring ways to take citizen measurements into account in their policy-making, including via an interactive map.¹⁹ Similarly, Bologna invites citizens to measure air quality themselves in order to expand their knowledge of the issue while raising awareness about air pollution.²⁰

Additionally, remote sensing technologies, which have already been deployed in several European cities²¹, will help monitor real-world emissions of cars entering LEZs. This way, the highest emitters can be identified and action taken accordingly on the basis of real-world data.

A re-evaluation of UVAR should be conducted once its initial objectives have been met. At that moment, tightening or changing the objectives of the access regulation might be considered, or even abandoning the scheme altogether (as has happened with temporary tolling schemes in the Nordic countries).

¹⁷ <https://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX%3A32008L0050>

¹⁸ For recent activity from the JRC on this issue: <https://ec.europa.eu/jrc/en/publication/evaluation-low-cost-sensors-air-pollution-monitoring-effect-gaseous-interfering-compounds-and>

¹⁹ <https://samenmeten.rivm.nl/dataportaal/>

²⁰ <http://www.fondazioneinnovazioneurbana.it/laboratorioaria/>

²¹ <https://www.trueinitiative.org/>

4. Specific points of attention with regards to UVARs

4.1 UVAR: stakeholders' ownership, acceptance and buy-in

The stakeholder ownership, acceptance and buy-in of UVARs is closely related to the item 2.6 "Involve Citizens and relevant Stakeholders". There are several good reasons to carefully look into the acceptance of the planned UVAR. Firstly, local policy makers are more likely to support measures endorsed by the electorate. Secondly, poor acceptance of or even resistance to the UVAR can stop it - a scheme which requires the major investment of public funds. UVARs are also schemes implemented for their substantial positive impact. In this sense, it would be problematic if the UVAR were to be stopped before reaching its goals, or if other solutions to the problems the UVAR solves are put in place before the UVAR ends. By gaining cross-party support for and wide societal acceptance of the UVAR, its can continue to be implemented across a series local legislative periods.

Beyond acceptance

Stakeholder or user acceptance conveys the idea that the UVAR planner is mainly concerned by the reaction of users to a solution that has already been designed and implemented without stakeholder involvement.

It is clear that proper UVAR planning should go beyond this, and instead include early stakeholder involvement and anticipate user needs and views.

When choosing a scheme, authorities should make the best use of participatory governance tools to ensure that users are effectively heard.

There are several ways to improve acceptance:

- The UVAR should address a clear and recognised objective, either solving a problem or creating opportunities.
- Before deciding on UVAR implementation, an assessment should look at different measures and the necessity of the implementation of a UVAR. The appro-

priateness and proportionality should be the starting point and addressed in dialogue with stakeholders.

- The scheme should be well-designed. Several design requirements have been mentioned in chapter 3. The design of the package of accompanying measures is crucial in this regard. The availability of good alternatives to the 'old' travel option is the most crucial step towards publicly accepted UVARs. The design should also be adaptable enough to enable the UVAR and its package of accompanying measures to be adjusted in light of new or unexpected issues that might reduce acceptance.
- The scheme should be well-communicated. Several communication requirements have been mentioned in the chapter 3. All communication activities should make the positive impacts clear to all stakeholders (businesses and members of the public) affected by the UVAR. Once the scheme has been decided on, good communication is essential to encouraging compliance. Communicating the impacts can also boost the UVAR's acceptability.
- Key politicians or other people that enthusiastically support the UVAR (so-called 'champions'- for instance trusted stakeholders or community groups) can help rally support for the scheme and facilitate its implementation.
- Demonstrations, trials and experiments can sometimes help create an understanding of why the UVAR is necessary and what its impact will be. Positive impacts can be highlighted and experienced.

What car drivers need when considering UVARs:

- An evaluation of alternative measures should be envisaged to see if the UVAR is the appropriate solution.
- The government implementing the UVAR should help create an understanding of regulations, costs and impacts.
- The UVAR's rules should be transparent.
- Occasional and foreign users should not be discriminated against.
- Information should be available to assist trip planning.

(Information provided by the FIA)

- Citizens and stakeholders should perceive and experience that the system is fair and transparent. Fair means that the enforcement is balanced and reasonable, and that the exemptions to the UVAR exist and are granted in a justifiable manner. Transparency means that there is clarity about the use of revenues (if any) and that the UVAR is implemented to reach its objectives; this prevents it being seen as a hidden tax. Positive impacts should also be made visible to citizens and stakeholders.
- A phased introduction of the UVAR, with gradually tightening standards or expanding zones, can help acceptance. The idea that citizens and road users can gradually adapt their behaviour, and that fleet owners can plan for improved vehicle characteristics, makes the scheme more acceptable.

How can acceptance be assessed? There are several methods, such as surveys, focus groups, and (social) media screening. It is important to regularly address the overall level of appreciation of the UVAR within UVAR planning and project meetings. Different parties involved in implementation - including local politicians who are in contact with city-related stakeholders on a daily basis - can bring together their views on this. Public participation activities are also an important channel for collecting stakeholders' views.

This being said, UVAR implementers must accept that 'there will always be opposition'. It is the art of the deal to keep communication lines open - even with those that oppose the measure -, to be factual and transparent, and to run a UVAR scheme that actually delivers on its policy goals. Once the scheme has been decided on, communication and discussion need to focus on compliance, rather than whether the scheme should be there.

4.2 UVAR as part of an integrated package of measures

The SUMP aspects of UVARs come into complete perspective when looking at the integrated packages of measures that accompany the UVAR. The SUMP will match the regulatory and restrictive push factor of the UVAR with measures that create incentives for change,

be they mobility management-related or infrastructure adaptations. Opinions differ greatly as to the optimal balance between these push factors and incentives schemes. Incentives can differ depending on local circumstances.

With regards to air quality, every effort should be made to make the air in cities cleaner. Vehicle-based measures like software updates, hardware retrofits of passenger cars and urban professional driver fleets should be utilised. Municipal fleets, buses, vans and other vehicles must be retrofitted or converted to alternative drive systems. A system to assess compliances once the retrofit or upgrade has been carried out should be established. At network level, other measures are needed, such as the intelligent control of traffic flows and better public transport services. Besides this, providing attractive alternatives to cars can also improve air quality, for example through better public transport and by improving walking and cycling infrastructure.

The combination of the UVAR with other measures can aid political negotiations related to and increase public acceptance of it. This issue is closely linked to the principle 'Develop all transport modes in an integrated manner' developed in section 2.4.

The right package of measures, together with the right timing, can increase UVAR impact. It can also improve the practical feasibility of UVARs. Increased public transport capacity and new/smart mobility services help cater for motorised users that choose not to pay a congestion charge. A balanced package of compensating measures also shows to citizens that policy makers look after those who are asked to change their behaviour. In the process, it helps create the impression that there is fairness in the system.

Finally, for those UVARs generating revenue, the accompanying measure package can be funded by the scheme's anticipated revenue. Road users then see how their contributions are reinvested in the transport system's continued improvement. It should be noted that most UVARs do not generate revenue, but will cost money to implement and run. Indeed, cities prefer compliance to the revenue from fines paid, as it means their objectives are being met.

An important question is: what is the best way to distribute the compensating or accompanying measures across the modes? Furthermore, should additional resources be allocated to new and upgraded infrastructure (such as park and ride facilities, bicycle paths, improved public spaces, and interchanges), or to improved services (e.g. the public transport offer, new mobility services, and shared bikes)? The balance (or split) between capital and revenue spending needs to be well-planned. Modelling or other assessment methods help determine which measures in the long-list of options are the most (cost-) efficient.

Accompanying measures may also be situated within the competences of regional or national authorities. For example, grants for retrofitting vehicles or to support modal change have been used in a number of cities, regions or countries.

In the ideal case, the UVAR scheme includes an up-front provision of alternatives. Users can then experience the new travel and transport options before implementation.

4.3 UVARs and freight: ideas for mitigating solutions

Specific attention should be paid to accompanying measures linked to freight. Measures such as consolidation or last-mile solutions require specific locations that must be linked to zone design. These freight schemes entail more complex value chains than passenger transport. The UVAR may be one factor driving their deployment, but integrated freight strategies are needed. An ongoing dialogue between city authorities and the freight sector can help.

The EC's study on urban freight²² included a specific sub-report on UVARs and freight. Stakeholders identified two preferred UVAR schemes for addressing local challenges related to urban logistics: Low-Emission Zones and Congestion Charging. The study also defined a series of mitigating solutions:

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

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

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

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

Suppliers schedule deliveries to meet the demands of their clients. If the retailers require deliveries during normal working hours, most lorry traffic will occur during the most congested daytime traffic periods. If a critical mass of businesses is able to adjust their schedules to accept deliveries when there is less traffic congestion, it could enable transport companies to deliver goods more quickly and at lower cost. This could result in less traffic congestion, reduced cost of goods

²² 2018, Study on urban logistics – “the integrated perspective” as consulted on https://ec.europa.eu/transport/themes/urban/studies_en

and economic benefits, whilst also being better for the environment.

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

The NOVELOG Sulp (Sustainable Urban Logistics Plans) guidelines²³ specify the creation of a multi-stakeholder platform for freight issues in a city: it is a mechanism for industry and local governments to work together in partnership to produce a tangible outcome to localised freight transport problems. This platform should be established to discuss all freight transport-related issues, not only the UVAR. Ideally, the UVAR should not be the first issue the group has to tackle. Instead, it will have been in existence long enough for there to be mutual trust and a productive working environment; the sort of conditions required to deal properly with a major project like the implementation of an UVAR scheme.

4.4 UVARs and occasional visitors (tourists, non-resident road users)

Certain UVAR features are of particular importance and relevance for occasional visitors to and road users from beyond the area in which a UVAR is in effect as well as :

- Pre-registration (i.e. online registration) is often needed to identify foreign vehicles. Whilst this is unfortunate, it is required in the current absence of an EU-wide solution.

²³ NOVELOG Sustainable Urban Logistics Plan Guidelines: http://novelog.eu/wp-content/uploads/2018/07/NOVELOG_Sulp-Guidelines.pdf

Best practices: Communicating with non-resident vehicle owners

In Antwerp, vehicles that should register before entering the city's LEZ such as compliant foreign vehicles (but forgot to do so can also register 24 hours after entry: <https://www.slimnaarantwerpen.be/en/LEZ/registration/overview>).

Drivers can do this online or at one of the LEZ machines: (<https://www.slimnaarantwerpen.be/en/LEZ/register-your-vehicle>).

In 2020, the Euro emission standards for entering the LEZ will be tightened. An extensive communication campaign to inform people about this will start at the end of 2019. This campaign will not only focus on the local population, but also target nearby countries, such as the UK. Different channels will be used, for instance radio, internet advertising, signage at petrol stations, and advertising on ferries and trains from the UK. As the city does not manage roads regional around and entering the city, it has no control over signage there. Thus, Antwerp has asked the regional government to implement and/or enlarge the LEZ signage found on these roads.

4.5 UVARs and SUMP funding

A common myth regarding UVARs is that they bring cash into city accounts.²⁴ However, unless the scheme specifically aims to raise revenue (e.g. the Nordic infrastructure packages) or taxes repeated mobility behaviour (e.g. congestion charges), UVARs should generally not be regarded as major income sources. In fact, they usually cost more money to implement.

Ideally, some forms of UVARs (including LEZs) do not bring in any revenue. With the target being clean air, the aim is to have as few infringements as possible. Revenues also decrease over time, as compliance to the set standards grows and fleet characteristics improve.

As mentioned before, the money flows surrounding the schemes should be transparent, be it investment, oper-

²⁴ As stated by CIVITAS SATELLITE UVAR Advisory Group members

ational, or revenue (through charging or fines). The societal benefits stemming from UVARs can be monetised, although this is not always straightforward, and the local authority will not always be the main group to profit. For example, the benefits of road safety improvements - measured in the reduction of road fatalities, injuries or crashes - are felt most by the individual, as well as the governmental body that funds health services.

UVARs should be managed in an economic and efficient way. The fact that up-front funding is required to finance the system as well as the accompanying measures needs to be reflected budgeting. Where possible, the system used to manage the scheme might also be shared by several schemes or used for different traffic-related public services.

4.6 UVAR2.0: how UVARs might evolve

The time from which current technological developments, such as automation and the conversion of vehicle fleets to alternative fuel sources, will likely begin to have a real impact is starting to coincide with the length of a typical SUMP planning period; five to ten years. Local authorities should take this into account when planning UVARs, even if they are being put in place to solve current issues.

These are technological trends to take into account:

- The vehicle fleet's overall environmental performance will improve, leading to better air quality legislation compliance. Therefore, this will require ever stricter LEZs if air quality standards are still not met. Climate change is also an increasing factor in cities' UVAR decisions and plans. At the same time, several Member States have stated target dates for phasing out conventionally fuelled vehicles. The UVAR systems and procedures are in place, and may be used for a different objective than was originally foreseen.
- Vehicles will increasingly become connected, both with each other and with urban infrastructure. Solutions

such as geofencing²⁵ are starting to appear on urban streets. This is being trialled in a number of places and may in the future be relevant for Zero-Emission Zones or for the routing of Longer Heavier Vehicles (super lorries), which due to their high weight and length require very specific infrastructure.

- Improved routing based on connectivity can make (temporary) access regulations 'embedded' or 'forgettable', as the driver will not need to intervene to avoid the consequences of the UVAR. Depending on its location, vehicles will automatically be rerouted, slowed down or switched to a clean fuel mode (if a hybrid).

Good practice:

Oslo's (Norway) Climate Budget is a key governance tool for reaching the targets adopted in Oslo's Climate and Energy Strategy. It budgets the city's CO₂ emissions in a similar manner to the city's finances. This means that the overall emissions for transport are capped, and that measures are taken accordingly. Tolling is implemented to achieve this goal.

²⁵ within specific zones, hybrid vehicles are switch to electric mode; trucks are slowed down in the neighbourhood of schools; trucks are rerouted away from bridges where they cannot pass due to their height.

5. Case material

5.1 An early adopter of a Limited Traffic Zone: Siena (Italy)

Between the late 1940s and early 1950s, rapid and largely unplanned expansion took place in Siena. This even saw the construction of buildings close to the medieval walls. Driven on by mass motorisation, the situation quickly became unsustainable. Siena, which was one of very few Italian cities to have kept its medieval alleys and narrow streets, became one of the very first cities to push back against this trend.

In July 1962, the mayor Ugo Bartalini prohibited parking and most types of traffic in the upper ring of Piazza del Campo, whilst also limiting the circulation of tourist buses. This was one of the first concrete measures taken to restrict traffic in Italy. Yet the problem of cars in historic centres was not only felt in Siena or Italy, but in all of Europe. In many places, it was necessary to prevent general traffic from crossing historic centres, whilst allowing limited local circulation.

Back in Siena, the year of 1965 saw a decisive council intervention. A new project for traffic regulation in the city centre was launched that was based on two key principles:

- Establish a central area reserved for pedestrians;
- Prevent the flow of through traffic in the historic centre, and instead create two separate circulation loops, one to the north and one to the south.

After a change in local government, partial access was again granted to through traffic in September 1966. However, the creation of the pedestrian area was not called into question. Indeed, over the following years the area began to expand.

In August 1972, a new mayor extended the pedestrian zone and prohibited vehicle entry into the city centre, resuming a course that has continued to this day.

In the 1980s and 1990s, the Limited Traffic Zone (LTZ) was extended to almost all of the historic centre. This was then divided into circulation and parking areas reserved for residents only. For residents, the only group allowed to park in the centre, a permit was re-

quired that cost 50,000 lire a month, a high amount at the time. This revenue was then allocated to cover increased public transport spending. Again, this was an innovative experiment at national level. Interchange parking facilities were also constructed in the suburbs, which led to the creation of a minibus network.

Since 1990, the Municipality of Siena has been running a minibus service in the heart of the city called "Pollicino". Operated together with the transport company Train, this provides access to the city's narrow streets. The city's various park and ride facilities act as the starting points for its journeys.

5.2 Offering alternatives in view of vehicle regulations: Madrid (Spain)^{26 27}

In the past few years, Madrid has struggled with problems such as air pollution and heavy traffic. To tackle these issues, Madrid plans to reduce the number of cars in the city and to promote public transport and active mobility modes, with new mobility services also forming part of this plan. For instance:

- The BiciMAD bike-sharing scheme provides 2,028 electric bicycles at 165 stations across the city centre. The bicycles are available throughout the year.
- The electric car-sharing providers, emov and Car2Go, now have 160,000 and 166,000 subscribers respectively. Altogether, their fleet exceeds 1000 electric cars.

The measures include:

- reducing the space dedicated to cars in favour of more sustainable modes;
- issuing parking permits related to pollutant levels;

²⁶ <https://www.h3bconnected.com/now-for-plan-a/>

²⁷ https://www.madrid.es/UnidadesDescentralizadas/Sostenibilidad/CalidadAire/Ficheros/PlanAire&CC_Eng.pdf

- setting public transport prices that are affordable for all members of society; and,
- introducing alternative modes whilst removing parking.

Madrid is actively encouraging a shift to cycling. It has doubled the number of shared bikes and extended docking stations beyond the M30 ring road for the first time.

EMT, the public transport operator for Madrid, is seeking to position itself as a provider of the sustainable mobility services of the future. The city has created its own Mobility as a Service (MaaS) application, MaaS Madrid, which aims to provide high-quality and real-time information on public transport and additional travel services in the Spanish capital.

The MaaS Madrid smartphone application brings all of the mobility service providers operating in Madrid together on a single platform. With the new app, the city of Madrid aims to position itself as a pioneer in shared mobility and multimodal transport. The app forms part of measure 21 of Madrid City Council's Plan A for Air Quality and Climate Change, which supports shared and multimodal mobility initiatives.

Launched in spring 2018 the MaaS Madrid app provides users with different, more efficient and eco-friendly ways to travel across the city. It contains georeferenced information, allowing users to identify all of the mobility services available in their surroundings. Initially, it will contain public transport and the sharing services Bicimad, Car2Go, Emov, Zity, Muving, eCooltra, loscoot, Obike and OFO. It will also facilitate access to taxi services. EMT will gradually introduce more features, such as route planning and comparisons, more customisation options, and the ability to book seats and tickets.

By selecting the origin and destination of their journeys in the "MaaS Madrid" app, users will be able to visualise a range of options tailored to their preferences – the fastest, the cheapest, the least polluting trip etc. – and reserve all of the necessary tickets, be it through the app itself or via the service providers.

Gradually other services will be incorporated, such as the station-based car subscription services Respiro and Blumove. EMT is working with these providers to differ-

entiate them technically from free-floating car sharing schemes. EMT is open in its approach and invites further companies to join the system.

In addition to serving the citizen, the city and the different operators that participate regard the tool as an opportunity to develop their services and to extend public-private collaboration further. Ultimately, it might even lead to a new model of urban mobility.

EMT also operates an extensive open data portal, providing statistical, dynamic and real-time data about the different services it provides (bus, public bike, mobility, parking etc.), as well as instructions on how to integrate this data with your own applications.

5.3 Tolling for infrastructure investments: Trondheim²⁸ (Norway)

Trondheim is one of the Norwegian cities that has over a decade's experience of using revenue from a congestion charge to invest in transport infrastructure and operation. The results have proven positive, and the city has negotiated its third package of measures.

In 2008, Trondheim was a city beset by traffic problems and lacked funds to build new infrastructure. In the same year, the Norwegian parliament adopted new targets to make Norway climate neutral by 2030. Local politicians in Trondheim decided to take action. Half of the city's greenhouse gas emissions were related to transport. Traffic had to be reduced. The City of Trondheim decided to set up a cross-administrative project involving Trondheim Municipality, South-Trøndelag County Authority, and the National Road Authority. The Green Partnership Agreement was born. Miljøpakken or Greener Trondheim is a partnership for sustainable transport. Its main goal is to cut greenhouse gas emissions through a suite of measures that includes reducing car traffic. At the same time, Trondheim is gaining some 3,000 new inhabitants every year. The corresponding

²⁸ ThinkingCities, October 2016

growth in transport demand must in practice be covered by walking, cycling or public transport.

The summer of 2008 already saw the first measures being implemented, with bus lanes established in the city centre. The effects were immediate. Buses arrived at their destinations more quickly and car traffic was reduced. The Norwegian parliament approved Miljøpakken in 2009. This gave Trondheim the possibility to receive financial support from the state towards implementing the programme. The most controversial measure was the reintroduction of a toll system with double charging for rush-hour traffic. Half of the income from the toll system goes to improving the road network, whilst the other half goes to developing green transport solutions. The transfer of funds from motorists to those who use environmentally friendly forms of transport was an explicit policy goal.

To date, the results have been impressive. The number of car trips has fallen from 58% to 52.9%. Traffic measured at the city's toll stations is 17% lower today than in 2010. Use of public transport is up by 60% since 2008. The number of cyclists commuting to and from the city centre has increased by 50% since 2010. The number of people walking to and from the city centre has increased by 28% since 2010. Last but not least, local air quality is better now than it has been in 20 years.

Proposing Miljøpakken was a brave move from local politicians. Although these restrictive measures were unpopular as at the beginning, a recent survey conducted by a local newspaper showed that public opinion has turned in favour of these measures.

Subject to legal confirmation after a specific period, Miljøpakken has entered its third phase in 2017. Trondheim signed the first Urban Environment Agreement among Norwegian cities. This agreement between the national and local authorities will bring more financial resources for green mobility in Trondheim.

6. List of references and links

6.1 Key sources

EU-wide Website on Urban Vehicle Access Regulations: www.urbanaccessregulations.eu

<http://www.eltis.org/resources/tools/study-urban-logistics-integrated-perspective>

https://ec.europa.eu/transport/sites/transport/files/themes/strategies/doc/2011_white_paper/white-paper-illustrated-brochure_en.pdf

<https://civitas.eu/content/civitas-insight-06-access-regulations-facilitate-cleaner-and-better-transport>

TOWARDS AN ASSESSMENT OF LIVABILITY IN THE ZTL: REVERSING THE TRAGEDY OF THE COMMONS OF THE HISTORIC CITY CENTER - THE CASE STUDY OF BRESCIA
By Michelle Mary DeRobertis, University of Brescia.

6.2 Guidance

<http://www.eltis.org/discover/case-studies/stockholm-achieving-sustainable-mobility-using-urban-vehicle-access>

NOVELOG guidelines for the Planning and Development of Sustainable Urban Logistics Plans (SULPs)

<https://civitas.eu/content/civitas-insight-06-access-regulations-facilitate-cleaner-and-better-transport>

<http://www.trafficintowns.org/>

6.3 Best practice

http://www.toscananovecento.it/custom_type/1965-la-chiusura-al-traffico-del-centro-storico-di-siena/

Berlin:
https://www.berlin.de/senuvk/umwelt/luftqualitaet/umweltzone/download/touristeninfo_en.pdf

Rotterdam:
<https://www.rotterdam.nl/loket/documentenkcc/OVVmanualRegistrationExemptions.pdf>

<http://www.eltis.org/discover/case-studies/giving-back-public-space-pedestrians-and-cyclists-vitoria-gasteiz-spain>

A ; Szarata et al, 2017, The impact of the car restrictions implemented in the city centre on the public space quality – available through *Sciencedirect*

<https://www.london.gov.uk/get-involved/mayor-london-draft-strategies-and-consultations>

http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2018/05/Oslo_Climate_Budget.pdf

7. Glossary

Congestion Charge (CC): The charge for driving a vehicle within a charging zone. It aims to reduce congestion within a specific area.

Cordon based UVARs: Vehicles are charged as they passed the boundary of an area. This is opposed to “area-based” where all movements within the zone are charged, which may vary by time of day, direction of travel, vehicle type and location. There can be a number of cordons with different rules/fees (EC, 2017).

Functional Urban Areas (FUAs): A Functional Urban Area consists of a city and its commuting zone; they therefore consist of a densely inhabited city and a less densely populated commuting zone whose labour market is highly integrated with the city (OECD, 2012).

Limited Traffic Zone (LTZ) Urban areas where access is regulated by other methods than payment or emissions (retrieved from <https://urbanaccessregulations.eu>).

Low-Emission Zones (LEZs): LEZs are areas where access is regulated by vehicle emission. The most polluting vehicles are regulated, and usually this means that vehicles with higher emissions cannot enter the area (retrieved from <https://urbanaccessregulations.eu>).

National Access Points (NAP): A NAP is a mechanism for accessing, exchanging and reusing transport related data, established under the ITS (Intelligent Transport Systems) Action Plan and Directive (EC, 2010).

Permeability: For the purpose of this Topic Guide, permeability describes the extent to which urban forms permit (or restrict) movement of vehicles in different directions.

Push and pull measures: Measures that persuade and incentivise sustainable behaviour are combined with measures that actively prevent undesired behaviour.

Quiet zone (Q-zones): An area where a low level of traffic noise is guaranteed by the reserving access only for low-noise vehicles. (Retrieved from <http://www.city-hush.eu/results.html>).

Single Digital Gateway (SDG): The Single Digital Gateway will provide easy online access to the information, administrative procedures and assistance services that citizens and businesses need to get active in another EU country (EC, 2016).

Superblocks. A superblock is a geographical space that covers several city blocks. Vitoria-Gasteiz has used the superblock model: Private cars and public transport are kept outside of the superblocks, and the inner streets are redesigned mainly for pedestrian use.

Ultra-Low-Emission Zones (ULEZ): Ultra-Low-Emission Zone is the terminology used in London for a Euro 6/VI diesel, Euro 4 petrol LEZ. In Germany, these have been termed ‘diesel bans’, and in Belgium as a later phase of the LEZ.

Urban Vehicle Access Regulations (UVARs): These are measures that regulate vehicular access to urban infrastructure (EC, 2013).

Toll Ring: Toll rings are the application of highway tolling schemes that are similar to a cordon but generally applied to regulate access to the entire city. This solution has been implemented in Singapore and in many Norwegian cities. As in the cordon-based schemes, flexibility is a key feature. (EC, 2017).

Zero-Emission Zone (ZEZ): A LEZ where only zero-emission vehicles (ZEVs) are allowed.

